General Surgery
Examination and Board Review

• More than 700 questions with detailed answer explanations
• Case-based approach sharpens clinical decision-making skills
• Topics mirror the certification exam outline
• Excellent prep for both written and oral exams

ROBERT B. LIM
DANIEL B. JONES
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General Surgery Examination and Board Review

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This book is dedicated to my amazing wife, Lisa. She has given me the strength and grace to pursue a project like this.

—RBL

And to my better half, Stephanie.

—DBJ
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Introduction

Are you a medical student gunning for High Honors or an intern trying to do well on your ABSITE examination? This review book prepares both the medical student and resident for success.

The casebook covers basic diseases and operations and the fundamental principles you just need to know. Relevant anatomy and basic surgical treatment options are the basis of clinical questions. The casebook makes it easy to recall important facts and relationships.

Read the casebook before walk rounds, teaching rounds, and lectures. In a few minutes, you will be ready for the operating room. In just a few weeks you will get through the entirety of the casebook.

Please enjoy and have fun learning.

Daniel B. Jones, MD
Preface

I am very honored to be an editor for this book. That at I would be involved in surgical education probably comes as a complete shock to those who knew me as a resident and medical student. It’s not that I didn’t value the importance of learning the scientific details of disease processes but I was more drawn to the romance and art of operating and actually touching surgical disease. As I gained experience, I realized the greatest times in my career were when the science and art met to cure a patient or answer a clinical dilemma. That is inspired me to seek out more information and attempt to solve more clinical scenarios.

But the amount of knowledge required for General Surgeons is enormous and the amount of questions it raises seems to grow daily. For the surgeon to be able to address these questions, he or she needs to have a mastery of the basics. That is book was created to give its readers a huge vault of knowledge that will prepare him or her for Board Certification and set them up for success in clinical practice. With that, they will more likely be able to see the art and science of surgery combined to result in better overall outcomes.

Robert B. Lim, MD
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SECTION 1
General Surgery
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A 54-year-old male presents to his perioperative appointment to undergo elective inguinal hernia repair. The patient has a BMI of 38 with a height of 72 in (1.83 m) and a weight of 127 kg (280 lb). He has a history of hypertension currently being managed with a calcium channel blocker. His wife reports increasing snoring at night with noticeable gasps for air when lying supine. Patient denies increasing daytime drowsiness. He has no history of prior surgeries and no family history of complications with anesthesia.

On physical exam, he has a neck circumference of 44 cm and a Mallampati score of 3. No cardiovascular or respiratory abnormalities are observed. His abdomen is obese with no evidence of caput medusa. Right inguinal ring weakness palpated on exam.

1. Which of the following is NOT a criterion for obesity hypoventilation syndrome (OHS)?
   A. Obesity (BMI > 30 Kg/m²)
   B. Neck circumference of > 48 cm
   C. Daytime hypoventilation
   D. Hypercapnia with PaCO₂ > 45 mm Hg
   E. Hypoxia with PaO₂ < 70 mm Hg

2. Which of the following is true regarding OSA in the perioperative and intraoperative evaluation and management of this patient?
   A. The patient has 2 out of 3 risk factors for OSA and therefore does not require polysomnography.
   B. Face mask pre-oxygenation will create a higher tidal volume than nasal prongs.
   C. The Mallampati score of 3 is not a risk for a difficult intubation.
   D. The critical closing pressure of this patient's airway is higher than non-OSA patients.
   E. The patient should be placed in the Trendelenburg position.

3. What is the patient ideal body weight based on the JD Robinson formula?
   A. 75 kg
   B. 98 kg
   C. 64 kg
   D. 106 kg
   E. 86 kg

4. Which of the following would be the best option for a paralytic agent in this patient?
   A. Vecuronium
   B. Cisatracurium
   C. Rocuronium
   D. Pancuronium
   E. Atracurium

5. Which of the following is true regarding the post-operative management patients with suspected OSA?
   A. The patient should be placed in the supine position while recovering to protect the surgical site.
   B. CPAP should be immediately available for use in postoperative patients with known or suspected OSA.
   C. Opioid dosing should be based on TBW rather than IBW.
   D. The use of thoracic epidural post-operatively is contraindicated in OSA patients.
   E. Use of CPAP post-operatively could increase the risk of complications.
ANSWERS

1. B. Patients with a neck circumference of > 48 cm have a high probability of developing obstructive sleep apnea (OSA); however it is not a criterion for OHS. OHS results in hypoventilation and hypoxemia due to the obesity, while OSA is the blockage of airway that occurs during sleep. Many obese patients have both. Patients with OHS are at a higher risk for perioperative morbidity and mortality. These patients are at a higher risk of airway collapse, blunted central respiratory stimulation, and pulmonary hypertension therefore placing these patients at a higher surgical risk.

   Criteria for OHS:
   a. Obesity (BMI > 30 kg/m²)
   b. Serum bicarbonate > 27 mEq/L
   c. SpO₂ < 93%
   d. ABG demonstrating hypercapnia PaCO₂ > 45 mm Hg and hypoxemia PaO₂ < 70 mm Hg
   e. An alternative cause of hypoventilation cannot be identified

2. D. If the surgery is elective, is likely to require large doses of anesthetic agent or opioids intraoperatively, and if there is a high suspicion of undiagnosed OSA in the perioperative period, it should be postponed with imminent evaluation and treatment as needed preoperatively. Evidence has shown that pre-oxygenation via nasal CPAP mask is superior to face mask oxygenation, despite potential air leaks if the mouth is allowed to be open. Nasal CPAP increases the pressure gradient between the nasopharyngeal and oropharyngeal cavities pushing the soft palate and tongue forward and therefore opening the airway; whereas the positive pressure through the face mask will induce an obstruction. Mallampati score of 3 includes visualization of the soft palate and base of uvula. Mallampati scores of 3 and 4 demonstrate difficulty intubation; however they cannot predict difficulty of BVM ventilation.

   The upstream pressure of the pharynx at which air entry/flow ceases is considered the critical closing pressure. The pressure can be increased by increase in lateral pillar fat pads compressing the airway, sleep resulting in muscle relaxation or induced by anesthesia. The ideal positioning for a patient with OSA is the ramped position of intubation or the lateral recumbent, if possible and in reverse Trendelenburg position to ease ventilation, increase total lung capacity, and decrease the longitudinal tension on the upper airway.

3. A. JD Robinson formula states:
   Man: 52 Kg (115 lbs) + 1.9 Kg (4.2 lbs) per inch over 60 in;
   Woman: 49 Kg (108 lbs) + 1.7 Kg (3.7 lbs) per inch over 60 in.

   This calculation is useful in this patient to determine optimal paralytic, anesthetic, and opioid dosing as well as mechanical ventilation control intraoperatively and post-operatively as needed.

4. C. All non-depolarizing neuromuscular blockers act by antagonizing the acetylcholine receptor in a
reversible/competitive manor. A rapid onset, short acting non-depolarizing agent would be the best option in this patient. Out of the options listed Rocuronium has an onset of 45 to 60 sec and duration of 30 to 60 min and would be the most ideal. Also obesity has not been found to alter the pharmacokinetics of Rocuronium and therefore can be dosed on IBW or actual body weight. Pancuronium is the longest acting and is used in patients that require paralysis > 1 hr and in patients with normal hepatic and renal function. Cisatracurium and atracurium undergo Hof man elimination with an onset of 1 to 2 min and are intermediate acting. These agents would be recommended in patients with renal or hepatic insufficiency. Vecuronium is also an intermediate acting NMBA and would be recommended in patients with cardiovascular disease as it has the least adverse side effect profile. Prolonged duration of paralysis can occur when using actual body weight in dosing atracurium and vecuronium. Avoidance of prolonged paralysis or large doses of longer acting neuromuscular blockers is key.

5. B. CPAP should be available for patients in the immediate post-operative period if OSA is known or suspected. If OSA is suspected, introducing CPAP in the immediate post-operative period can induce anxiety due to the discomfort of the mask and confusion from the remaining sedatives on board. The proper positioning for optimal airway patency is in the upright and lateral decubitus position if possible. Opioid dosing should be based on IBW rather than TBW due to potential for prolonged duration of action with TBW in obese patients resulting in suppression of respiratory drive and decrease pharyngeal muscle stimulation. The use of a post-operative epidural can be beneficial in patients undergoing a large abdominal operation at risk for requiring large doses of opioids for pain control. The use of CPAP in the post-operative period has not been shown to increase complications, specifically the positive pressure ventilation has not been proven to increase leak rates in bariatric surgery patients.

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Oto et al. Continuous positive airway pressure and ventilation are more effective with a nasal mask than a full face mask in unconscious subjects: a randomized controlled trial. Critical Care. 2013;17:1–11.


A 59-year-old female with poorly controlled hypertension on three antihypertensive medications including a beta-blocker, angiotensin converting enzyme inhibitor, and a calcium channel blocker, presents for a routine surgery. At her preoperative visit, she is instructed to hold her home ACE inhibitor the day of surgery. She then undergoes an otherwise uncomplicated cholecystectomy with intraoperative cholangiogram. However, in the postoperative care unit, she develops hypertension with readings of 200/140. Her other vital signs are within the normal range. The anesthesia provider performs an eye exam and notes papilledema. Nitroprusside is administered IV for treatment.

1. Regarding the immediate management of this patient’s malignant hypertension, which of the following is correct?
   A. Goal BP is reduction to normal rage of SBP < 120, DBP < 80 as soon as possible to prevent stroke.
   B. Reduction of DBP to 100-105 over 3 hours with maximum fall in BP by 25% over 24 hours is needed to prevent stroke.
   C. Heart rate control is acutely needed to prevent worsening cerebral edema.
   D. Blood pressure should be maintained at current elevated levels.

2. Regarding malignant hypertension, which of the following is a clinical sign of this diagnosis?
   A. Blood pressure > 150/110
   B. Papilledema

3. Regarding the medication nitroprusside, which of the following is a feared side effect with excessive use?
   A. Cyanide toxicity
   B. Tremor
   C. Stroke
   D. Myocardial infarction
   E. Angina pectoris

4. Regarding medications to treat malignant hypertension acutely, which of the following is most likely to cause reflexive tachycardia?
   A. Labetolol
   B. Hydralazine
   C. Metoprolol
   D. Clevidipine
   E. Fenoldapam

5. Regarding underlying causes of poorly controlled hypertension, which of the following is the most likely cause in this patient?
   A. Pheochromocytoma
   B. Cushing’s syndrome
   C. Renal artery stenosis
   D. Thyroid storm
   E. Glomerulonephritis
ANSWERS

1. **B.** The goal in malignant hypertension is reduction in DBP to 100-105 with maximum fall in by 25% of highest BP value over 24 hours. T is slow decrease prevents reflexive vasoconstriction via normal body auto-regulatory mechanisms leading to stroke. Reduction of blood pressure to the normal range increases the risk of stroke and is not recommended.

Heart rate control is not a main goal of care in malignant hypertension. The mechanism of cerebral edema is felt to be overcoming the body’s auto-regulatory mechanism of vasoconstriction with increase in MAP allowing for a relatively constant end organ perfusion pressure. When BP increases above 180 systolic, auto-regulatory vasoconstriction fails, and vasodilation is seen leading to an increase in blood flow to the brain. BP control, not heart rate, prevents cerebral edema by reducing cerebral perfusion pressure (intracranial pressure – mean diastolic pressure) and permitting auto-regulation thus reducing end organ damage.

2. **B.** Malignant hypertension is defined by blood pressure > 180/120 with signs of cerebral edema and/or end organ damage. Cerebral edema is characterized by clinical signs of brain swelling. Papilledema is the most worrisome sign. However, retinal hemorrhages and retinal exudates are indicative of hypertension causing damage to arterioles and capillary beds. Other end organ findings include acute kidney injury, myocardial infarction, aortic dissection or bowel ischemia.

Tachycardia is not a criterion for diagnosing malignant hypertension. Tachycardia is commonly seen in postoperative patients and could be attributed to catecholamine release from the stressors of surgery, pain, intravascular depletion, medications, arrhythmias, and/or atelectasis. Its presence necessitates close observation and thorough work-up.

3. **A.** Nitroprusside is an arterio-venous dilator that has rapid onset and short half-life. It, as well as fast acting medications like clevidipine, nicardipine, labetalol, and fenoldapam, are used for acute treatment of hypertension. With over administration of nitroprusside, cyanide toxicity can develop as this medication contains cyanide groups (carbon triple bonded with nitrogen). Cyanide toxicity is detrimental to aerobic metabolism at the cellular level by inhibiting the last enzyme in oxidative phosphorylation, cytochrome oxidase (a3). Cyanide toxicity can present with headache, nausea, emesis, and flushing, hepatic and/or renal failure. T e treatment of cyanide toxicity is multimodal and includes sodium nitrite, hyperbaric oxygen, and sodium thiosulfate.

Tremor is not a known side effect of nitroprusside, but hypereflexia is commonly seen in toxic levels of this drug leading to cyanide toxicity.

Stroke, myocardial infarction, and angina pectoris are not published side effects of nitroprusside. T ese are more characteristic of malignant hypertension itself due to end organ damage from capillary and arteriole damage to the heart.

4. **B.** Hydralazine is a direct arteriolar vasodilator. It has rapid onset and short half-life administered IV. It can commonly cause reflexive tachycardia by two mechanisms. Reflexive catecholamine release in response to vasodilation and decreased vascular resistance directly stimulates the cardiac myocytes by beta-1 adrenergic receptors leading to tachycardia. Additionally, due to decrease in renal blood flow, the juxtaglomerular apparatus secretes renin leading to increased aldosterone secretion. Aldosterone is a potent vasoconstrictor that decreases venous return. As a compensatory mechanism, heart rate increases to compensate and keep cardiac output constant (CO = HR × SV). Reflexive tachycardia is commonly seen in patients who are not concomitantly on beta blockers and angiotensin-converting enzyme (ACE) inhibitors.

Labetolol is both and alpha-1 and beta-1 antagonist. It has rapid onset and is ideal for patients with tachycardia and some hypertension. It does not cause reflex tachycardia due to inhibition of beta-1 receptors.

Metoprolol is a beta-blocker and will decrease heart rate. It is ideal in atrial fibrillation, with little efficacy in malignant hypertension.

Clevidipine is a dihydropyridine calcium channel blocker. It has rapid onset, very short half-life, and is administered intravenously. Because it works peripherally, it does not cause reflexive tachycardia.

Fenoldapam is a dopamine-1 receptor agonist. It commonly causes flushing and hypotension. It does not cause tachycardia because it works peripherally.

5. **C.** Renal artery stenosis is a common underlying cause of malignant hypertension and is frequently seen in Caucasians who have poor blood pressure control despite multimodal therapy. Renal artery stenosis can present as worsening azotemia in relatively young individuals, poorly controlled hypertension,
and/or malignant hypertension. It is diagnosed non-invasively via renal artery duplex and can be treated with renal artery stenting. However, this treatment is becoming more controversial given the recent publication of the CORAL trial (Hermann SM et al. 2013) arguing for medical management alone.

Pheochromocytoma is a catecholamine releasing tumor that can cause hypertension. It is usually episodic and can present with flushing, palpitations, diaphoresis, and other signs of catecholamine release. It is diagnosed clinically by history and urine VMA's.

Cushing's syndrome can cause hypertension due to cortisol excess, but is not as common as renal artery stenosis in malignant hypertension. Conn's Syndrome or hyperaldosteronism is the over production of aldosterone by the adrenal gland can also cause hypertension.

Thyroid storm typically presents with tachycardia. It is treated typically with nonselective beta-blockade and propylthiouracil (PTU).

Glomerulonephritis seen in nephritic syndrome can cause hypertension and renal failure. Additionally, both renal artery stenosis and malignant hypertension alone can cause renal failure. However, renal artery stenosis and not GN is associated with malignant hypertension.

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A 74-year-old female with COPD and a baseline oxygen requirement presented to the emergency department with subjective fevers, headache, and jaw claudication. Laboratory evaluation was notable for an erythrocyte sedimentation rate (ESR) of 56 mm/hr. A non-contrast CT of the head was obtained which revealed no acute pathology. The patient was admitted to the internal medicine service and started on high dose prednisone with a working diagnosis of giant cell (temporal) arteritis. During a temporal artery biopsy, an operating room fire occurs.

1. Which of the following is correct regarding operating room fires?
   A. Two of the three components of the classically described “fire triad” must be present for an OR fire to occur.
   B. The most common OR fire fuel is the monopolar electrocautery “Bovie”.
   C. An oxidizer enriched atmosphere often exists in the entire operating room.
   D. Alcohol containing prep solutions need to be completely dry before starting a procedure.
   E. Fiberoptic light sources for endoscopic surgery do not serve as an ignition source.

2. Which of the following is correct regarding this scenario?
   A. Surgery on the head and neck should be identified preoperatively by the surgeon and anesthesiologist as “low risk”.
   B. Intraoperative communication between the surgeon and anesthesiologist is not needed in a case of expected short duration.
   C. Sedation with open gas delivery device would be preferred to general endotracheal anesthesia in this patient to prevent an OR fire.
   D. Surgical drapes should be configured in a manner as to minimize the accumulation of oxidizers.
   E. Moistening surgical sponges has no impact in preventing an OR fire.

3. In the event of fire involvement of the airway or breathing circuit, the best first step is to:
   A. Stop the flow of all gases to the airway.
   B. Remove all fuels from the airway.
   C. Activate fire alarm.
   D. Perform fiberoptic bronchoscopy with the endotracheal tube in place.
   E. Pour saline into the airway.
1. D. In order for a fire to occur, all three components of the “fire triad” must be present. These include fuel, and oxidizer, and an ignition source. Fuel for fire is plentiful in the operating room. Some examples include drapes, patient’s hair, surgical gowns, blankets, endotracheal tubes, and laryngeal mask airways and volatile surgical compounds (e.g., alcohol containing prep solutions, acetone, etc.). It has been shown that alcohol containing prep solutions with as little as 20% alcohol can ignite with diathermy or hot wire cautery and so they must be allowed to dry before surgical electricity is used. Oxidizers in the operating room are generally either oxygen or nitrous oxide. These oxidizers can accumulate and form an oxidizer enriched atmosphere in closed or semi-closed breathing systems and from tenting of surgical drapes. Ignition sources in the operating room are equally as plentiful. Some common examples include electrosurgical devices, heated probes, lasers, fiberoptic light cables, argon beam coagulators, drills and defibrillator pads.

2. D. According to the American Society of Anesthesiologists 2013 Task Force on operating room fires, an endotracheal tube or LMA should be considered in patients undergoing moderate to deep sedation or that have a baseline oxygen requirement. Head and neck surgery should be considered “high risk” for an OR fire and as such, communication between the surgeon and the anesthesiologist is mandatory regardless of the length of the procedure. Surgical drapes should be arranged to prevent an accumulation of oxidized air. Moistened surgical sponges can help prevent OR fires.

3. A. Immediate actions to be performed in the event of an airway fire include first removing the endotracheal tube or LMA, then stopping the flow of ALL gases, removal of fuel sources away from the airway, and pouring saline into the airway. Once the fire has been extinguished, actions should include ventilation of the patient while avoiding oxidizer-enriched environments, inspection of the tracheal tube or LMA to ensure no fragments remain in the patients airway, and consideration of bronchoscopy. Bronchoscopy is a relatively safe procedure in experienced hands in diagnosing inhalational injury but is not part of the immediate management of an airway fire.

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The patient is a 37-year-old female without any significant past medical history undergoing a laparoscopic partial right hepatic lobectomy for a large symptomatic hepatic adenoma in segment VI of the liver. Endotracheal intubation is performed without complication and the abdomen is entered via the Hassan technique. The lesion is identified on the inferomedial aspect of segment VI. To dissect the lesion away from the liver parenchyma, an argon beam coagulator is used. Two hours after the start of the procedure, there is an abrupt decrease in the patient's ETCO$_2$ from 30 to 10 mm Hg and spO$_2$ from 100% to 40%. This is rapidly followed by a decrease in arterial blood pressure to 60/25 mm Hg and heart rate from 80 to less than 20.

1. Why is the argon beam coagulator used over other types of electrocautery?
   A. The flow of gas clears the site of fluids and blood, enhancing visibility.
   B. Rapid non-contact uniform tissue coagulation over a large area
   C. Less adjacent tissue damage from reduced depth of penetration
   D. Less generation of surgical smoke
   E. All of the above

2. What was the most likely cause of this patient's decrease in ETCO$_2$ and arterial blood pressure?
   A. Acute myocardial infarct
   B. Decreased venous return secondary to pneumoperitoneum
   C. Aspiration
   D. Gas embolism
   E. Severe cerebral vascular accident

3. What is the most important factor associated with an increased risk of venous gas embolism when using argon beam coagulation?
   A. Use under pneumoperitoneum
   B. High flow rate of argon gas
   C. Holding the tip of the electrode at a right angle to the tissue
   D. Placing tip of argon beam electrode in direct contact with tissue surface

4. What steps can be taken to reduce these risk factors?
   A. Never place the electrode tip less than several millimeters from the surgical site.
   B. Limit argon flow settings to lowest level that provides the desired clinical effect.
   C. Move the hand piece away from the tissue after each activation.
   D. Flush abdominal cavity with CO$_2$ between extended activation periods of use.
   E. All of the above

5. What would be your next step in management of this patient?
   A. Continue the surgery.
   B. Administer atropine and initiate vasopressors.
   C. Discontinue pneumoperitoneum and place patient in Durant's position.
   D. Perform emergent TEE to diagnose a gas embolism.
   E. Begin immediate volume resuscitation.
ANSWERS

1. E. Argon beam coagulation has gained popularity among surgeons as a useful tool to achieve hemostasis in bleeding surfaces of highly vascularized organs such as the liver and spleen. It utilizes a monopolar electrode to partially ionize a stream of argon gas that is directed towards the tissue for coagulation. The ionized argon beam acts as an efficient pathway, conducting a high-frequency electric current from the electrode to the target tissue resulting in a fine spray of electrical sparks.

As the electrical beams directed from the electrode to the target tissue cause desiccation, the electrical conductivity of the target tissue is lost. If continually applied, the beams automatically move to nearby non-desiccated and still electrically conductive tissue allowing for rapid uniform coagulation over a large area without any tissue contact. Furthermore, as a result of the loss of electric conductivity at a treated site, the depth of penetration of the electrical energy is reduced. This, coupled with the fact that the use of argon gas, due to its inert nature, neither carbonizes nor vaporizes biologic tissue so that the thermal effects are limited, results in less adjacent tissue damage.

2. D. With use of the argon beam coagulation system in laparoscopic procedures, the argon system acts as a secondary source of pressurized gas and argon can accumulate in the closed peritoneal cavity. With damage to any significant blood vessels, the gas under pressure can enter the vasculature posing a risk of embolism that could be a mixture of both argon and carbon dioxide. Moreover, the argon gas stream that flows between the electrode and the tissue can cross any disrupted mucosal membrane surface and be flushed directly into the microvasculature.

Although argon is physiologically inert, it is 17 times less soluble than carbon dioxide (0.029 versus 0.495 ml gas ml\(^{-1}\) blood) and as such, argon-rich emboli are not as readily absorbed from the blood stream as CO\(_2\) and may pass into the systemic circulation. At the standard flow setting of 4 L/min used typically for hemostasis in highly vascularized organs, the argon beam electrode can produce 67 ml of gas in only one second which, if embolized, can lead to significant cardiopulmonary dysfunction and be potentially lethal in an average size adult. Furthermore, at such a high flow rate argon gas clearly exceeds pressure in the venous system and can embolize not only through major veins but also through small peripheral veins.

3. D. The first few cases of venous embolism with use of the argon beam were reported during laparoscopic procedures and therefore, the theory of over-insufflation and over-pressurization of the abdominal cavity caused by the accumulation of argon gas under pneumoperitoneum was thought to lead to these embolic events. However, given that venous emboli have occurred in several cases of patients undergoing procedures without pneumoperitoneum, this theory cannot fully explain the incidence of these events. Ikegami et al. (J Hepatobiliary Pancreat Surg. 2009;16(3):394–8) compared seven reported cases of venous embolism using argon beam coagulation and identified the following risk factors:

1. Using the argon gas under pneumoperitoneum;
2. Puncturing the liver parenchyma (hepatic needle biopsy);
3. Possible injury to the hepatic venous system; and
4. Placing tip of argon beam electrode in direct contact with tissue surface.

On review of the literature, it appears that more important than the issue of use under pneumoperitoneum is that of placing the tip of the argon beam electrode in close or direct contact with the tissue that is being treated. Multiple cases have been described, without the use of pneumoperitoneum, where this is clearly the issue and in the series described above, though only three cases described this, it is possible that more might have had this condition and simply not reported.

When used at flow rates of 0.2 to 2 L/min and a power of 20 to 80 W as described in the field of interventional pulmonology for ablation of small lesions, the argon beam system can penetrate the tissue up to 5 mm in depth. However, when used for the purpose of hemostasis in highly vascularized tissues such as the spleen or hepatic parenchyma, a flow rate of 4 L/min and power of 150 W is typical. This allows for even further penetration and when coupled with direct surface contact could allow for vessel damage and for the argon gas to be flushed directly into the venous system.

4. E. The cautions of the manufacturer include:

1. Never place the electrode tip less than several millimeters from the surgical site.
2. Limit argon flow settings to lowest level that provides the desired clinical effect.
3. Hold the tip of the electrode at an oblique angle.
4. Move the hand piece away from the tissue after each activation.
5. Flush abdominal cavity with CO\textsubscript{2} between extended activation periods of ABC.
6. Always leave one instrument cannula open to the atmosphere.

Another recommended tip is the use of a venting port at all times when operating laparoscopically and using surgical energy. This will allow gas to escape but maintain a pneumoperitoneum.

5. C. In conjunction with appropriate cardiac resuscitation according to ACLS guidelines if indicated, the treatment of a patient suspected of having a CO\textsubscript{2} or any gas embolism should include immediate discontinuation of CO\textsubscript{2} insufflation. The patient should be placed in Durant’s position (left lateral decubitus with steep head down). This allows the gas to rise into the apex of the right heart, preventing entry into the pulmonary artery and keeping it there until it slowly absorbs. Use of nitrous oxide inhalant should be discontinued to allow for hyperventilation with 100% oxygen to increase clearance of CO\textsubscript{2} or any other gas and to relieve hypoxemia. Volume expansion with bolus crystalloid may reduce further gas entry by elevating CVP. And lastly, placement of a central venous catheter for attempted aspiration of the gas from the right heart may also be performed. While a transesophageal echo (TEE) may be diagnostic in the event of a venous gas embolism, it is not a priority in the unstable patient with suspected gas embolism.

**BIBLIOGRAPHY**


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Advances in Laparoscopy

Robert B. Lim
A 32-year-old woman, with a body mass index of 30 kg/m², was admitted to the hospital with acute appendicitis. She was consented for a laparoscopic appendectomy. She had a previous surgical history of cesarean section.

Following the administration of general anesthesia, a curvilinear infra-umbilical skin incision was made. Blunt dissection was carried down to the fascia and the fascia was elevated and incised. Entry into the peritoneal cavity was confirmed visually and a Hasson trocar was inserted into the peritoneal cavity.

1. What is the safest technique to gain access to the peritoneum for laparoscopic surgery?
   A. Open technique (Hasson)
   B. Veress needle
   C. Direct trocar technique
   D. None of the above

2. Following insufflation, a 30° laparoscope was inserted. Upon general laparoscopic examination of the peritoneal cavity, it was apparent that a retroperitoneal hematoma was forming. What is the most commonly injured vessel during trocar placement?
   A. Iliac vein
   B. Inferior vena cava
   C. Aorta
   D. Lumbar veins
   E. Superior mesenteric vessels

3. Injury to a major vessel after trocar placement is usually signified by?
   A. Visible bleeding
   B. Retroperitoneal hematoma
   C. Bradycardia
   D. Hypoxia

4. The distance between the abdominal wall and the aortic bifurcation in normal weight women (BMI < 25 kg/m²) is?
   A. 1.5 cm
   B. 2.4 cm
   C. 3.5 cm
   D. 0.4 cm
ANSWERS

1. **D.** There have been many studies done comparing the safety of the open technique to the closed and direct entry techniques. There has been no obvious advantage of one technique over another. One large meta-analysis showed an incidence of vascular injury to be 0.44% in the closed cases compared to 0% in the open cases. Another large study compared the Veress, open and direct trocar techniques, and found a rate of vascular injury of 0.04%, 0.01%, and 0% respectively.

2. **A.** Vascular injuries may involve retroperitoneal, intraperitoneal or abdominal wall vessels. Rates of major vascular injury during initial trocar entry are between 0.05% and 0.5%. The sites of injury from most common to least common are iliac vein, greater omental vessels, inferior vena cava, aorta, pelvic and superior mesenteric veins, and lumbar veins. Injury to a major vessel is usually signified by visible bleeding and hemodynamic instability. If an injury is confirmed or highly suspected, especially in the retroperitoneum, convert to an open procedure and explore the area in question.

3. **A.** Vascular injury is usually diagnosed by direct view of bleeding in the abdominal cavity. The absence of free intraperitoneal blood caused by retroperitoneal bleeding may delay the diagnosis, because blood is not observed through the laparoscope. Clinical signs of hemodynamic instability (tachycardia, hypotension), shortly after needle or trocar insertion, suggest a vascular injury. High intraabdominal pressure secondary to pneumoperitoneum is associated with a decrease in venous return, which in turn, can reduce arterial bleeding. Furthermore, a retroperitoneal hematoma can decrease a vessel leak, restraining the bleeding.

Unfortunately, 15% to 50% of the vascular injuries are not diagnosed at the time of injury. The delay has contributed to mortality rates of 3% to 30% for vascular injuries.

4. **D.** A study by Hurd et al. (Obstet Gynecol. 1992;80(1): 48–51) that found that the distance between the umbilicus and the aortic bifurcation was 0.4 cm in normal weight women (BMI < 25 kg/m), 2.4 cm in overweight patients (BMI 25–30 kg/m) and 2.9 cm in obese patients (BMI > 30 kg/m). Lifting the abdominal wall may improve safety by increasing the distance between the abdominal wall and the viscera. Lifting the abdominal wall by placing towel clips within 2 cm of the umbilicus has been shown to provide significant elevation of the peritoneum (6.8 cm above the viscera) that was maintained during insertion.

BIBLIOGRAPHY


Ms. B is a 33 year-old female presenting to a general surgery clinic to be evaluated for a potential cholecystectomy. She has a history of periodic symptomatic biliary colic over the past nine months. Approximately 6 weeks ago, she was evaluated in the local emergency department for severe right upper quadrant pain. A right upper quadrant ultrasound showed no evidence of cholecystitis but did show multiple stones in the gallbladder. Her pain subsided with pain medications and IV fluids, and she was discharged from the emergency department with outpatient general surgery follow-up. Prior to this, she had had two additional episodes of intermittent right upper quadrant pain.

She is an otherwise healthy individual, only taking oral birth control medications and a multivitamin daily. Her body mass index is 26 kg/m². She has had no previous abdominal operations.

Her main concern is scarring that may result from a potential gallbladder operation, and she comes to you to discuss this.

1. **What is the most appropriate intervention to recommend at this time?**

   A. Standard laparoscopic cholecystectomy by general surgeon
   
   B. Single-incision laparoscopic (SIL) cholecystectomy by general surgeon with no experience in SIL
   
   C. Referral to specialty center for transvaginal Natural Orifice Translumenal Endoscopic Surgery (NOTES) cholecystectomy
   
   D. Ursodiol 8 to 10 mg/kg/day (in 2 divided doses daily)

2. The SIL approach is more technically demanding than standard multi-port laparoscopic surgeries, and requires additional specialized training. Which is the most relevant reason for the increased technical difficulty in SIL?

   A. Loss of triangulation
   
   B. Cramped external working space secondary to close proximity of instruments causing ergonomic difficulty
   
   C. Decreased field of view
   
   D. Reduced range of motion of instruments

3. A patient was referred to a surgeon within the same institution who is well-experienced in single incision laparoscopic cholecystectomy. When discussing the single incision approach with the patient, attention should be brought to which potential complication that may be seen more frequently in single-incision cholecystectomy compared to standard multi-port cholecystectomy?

   A. Significant bleeding complications
   
   B. Post-operative herniation
   
   C. Pain
   
   D. Surgical site infections

4. A patient with achalasia is expressing significant concerns over cosmesis. Which developing minimally invasive technique is considered an acceptable alternative to a multi-port laparoscopic Heller myotomy?

   A. Per-oral endoscopic myotomy (POEM)
   
   B. Single-port laparoscopic Heller myotomy
   
   C. Hand-assisted laparoscopic Heller myotomy
   
   D. Transvaginal NOTES myotomy
5. Which of the following is true regarding NOTES?
A. Safe access to the peritoneal cavity is generally not difficult to accomplish.
B. Effective management of iatrogenic intraperitoneal complications are easily recognized.
C. Effective training requirements are well established.
D. Most new equipment have multitasking platforms to accomplish procedures.

ANSWERS

1. A. Multi-port laparoscopic is considered the gold standard approach to cholecystectomy, compared to open approach, given equivalent serious complications, improved cosmesis, improved pain and decreased length of stay. Particularly considering the patient's concerns regarding cosmesis, an open approach would not be appropriate in this case.

Ursodiol does not exert an influence on symptomatic gallstones that is nearly as efficacious or durable compared to cholecystectomy. Particularly considering this patient is a very low risk surgical candidate, cholecystectomy is the correct approach.

Although there have been a number of large series published regarding intra-abdominal natural orifice transluminal endoscopic surgery procedures (NOTES; the majority of which are transvaginal cholecystectomy), NOTES procedures require highly specialized training, specialized technology and mastery of the flexible endoscope. A rigorous randomized controlled trial comparing NOTES cholecystectomy to standard laparoscopic cholecystectomy is underway and nearing completion (NCT01171027).

Furthermore, the vast majority of clinical NOTES transvaginal cholecystectomy cases reported were hybrid cases, with at least one laparoscopic port. In the absence of rigorous comparative data regarding NOTES cholecystectomy to the standard of care, it would be premature to recommend this as the best treatment option available.

Finally, there is a definite learning curve to single incision cholecystectomy. One particular study demonstrated a learning curve of about 25 cases, with the majority of major complications, including conversion to standard or open cholecystectomy, to occur in the first 10 cases. Given this, despite the patient’s concerns regarding cosmesis, the safest and most appropriate option presented would not be a single incision cholecystectomy by a surgeon who had never performed that procedure before, but a multi-port laparoscopic cholecystectomy by a general surgeon.

2. B. Given the instrument ports in single-port laparoscopy (SIL) surgery are in such close proximity to each other, the surgeon must utilize laparoscopic devices which are, in essence, operated in parallel, causing difficulty in triangulation and awkward operating postures. Curved instruments are commercially available providing some limited triangulation. The close proximity of the laparoscopic instruments, often requiring a crossing of the devices, is considered the most challenging aspect of SIL in comparison to a multi-port approach. Furthermore, given the camera can only be placed in one anatomical position (umbilicus), it can create a decreased field of view compared to multi-port access. In the same regard, given the instruments are relegated to a single anatomical position, the range of motion of the instruments can at times be compromised compared to a multi-port approach, but these latter two reasons are considered less significant and encountered less frequently than the ergonomic difficulties of SIL.

It has been proposed that robotic single-incision laparoscopic techniques may overcome the ergonomic difficulties of current SIL procedures.

3. B. A recent meta-analysis performed demonstrated that there were no clinically significant differences in bleeding or pain between single incision and standard multi-port cholecystectomy. Another meta-analysis also demonstrated no difference in surgical site infections. There are no high quality data demonstrating that there is a comparative mortality difference with either procedure.

There is, however, a significant difference in post-operative incisional hernia, with more occurring in the single incision group. This should be explained to the patient in the clinic, particularly if she is planning to become pregnant in the future. An increase in post-operative hernia is likely secondary to the length of the fascial incision required by whichever single-incision platform is chosen. The fascial incision can be up to 7 cm with some devices.

Furthermore, there are data that the rate of procedural failure is higher in the single incision group (mainly relating to conversion to multi-port laparoscopic) and the time of procedure is longer in the single incision group.
Finally, relative to this patient, there are data that single incision laparoscopic cholecystectomy fares better on post-operative cosmesis scores than multi-port cholecystectomies.

4. A. Multi-port laparoscopic Heller myotomy is the current gold standard operative approach for the treatment of achalasia. A single incision laparoscopic approach has been described in the literature, but only as single case reports. The anatomical location of the repair makes a single incision approach difficult, and this technique has not been widely adopted.

Peroral Endoscopic Myotomy (POEM) is an endoscopic surgical approach that was first described less than a decade ago, and has gained increasing attention and adoption by surgeons and gastrointestinal endoscopists alike. The procedure consists of endoscopically creating a submucosal tunnel in the distal esophagus, followed by creating a complete myotomy, then retraction of the endoscope and closure of the submucosal tunnel with endoscopic clips. There are no reports of a hand-assisted laparoscopic approach. There are no cases of transvaginal NOTES myotomy in the literature. This would be a risky NOTES procedure, given the extreme length of instruments needed to perform the myotomy with this approach. There are also no reports of a hand-assisted laparoscopic approach.

There remain significant concerns regarding adequate training for NOTES procedures. There are questions regarding the appropriate composition of teams (gastroenterologist versus surgeon versus both), the amount of advanced flexible endoscopy experience required, and the appropriate amount of ex-vivo simulation and live animal training prior to human attempts.

In addition, there is a 5% to 10% rate of complications cited in current NOTES registries. There is concern that current endoscopic techniques may not be able to adequately address intraperitoneal surgical complications, and that the delay in transitioning to a laparoscopic approach to definitively manage complications may result in poorer outcomes. Additionally, if gastroenterologists are a part of the NOTES team (as they may be more facile with advanced flexible endoscopy), they are likely to be less familiar with the intraperitoneal anatomy and may not as easily recognize intraoperative complications.

Finally, a pure NOTES approach using a flexible endoscopic approach requires a single operator to manage both the visualization and spatial positioning of the endoscopic tools concurrently, which can be cumbersome and is difficult in a NOTES application. A multitasking NOTES platform would be of profound benefit to the operator.

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A 65-year-old man with a medical history of hypertension presents to the emergency room complaining of rectal bleeding for 3 months. On physical exam, a rectal mass and scant gross blood is discovered during a digital rectal exam. A proctoscopic evaluation localizes the mass in the anterior rectum only 4 cm from the dentate line. A colonoscopy does not reveal any concomitant lesions and a biopsy of the lesion confirms the mass is adenocarcinoma. On endoscopic ultrasound, the mass extends through the muscularis propria with one abnormal lymph node. There is no involvement with the sphincter muscles. His workup includes a CT of the abdomen and pelvis, with no signs of metastasis. He completes neoadjuvant chemotherapy and returns to clinic to discuss surgical treatment. Based on the location of the tumor you recommend a robotic-assisted laparoscopic anterior resection with a diverting loop ileostomy.

1. Which of the following is true regarding the differences between robotic and laparoscopic resection of rectal cancer?
   A. Improved oncologic resection lymph node sampling and margin resections
   B. Decreased incidence of bladder and erectile dysfunction in men undergoing robotic-assisted low anterior resection
   C. The robotic approach has decreased conversion rates compared to laparoscopic.
   D. The increased cost of the robotic approach is offset by the significantly decreased hospital length of stay and complication rate.

2. Of the following surgeries, which has been shown to benefit from the robotic approach?
   A. Cholecystectomy
   B. Nissen fundoplication
   C. Prostatectomy
   D. Adrenalectomy
   E. Pancreatectomy

3. Which of the following patients would most likely benefit from a robotic-assisted versus laparoscopic surgery for colorectal cancer?
   A. 75 year old admitted with a lower gastrointestinal bleed, found to have a bleeding cecal tumor on colonoscopy
   B. 60-year-old man with a low rectal cancer that is abutting the prostate on endoscopic ultrasound
   C. 64-year-old man with no significant medical history with a descending colon mass
   D. 55-year-old man admitted with obstipation found to have an obstructing sigmoid tumor

4. Of the following, which is considered to be one of the advantages of robotic surgery?
   A. Decreased overall cost
   B. Motion scaling, which increases the light in difficult to reach places
   C. Improved ergonomics for the operating surgeon, avoiding fatigue and potential disability
   D. The ability to perform multi-quadrant procedures with ease
   E. Endowrist technology, which allows better tactile sensation
5. Which of the following is true regarding the training required to perform robotic-assisted laparoscopic surgery?

A. As part of the learning curve for robotic-assisted laparoscopic colorectal surgery, surgical efficiency is best determined by operative time.
B. The learning curve for robotic-assisted laparoscopic colorectal surgery is well defined.
C. Simulation for robotic surgery is undeveloped, and, therefore, not useful in honing these skills.
D. There are no regulated, standardized training programs for surgeons interested in performing robotic-assisted laparoscopic surgery.

ANSWERS

1. C. The literature that analyzes robotic-assisted low anterior and abdominoperineal resections, demonstrates a lower conversion rate to open laparotomy as the most significant advantage. A systematic review and meta-analysis in 2011 suggested that the conversion rate to open surgery in the robotic group was significantly lower than that with laparoscopic surgery. Another meta-analysis recently confirmed these findings by reporting a trend toward lower conversion rates in the robotic surgery study arm. However, there was no significant advantage of the robotic approach in regards to the operative time, blood loss, length of stay, and complications. The potential advantages of robotic surgery include a more accurate pelvic dissection and, therefore, a decrease in nerve injury in men resulting in decreased bladder and erectile dysfunction. However, these advantages have not been well elucidated in the literature. Some small studies have shown that there may be an earlier return of function in the robotic group but the incidence of genitourinary dysfunction appears to be the same in either approach.

2. C. Although the types of surgeries performed with robotic-assisted laparoscopy have greatly increased over the last several years, there is still debate regarding the benefit of robotic surgery. Although the advantages of robotic-assisted laparoscopic prostatectomy (RALP) are still debated, there is an increasing amount of literature about this procedure. RALP has become one of the most common robotic-assisted surgeries, which accounted for 67% of all prostatectomies performed in 2009. It demonstrates the preference of surgeons to use robotics in a small space such as the pelvis. Despite the ongoing debate, some have shown a cost-effectiveness of robotic-assisted prostatectomy in high volume centers if over 150 surgeries are performed per year.

3. B. Robotic-assisted laparoscopic surgery is rarely applied to emergent operations. As well, a laparoscopic approach is rarely preferred in an urgent colorectal operation including obstruction due to an obstructing colon cancer. A randomized trial of robotic-assisted versus laparoscopic colectomy for right colon cancer showed hospital stay, surgical complications, postoperative pain score, resection margin clearance and number of lymph nodes harvested were similar in both groups, but the costs associated with the robotic-assisted right colectomy were higher. A nationwide analysis of robotic colorectal surgery revealed anterior resections for rectal cancers were the most common robotic assisted colorectal surgery performed in the United States, accounting for 40% of all robotic cases. A larger percentage of all rectal cancers are being performed robotically compared to colon resections, with a tendency toward higher use of robotic-assisted techniques in males undergoing anterior resection for rectal cancer. It is study suggests that robotic assistance may be of no added benefit in routine colon resections, but selective application in complex rectal cancer procedures may prove to have long-term benefits. Of the choices listed, the patient with the low rectal cancer abutting the prostate is most likely to benefit from robotic-assisted surgery.

4. C. There are many advantages of robotic-assisted laparoscopic surgery including: three-dimensional high definition vision; visual magnification up to 15 times normal; motion scaling that will eliminate a natural hand tremor as motions are deamplified up to a scale of 5 to 1; improved ergonomics for the operating surgeon; and EndoWrist technology, which allows the instrument to imitate normal wrist and elbow motions. However, there are many disadvantages including: increased operative time and cost, the loss of tactile sensation, an evolving learning curve and difficulty when operating in multiple quadrants of the abdomen. It is latter challenge is a particular problem is highlighted during mobilization of the splenic flexure in the left upper quadrant during a rectal resection. It is can be solved by performing a hybrid procedure, in which the splenic
flexure is initially mobilized laparoscopically and the rest is completed robotically.

5. D. Operative time is an inadequate surrogate to determine learning curve for robotic surgery for many reasons; most importantly shorter operative times are not reflected in patient outcomes. A systematic review of trials examining learning curve in laparoscopic and robotic-assisted colorectal surgery suggests that using operative time is too simplistic and the authors conclude that a shift toward a multidimensional assessment, such as a cumulative sum (CUSUM) model, which assesses trends in surgical outcomes, should be encouraged. Because learning curve has been studied with multiple ways with differing numbers of parameters, the learning curve is not well defined. Simulation for robotic surgery is available and shown to be useful in attaining competency prior to performing surgeries on patients. For instance, an inexpensive and synthetic pelvic training model has been developed to teach the complex skills needed for successful completion of robotic rectal dissection. Surgeons are not necessarily required to complete a competency based training program prior to integrating robotic-assisted surgery into their practice. A systematic review has demonstrated that there are many different types of training programs described, and provides guidelines for the development of a structured training program.

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You are asked to start a Minimally Invasive Surgical (MIS) program at a new community hospital. The chief of staff has asked you to evaluate all the new minimally invasive techniques and equipment, specifically with regards to patient safety, so that the hospital can purchase the proper equipment for your program.

1. With regards to CO₂ insufflation in laparoscopic surgery, which of the following statements is true?
   A. Reports estimate that an average laparoscopic colectomy requires approximately 200 to 280 liters of carbon dioxide.
   B. Insufflation filters composed of mesh with 0.1- to 0.3-micron pores have been developed to exclude the possibility of peritoneal contamination or disease transmission through the flow of intra-peritoneal fluid or particulate matter from the patient to the insufflator and then to the next patient.
   C. Several randomized controlled trials have demonstrated a clinical benefit as well as a decrease in lens fogging with the use of warmed and humidified air.
   D. Touching the laparoscope tip on viscera is a maneuver that is commonly used in laparoscopic surgery. However, this should be performed cautiously as the laparoscope tip temperature can commonly exceed 200°F.
   E. If the surgeon experiences difficulty with pneumoperitoneum and inadequate relaxation of the abdominal wall, a discussion with the anesthesia team regarding consideration for additional sedation or paralysis is not appropriate.

2. Regarding safe use of energy devices in laparoscopic surgery, such as monopolar instruments, which of the following is true?
   A. Thermal injury cannot occur from another instrument if the electrically active instrument is not touching it.
   B. Disruptions in the insulation of an active instrument may discharge energy to surrounding structures or tissues leading to inadvertent thermal injury.
   C. Using monopolar devices on the so-called “coagulation” mode creates less lateral energy spread than the so-called “cut” mode.
   D. Capacitive coupling cannot occur when a non-conductor separates two conductors.
   E. If the active electrode of a robotic instrument is inserted through a non-metal trocar, the non-metal trocar acts can function as a capacitor, causing potential injury.

3. With regards to robotic-assisted laparoscopic surgery, which of the following is correct?
   A. The current robotic surgery system has four degrees of freedom with its instruments.
   B. The current robotic surgery system has afforded the surgeon the ability to perform laparoscopic surgery with full control of up to two surgical instruments and the camera.
   C. Potential advantages of the robotic surgery system include tremor reduction, 3-D visualization, and increased wrist action at the surgical site compared with traditional laparoscopic instruments.
D. Industry representatives can be present to ensure that the equipment is functional, and are trained to influence surgical decision.

E. If needed, intra-operative cholangiogram is not possible during a robotic-assisted laparoscopic cholecystectomy.

4. While performing robotic-assisted or traditional laparoscopic surgery, which of the following is true regarding management of an intra-operative complication?

A. While performing a robotic-assisted Nissen fundoplication, the surgeon encounters an isolated iatrogenic distal esophageal perforation. The next step would include primary single-layer repair without the planned fundoplication.

B. While performing a laparoscopic single-site Nissen fundoplication, the surgeon accidently entered the pleural cavity. The appropriate next step would be immediate placement of a chest tube and discontinuation of the procedure.

C. During a robotic-assisted laparoscopic incisional hernia repair, the surgeon encounters an enterotomy while performing enterolysis on the anterior abdominal wall. The next step in management should include primary repair and mesh placement if the spillage is controlled and considered minimal.

D. Crepitus observed in the chest or the neck during robotic-assisted or laparoscopic Nissen fundoplication is a potential side effect and will most likely improve without any intervention.

E. After completing a difficult single-site laparoscopic bilateral inguinal hernia repair, the surgeon notices that the insufflation pressure was set at 40 mm Hg during the case. The next step includes explaining the technical error to the patient in the recovery room and scheduling a follow-up in the office one week later.

ANSWERS

1. D. To maintain pneumoperitoneum throughout a case, a significant amount of CO₂ is frequently required. The duties of the surgical team include: monitoring the intra-abdominal pressure during the case, identifying the amount of CO₂ remaining prior to the start of the surgical procedure and having a replacement tank in reach if needed, especially for long or difficult cases. One report estimated that an average laparoscopic colectomy requires approximately 110 to 180 L of carbon dioxide. The surgeon should be aware of that fact, making sure to check CO₂ pressure in the tank prior to start the surgery and clarify that a replacement tank is available, if needed.

The possibility of peritoneal contamination or disease transmission through the flow of intra-peritoneal fluid or particulate matter from the patient to the insufflator (and then to the next patient) has been a concern since the early days of laparoscopy. To address this concern, insufflation filters composed of mesh with 0.1 to 0.3-micron pores have been developed, which limit, but do not exclude the possibility of disease transmission.

Warmed, humidified gas is sent directly from the insufflator (or gas is sent from the insufflator through a warming and humidification system prior to patient delivery) in order to enter the peritoneal cavity at body temperature. In addition to the theoretical benefit of improved visualization attributable to condensation prevention, there is some evidence that warm, humidified gas can also reduce hypothermia and pain; however, several randomized controlled trials have failed to show either a clinical benefit or a decrease in lens fogging with the use of warmed, humidified air.

Wiping the laparoscope tip on the viscera, often the liver or small bowel, is another maneuver that is commonly used and is often effective. However, this should be performed with extreme caution as the laparoscope tip temperature can often exceed 200°F.

2. B. Current concepts in electrosurgery are based on the idea of monopolar and bipolar instrumentation. Monopolar instruments are an “active” electrode, to deliver concentrated energy, and require a second, “dispersive” electrode, placed on the patient to complete the circuit. Of en, the size of the dispersive electrode is much larger than the active electrode to decrease the delivered energy and prevent thermal injury. Bipolar instruments in comparison contain both the “active” and “dispersive” electrodes in a single hand instrument, thereby delivering concentrated and focused energy to a particular location. Additionally, two modes of energy delivery are used in modern day electrosurgical units. The “cut” mode delivers a low-voltage, continuous output, while the “coagulation” mode delivers a high-voltage, interrupted output. These modes reflect the energy waveforms and not their designated labels. For further information,
Metallic trocars are often utilized in both laparoscopic and robotic surgery for cost reduction with current robotic surgery instrumentation requiring the use of metal trocars. It is important to understand the associated possible injuries if these trocars are placed beyond the suggested fascial point and/or come in touch with intra-abdominal organs. With direct coupling, the capacitor generates an electrostatic field between the active electrode and the metal trocar, and as electricity passes through the active electrode, the electrostatic field can transfer energy to the metal trocar, which will then discharge the energy in the form of heat, leading to burns of the skin and abdominal wall, which is common in robotic-assisted surgery performed using metal trocars. The use of non-conductive plastic trocars can avoid this phenomenon.

The use of monopolar instruments possesses an additional risk, known as capacitive coupling, where by electrical energy is stored in a capacitor (instrument) and then discharged when the circuit is completed. Often, injuries of this type occur with accidental contact of a recently used instrument, which retains stored energy, with nearby tissue causing accidental thermal injuries. Thus, whenever monopolar electrocautery is being utilized, it is important to ensure that there is a safe distance between the active instrument and all other metallic objects.

3. C. Robotic surgery has up to 7 degrees of freedom with its instruments and provides the ability to perform laparoscopic surgery with full control of up to three different surgical instruments as well as the camera by a single operator. The potential advantages of robotic-assisted laparoscopic surgery include tremor reduction, 3-D visualization, and increased wrist action at the surgical site.

Intra-operative cholangiogram is possible during robotic cholecystectomy and if needed any of the robotic arms can be undocked and moved away for cholangiography and/or placement of assistant ports.

Application of surgical safety standards to robotic surgery include credentialing, mentorship, knowledge of laparoscopic physiology, case selection appropriateness to skills level, conversion to an open procedure when needed, and industry representatives can be present to ensure that the equipment is functional, however they are not trained or credentialed to influence any surgical decision making.

4. D. Given that safely performing minimally invasive surgery requires an advanced set of skills, the American Board of Surgery adapted the Fundamentals of Laparoscopic Surgery (FLS) course prior to being eligible sit for board examination. Surgeons performing minimally invasive surgery should be prepared to deal with potential complications that could arise, as well as be comfortable with the open technique, if needed.

Possible complications of both robotic-assisted and laparoscopic Nissen fundoplication include entering into the pleural cavity, which is often managed by decreasing the insufflation pressure and good communication with the anesthesiologist. As long as the patient remains stable and there is no difficulty in ventilation the procedure can continue as planned and post-operative chest X-rays can be obtained to confirm the resolution of CO₂. Chest tube placement is not immediately required, unless the patient becomes symptomatic.

Iatrogenic injury to the esophagus is a potential complication during Nissen fundoplication and can be avoided by handling the esophagus with umbilical tape (the no-touch technique). It is recommended to repair an iatrogenic injury with a primary, two layers closure with the planned portion of the Nissen wrap covering the primary repair site. An enterotomy is a contraindication for synthetic mesh placement irrespective to the amount of spillage or contamination and should not be performed.

Crepitus is often seen after mediastinal dissection and usually resolves spontaneously without any additional treatment. Monitoring insufflation pressures during surgery is important throughout the duration of a case since high insufflation pressures can lead to serious complications such as difficulty with extubation due to CO₂ retention and end-organ ischemia (for example, acute renal failure). For these reasons, patients that undergo procedures with high insufflation pressures should be admitted to the hospital for observation and closely followed clinically.

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A 37-year-old man and his 16-year-old daughter are brought into the emergency department via ambulance after being involved in an automobile collision. The man is fully conscious and alert. He informs the hospital staff that both he and his daughter are Jehovah’s Witnesses. Radiological studies indicate that the man suffered a broken pelvis and his daughter is experiencing internal bleeding. It is concluded that both individuals will need surgery.

1. Lab work indicates that the man has a low hemoglobin and hematocrit count thereby putting him at a greater need for blood transfusion. He is adamant that he cannot receive any blood products because of his religion. What is the next step you must do?
   A. Respect his wishes and proceed with bloodless surgery protocols.
   B. Begin searching for a nearby bloodless surgery center that is better equipped to handle his situation.
   C. Discuss his belief.
   D. Call the Hospital Liaison to determine what are your legal responsibilities.

2. The man’s daughter is going in and out of consciousness. At no point does she verbally confirm her refusal of blood products. However a nurse finds a signed but undated blood refusal card in her pocket. What is the appropriate response?
   A. Use whatever means are necessary during surgery. The patient is a legal minor and thus you have the right under doctrine of parens patriae to do so.
   B. Her father still maintains legal right over her because she is not of legal age. Make sure he is clear of any added risks associated with her surgery if he refuses any blood products for his daughter.
   C. She is old enough to be considered a “mature minor.” Therefore her decision to refuse blood products must be respected.
   D. Call risk management.

3. The man decides at the last minute to accept blood products. What is a possible consequence for his decision if word got out?
   A. He would be ostracized by his mother.
   B. Be required to pay a $25,000 donation to expunge his transgression.
   C. Lose the privilege of attending church services until church elders deemed him sufficiently repentant.
   D. All of the above

**ANSWERS**

1. C. Talk to the patient privately in order to get a better understanding of his personal beliefs. The Jehovah’s Witnesses (JW) religion is known for its refusal to allow blood transfusions. The current JW position includes unconditional refusal of whole blood, packed red blood cells, white blood cells, platelets, and plasma. It includes the autologous transfusion of their own pre-deposited blood. However, many Witnesses accept intra-operative blood salvage so long as their blood remains in circulation within the body. They may also accept albumin, immune globulin, hemophilia...
preparations, sera, and even organ transplantation on an individual decision. It is therefore vital that each case be discussed and treated individually.

Witnesses cannot be treated appropriately without exploring personal conviction and preference. It is important that the physician discuss these matters in private. The patient’s autonomy to make medical decisions can be greatly influenced by family members, friends, and congregational members. Case reports have even shown that patients have changed their earlier decision to accept blood treatment after being visited by hospital liaison committee members. These members are often called upon by doctors in order to help determine individual treatment. Due to their potential influence, this practice may have to be reconsidered.

2. **D.** Contact risk management if unsure. It is important for medical professionals to be familiar with their particular state’s laws regarding minors’ consent authority. Most states require parental consent and do not permit mature minors to consent to general medical care. However, parental rights are not absolute. They have a responsibility to make decisions that ensure the health and safety of their child. Courts can exercise their power under the doctrine of parens patriae to force medical treatment when parents put their child’s health in jeopardy. The case of Prince v Massachusetts is often cited because it clearly mentions that parents have every right to die for their religious belief but cannot make that same decision for their children.

3. **A.** He would be ostracized by his mother. Muramoto has cited Church literature that appears to teach that JW’s who come across conf dential medical information are obligated to bring that information to the attention of the church elders. Not only could there be legal ramifications for any healthcare worker caught doing so, but there could be a resulting coercive effect in a JW patient’s decision making process. A breach in conf dentiality could affect a church member in other serious ways.

   In 1961 the JW began to enforce the policy of blood refusal by “disfellowshipping”, or expelling, un-repentant members who willfully accept blood components that are prohibited. The Church conducted judicial proceedings whenever members were suspected of receiving blood products. These proceedings would ultimately yield an involuntary confession from the patient and result in his disfellowshipping. Witnesses, which included family and friends, would then be instructed to ostracize and shun the expelled individuals. This practice is used by the JW to serve as a deterrent for anyone acting against its teachings. Dissidents within the JW have voiced that the practice coerces and compromises autonomous decisions in medical care.

   In June 2000, the church released a statement indicating that there would be a procedural change in which the congregation would no longer initiate the action to revoke membership for a baptized member who willfully and without regret accepts blood transfusions. It would be left up to the individual to come forth and divulge his own actions to the church. The person would then be labelled as “disassociated” because he had willfully broken a core tenet of their faith. This too would subject the individual to being ostracized. The important difference between these two processes is that a JW member could now keep quiet about receiving blood and avoid excommunication altogether. Maintaining patient confidentiality is therefore paramount.

**BIBLIOGRAPHY**


An 85-year-old female presents to the hospital with nausea, vomiting, abdominal pain, and distension for the past two days. The pain rapidly worsens over the next hour and the patient is taken to the OR with the diagnosis of mesenteric ischemia. The patient has a past medical history of coronary artery disease, COPD, and osteoporosis. She currently lives in a nursing home and is able to perform activities of daily living with assistance. Before taking the patient to the OR, you confirm that the patient has no living will or durable power of attorney, but does state that she “wouldn’t want to be a vegetable on a machine.” During the surgery the patient is found to have extensive necrotic bowel from the ligament of Treitz to the transverse colon. The patient is closed without resection. After surgery the patient rapidly deteriorates and develops severe septic shock. A discussion occurs with the patient’s family about the poor prognosis of this illness. The patient’s daughter, whom is the next of kin, states that she wants everything to be done for her mother and threatens legal action if her wishes are not granted.

1. What is the next appropriate step in managing this patient?
A. Take the patient back to the OR to perform a subtotal colectomy as per the daughter’s wishes.
B. Inform the daughter that she has no decision making capabilities and proceed with palliative care.
C. Remove the patient from nutritional support and hydration.
D. Consult the hospital’s ethics committee.
E. Continue to discuss options with the family.

2. In regards to advance directives, which statement is correct?
A. Advanced directives are not transferable between states.
B. Oral advance directives are legally valid.
C. A living will takes precedence over appointed surrogate decision making.
D. Advance directives are always followed verbatim.

3. In regards to life-sustaining medical treatment, which statement is correct?
A. There is no ethical difference between withdrawing and withholding treatments.
B. Risk management personnel must be consulted before life-sustaining medical treatment may be terminated.
C. A patient has to be terminally ill for life support to be stopped.
D. It is permissive to withhold “extraordinary” care, but not “ordinary” care.
E. It is illegal to provide palliative care to a terminally ill patient if there is a possibility that this may hasten the patient’s death.

ANSWERS
1. E. When making decisions about end of life care it is important for all involved parties to have a general consensus about care. Emotions and psychological strain can heavily influence decision making, but it is important to remind involved parties that the most important decision making factor is what the patient would have wanted. If the patient is no longer
Risk management personnel are consulted to limit legal risk in regards to patient care. Some hospital policies may require a consult before terminating life-sustaining treatment, but there is no law that indicates this as a prerequisite.

There is a very fine line that marks the distinction between “extraordinary” care and “ordinary” care. Extraordinary care or heroic measures are ones that take over normal physiologic function of the body in end-organ failure. Examples would include the use of ventilators for pulmonary failure or hemodialysis for kidney failure. Ordinary care helps the body sustain itself, with treatment such as IV fluids, tube feeds, or antibiotics. In a Supreme Court ruling in 1983, it was found that any treatment could be declined under the Fourteenth Amendment of the U.S. Constitution, be it extraordinary or ordinary, as long as this is in the best interests in the patient and the burden of medical care outweighs the benefits.

The principle of “double effect” states that it is ethical to initiate a treatment that is intended to benefit a patient even if the there is an unintended negative consequence. The benefit must be sufficiently substantial to outweigh the risk. The act must also directly cause the benefit and not be intrinsically harmful. An example would be giving a patient high dose opiates to relieve pain, but then unintentionally hastening the patient’s demise by way of respiratory depression.

BIBLIOGRAPHY

Skin and Soft Tissue

Richard Smith
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1. A 70-year-old male presents to your office with a concerning 2 cm painless lump on his left hip that he noticed over the last year, which is firm and dome-shaped. An excisional biopsy is performed, demonstrating a Merkel cell carcinoma (MCC) with negative margins. Regarding MCC, which of the following is true?
A. The Merkel cell polyomavirus likely contributes to the development of most Merkel cell carcinoma.
B. A sentinel lymph node biopsy is required only for tumors > 2 cm in size.
C. Risk factors for Merkel cell carcinoma include having dark skin, a weakened immune system, and overexposure to UV radiation.
D. Merkel cell dense-core granules stain positively for the neuroendocrine marker neuron specific enolase.
E. Current recommendations for tumor excision are with a 0.5-cm margin for tumors < 2 cm in size and 2-cm margins for those > 2 cm in size.

2. A 50-year-old fair skinned, blue-eyed male presents to your office with a skin lesion on the pinna of his right ear concerning for a melanoma. Biopsy determines a superficial spreading melanoma with a depth of 1.1 mm. What is the next step in the management of this patient?
A. Wide local excision and sentinel lymph node biopsy
B. High dose interferon alpha 2b is recommended
C. Radiation therapy
D. Excisional biopsy and a total parotidectomy
E. Complete surgical excision with a 0.5 cm negative margin

3. An 86-year-old female presents to your office with a new 1.8-cm raised pearly nodule with surface telangiectasias on her cheek. Which of the following would be the best option in her management?
A. Surgical excision with 1 cm margins
B. Cryotherapy
C. Mohs microsurgery
D. Radiation therapy
E. Topical imiquimod

4. A 61-year-old male presents to your office with a lesion on his lower lip. Biopsy confirms a squamous cell carcinoma, 2 cm in diameter. In regards to squamous cell carcinoma (SCC), which of the following is true?
A. Squamous cell carcinoma of the lip most often presents on the upper lip.
B. Squamous cell carcinoma is the second most common cutaneous cancer in patients who have had a kidney transplant.
C. Actinic keratosis is not a risk factor for the development of squamous cell carcinoma.
D. Lip defects involving at least one-third of the lip require regional flaps such as an Abbe flap.
E. Margins for low risk squamous cell carcinoma range from 1.0 to 2.0 cm.
5. A 79-year-old male presents with 2-cm scaly pink lesion on his scalp that his primary care physician has been following for the last two years. Biopsy confirms the diagnosis of a basal cell carcinoma. Which of the following is correct in regards to basal cell carcinoma?

A. Basal cell carcinoma is the second most common form of skin cancer, after squamous cell carcinoma.
B. Superficial basal cell carcinomas are scaly, pink to red lesions frequently confused with psoriasis or other eczematous dermatoses.
C. Basal cell carcinomas commonly develop in burn scars or chronic inflammatory wounds.
D. Surgical margins for low risk basal cell carcinoma range from 0.5 to 1.0 cm.
E. Mohs microsurgery cannot be considered an option in the treatment of basal cell carcinomas.

ANSWERS

1. A. The mainstay of therapy for patients newly diagnosed with primary MCC remains surgical. Current recommendations are based on the clinical size of the primary tumor and call for tumor excision with 1 cm margins for tumors that are 2 cm in size and 2 cm margins for those that are greater than 2 cm in size. Radiotherapy has been used as monotherapy for primary tumors with reported success, but until more data become available, surgery remains the mainstay of therapy for primary MCC tumors. Furthermore, Feng et al. characterized a novel polyomavirus, the MCPyV, and suggested an association between it and the pathogenesis of MCC. This work has sparked great interest in MCC and has opened a new pathway in the study of viral tumorigenesis.

The role of chemotherapy in the treatment of MCC remains unclear. Since nearly one-third of clinically node-negative patients harbor microscopic nodal disease, sentinel lymph node biopsy (SLN) is currently recommended for Merkel cell carcinoma at the time of wide local excision. SLN biopsy has been shown to be important in the staging and prognosis of MCC, and SLN status is included in the most recent American Joint Committee on Cancer (AJCC) staging guidelines. SLN biopsies should be examined by both hematoxylin and eosin (H&E) and immunoperoxidase staining, including CK20. If sentinel nodes are positive, completion lymph node dissection of the nodal basin followed by radiotherapy of the basin is recommended. In cases where SLN positivity is found on immunostaining but not H&E staining of the lymph node, radiotherapy without complete lymph node dissection has been suggested as sole regional therapy. Dark skin is not a risk factor; “white skin” is. The other two are risk factors.

2. A. Tumor thickness is critical for establishing the prognosis in melanoma and regional metastases indicates poor prognosis. Frozen sections have no role in the diagnosis or treatment of melanoma. Once the dermis in invaded the probability of regional or distant metastases increases substantially. Lymphoscintigraphy and sentinel lymph node biopsy became the primary method of identifying nodal drainage patterns replacing the prior suggested nodal drainage based on location. Tragus and anterior pinna lesions were thought to metastasize to the parotid gland and anterior cervical lymph nodes, whereas posterior pinna lesions were thought to spread to the mastoid bone and occipital and posterior cervical nodes. Complete surgical excision with 1 to 2 cm margin is the treatment of choice. Elective neck dissection is generally not recommended for lesions less than 1 mm in thickness, whereas lymphadenectomy may offer survival advantage and better local control for lesions > 1 mm in depth and positive sentinel lymph node biopsy (see Table 11-1). Interferon alpha-2b is recommended for patients with lymph node positive disease. Different types of melanoma are described in Table 11-2.

### Table 11-1 EXCISION MARGIN OF MELANOMAS

<table>
<thead>
<tr>
<th>T Stage</th>
<th>Depth of Invasion (mm)</th>
<th>Suggestion Margin (cm)</th>
</tr>
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<tbody>
<tr>
<td>T1</td>
<td>&lt;1</td>
<td>1</td>
</tr>
<tr>
<td>T2</td>
<td>1–2</td>
<td>1</td>
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<tr>
<td>T3</td>
<td>2.01–4</td>
<td>2</td>
</tr>
<tr>
<td>T4</td>
<td>&gt;4</td>
<td>2</td>
</tr>
</tbody>
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3. C. Basal cell carcinoma could be treated either surgically or medically. Treatment options include wide local excision, Mohs microsurgery with 4 mm margins, curettage, and cryosurgery. The standard treatment for larger basal cell carcinoma is surgical excision with cure rates greater than 99% for primary lesions; however for small lesions or lesions in areas such as the face, Mohs microsurgery is the preferred treatment option. Non-surgical treatments, typically reserved for non-surgical candidates include radiotherapy,
topical and photodynamic therapy. Topical therapy includes 5-fluorouracil and imiquimod. Imiquimod, a nonspecific immune response modifier, has been approved for the treatment of superficial basal cell carcinoma smaller than 2 cm for five times per week for the duration of 6 weeks with clearance rate more than 80%.

4. D. In immunosuppressed transplants patients, SCC is the most common skin cancer and it tends to have a more aggressive behavior. Lip carcinoma is the most common oral cavity cancer, with a majority of these lesions occurring on the lower lip. A majority of patients with oral cavity carcinomas have a history of either excessive alcohol intake or tobacco use. Lip carcinoma most likely presents as an exophytic mass and diagnosis is obtained by biopsy. Risk factors for SCC include actinic keratosis, burn wound scars and chronic inflammatory wounds. Large defects that involve up to two thirds of the lip require local flaps such as Abbe or Estlander.

5. B. Basal cell carcinoma is the most common form of skin cancer followed by squamous cell carcinoma. Basal cell carcinoma often presents as pearly nodules with telangiectases and may bleed occasionally. A skin biopsy to establish a diagnosis is important before treatment of any skin cancer. Margins for low risk squamous cell carcinoma range from 0.5 to 1.0 cm. Margins for low risk basal cell carcinoma range from 0.3 to 0.5 cm. Additionally, Mohs microsurgery is considered an option in non-melanoma skin cancers. Bottom line, squamous cell carcinomas most often arise in chronically damaged skin or within actinic keratosis, in burn scars, and chronic inflammatory wounds.

BIBLIOGRAPHY

You are consulted on a 35-year-old male, who otherwise healthy, was initially admitted 26 days ago in septic shock secondary to a necrotizing soft tissue infection of the right lower extremity. He required high-dose vasopressors for several days following emergent operative debridement and institution of broad-spectrum antibiotics. He was recovering well in the ICU and was recently extubated. However he developed tachycardia, fever, and leukocytosis. The ICU team calls you to evaluate because they are unable to identify a source of infection. You examine his back and find a pressure sore overlying the right ischial tuberosity approximately 4 × 5 cm in size with a black eschar overlying, expressible malodorous fluid, and surrounding cellulitis.

1. **What is the stage of this pressure ulcer?**
   A. Stage I  
   B. Stage II  
   C. Stage III  
   D. Stage IV  
   E. Unstageable

2. Surgery is performed and when the black eschar is removed, purulent fluid is expressed. After extensive operative debridement to healthy tissue, you find that the wound extends to bone. Which of the following would preclude use of Negative Pressure Wound Therapy (NPWT)?
   A. Chronic wounds  
   B. Diabetic wounds  
   C. Wound location  
   D. Meshed skin grafts  
   E. Wounds that require hemostasis

3. **Which of the following patients would be the best candidate for flap reconstruction?**
   A. A 48-year-old male with Stage I sacral ulcer and has no medical comorbidities  
   B. A 34-year-old male recovering from brain injury with a Stage IV ischial ulcer that recently underwent treatment for osteomyelitis  
   C. A 74-year-old homeless male with Stage III sacral ulcer  
   D. A 48-year-old poorly controlled diabetic male with Stage III pressure sore overlying the right greater trochanter  
   E. A 56-year-old male with Stage III chronic sacral ulcer who refuses to stop smoking despite hospitalization

4. **Multiple options for treatment of pressure sores exist. Which of the following options should be avoided?**
   A. Primary closure  
   B. Local wound care  
   C. Skin grafts  
   D. Musculocutaneous reconstruction  
   E. Fasciocutaneous reconstruction
ANSWERS

1. E. Accurate staging of pressure wounds is important because it guides management. Staging is as follows:

Stage I: Non-blanchable erythema of intact skin; impending skin ulceration.
Stage II: Partial-thickness skin loss involving epidermis and/or dermis; ulcer is superficial and presents clinically as an abrasion, blister, or shallow crater.
Stage III: Full-thickness skin loss involving damage or necrosis of subcutaneous tissue that may extend down to, but not through, underlying fascia; ulcer presents clinically as a deep crater with or without undermining of adjacent tissue.
Stage IV: Full-thickness skin loss with extensive destruction, tissue necrosis, or damage to muscle, bone, or supporting structures.

Unstageable/Unclassified: There are also “unstageable” pressure sores that are commonly incorrectly staged. These are pressure sores with slough/eschar than need to be debrided before one can see how deep they truly are, and can then be accurately staged.

Suspected Deep Tissue Injury: Purple or maroon localized area of discolored intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear.

2. E. Negative pressure wound therapy (NPWT) is becoming a valuable resource used by surgeons to manage difficult wounds. NPWT devices consist of an adhesive semi-occlusive dressing, tubing connected to a collection canister and a vacuum source, and an interface material to distribute the vacuum (open-pore polyurethane hydrophobic foam).

Negative pressure on the sealed, airtight wound results in:
• Increased blood flow to the wound
• Removal of excess fluid that may retard cell growth and proliferation
• Micro- and macro-deformation of the wound:
  • Macrodeformation is the visible stretch that occurs when the sponge contracts. It serves to draw the wound edges together, provide direct and complete wound bed contact, distribute negative pressure, remove exudate and infectious materials.
  • Microdeformation occurs at the cellular level and leads to cell stretch. It reduces edema, promotes perfusion, and promotes granulation tissue formation by facilitating cell migration and proliferation
• Maintenance of wound homeostasis: the semi-occlusive dressing and foam with insulation qualities minimizes evaporation, desiccation, and heat loss

The following are common indications for negative pressure wound therapy:
• Chronic, diabetic wounds or pressure ulcers
• Meshed grafts (before and after)
• Flaps
• Chronic and acute wounds
• Subacute wounds (dehisced incisions)

The following are contraindications to negative pressure wound therapy:
• Fistulae to organs/body cavities
• Necrotic tissue that has not been debrided or eschar
• Untreated osteomyelitis
• Wounds that require hemostasis
• Placing dressing on exposed blood vessels (including anastomotic sites) or organs
• Wound malignancy

Caring for the pressure sore patients involves more than addressing the wound. Wound healing in chronic wounds requires a systemic strategy, including nutritional assessment and maintenance, control of both systemic and local infection, avoidance of excessive moisture/incontinence, pressure and muscle spasm relief, surgical debridement and wound closure.

3. B. Most commonly, Stage III/IV pressure sores are referred for soft tissue reconstruction. Unfortunately some of these patients are not suitable candidates for medical or social reasons. Since these surgeries are frequently fraught with complications, there are multiple patient characteristics to optimize before coverage can be considered:
• Nutritional status
• Control of medical comorbidities
• Presence of muscle spasticity (Can this be controlled with anti-spasmodics?)
• Tobacco dependence
• Social situation (assess for presence of a responsible caretaker at home—and subsequent appropriate residence at own home vs facility), appropriate specialty mattress at residence, strict regimen of
frequent turning to prevent flap necrosis/failure, appropriately padded wheelchair
• If osteomyelitis is present, then the patient likely needs bony debridement and tailored IV antibiotic therapy (typically for 6 weeks) before soft tissue reconstruction can be attempted.
• Consideration of adverse drug factors like use of steroids or immunosuppressants
• Control of different causes of maceration like fecal or urine incontinence
• Medical non-compliance

Once these medical/social issues are addressed, the wound can then be optimized with thorough debridement and dressing care, in preparation for flap reconstruction.

4. A. When planning therapeutic treatment of pressure sores, the choice of closure strategy depends not only on the location, size, and depth of the ulcer, but also on the previous management strategies employed. Primary closure should be avoided. These wounds tend to have an absence of adequate tissue and primary closure leads to tension, scarring over the original bony prominence, and dehiscence. Skin grafting has a limited success rate, as grafting tends to provide unstable coverage. Musculocutaneous flaps provide adequate blood supply, bulky padding, and are effective in treating infected wounds. Fasciocutaneous flaps offer an adequate blood supply, durable coverage, and low rates of functional deformity.

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A 50-year-old Caucasian female was referred to general surgery by her primary care provider for evaluation of a mole to her left medial calf. On examination of her left medial calf, she has a 9 mm diameter pigmented lesion with irregular borders and color variation. Excisional biopsy is performed.

1. Pathology will most likely show which histologic subtype of melanoma?
   A. Acral lentiginous
   B. Desmoplastic
   C. Lentigo maligna
   D. Nodular
   E. Superficial spreading

2. If her melanoma is 2.2 mm thick, the surgical skin margin for a wide local excision of the primary lesion should be at least
   A. 0.5 cm
   B. 1 cm
   C. 2 cm
   D. 3 cm
   E. 4 cm

3. Which of the following is a poor prognostic indicator in melanoma patients?
   A. Extremity location
   B. Low Breslow thickness
   C. Female gender
   D. Elevated LDH
   E. Younger age

4. Regarding sentinel lymph node biopsy in patients with melanoma, which of the following is FALSE?
   A. Completion lymph node dissection is recommended to achieve regional control in melanoma patients with positive sentinel lymph nodes.
   B. Sentinel lymph node biopsy is indicated for intermediate thickness melanomas (Breslow thickness, 1 to 4 mm) regardless of ulceration or mitotic rate.
   C. Sentinel lymph node biopsy is indicated for staging in patients with thick melanomas (T4; Breslow thickness > 4 mm).
   D. In patients with clinically localized melanoma, sentinel node status is the most important prognostic indicator.
   E. Sentinel lymph node biopsy is mandatory in all patients with thin melanomas (< 1 mm) if there are high-risk features.

5. Regarding metastatic melanoma, which of the following is FALSE?
   A. Surgery for patients with Stage IV melanoma confers a survival advantage over systemic medical therapy alone.
   B. The primary objective of metastatectomy for Stage IV melanoma is resection of all known disease.
   C. Recurrent Stage IV disease is not a contraindications to surgery for metastatic melanoma.
   D. In-transit metastases occur less than 2 cm from the primary melanoma and are located between the primary melanoma and the regional lymph node basin.
   E. More than 50% of patients with Stage IV melanoma will develop brain metastases.
ANSWERS

1. **E.** Seventy-five percent of all malignant melanomas are superficial spreading melanomas. Most arise de novo but they may be associated with a pre-existing nevus. They grow radially before growing vertically. Typical locations are in sun-exposed areas, namely the back in men and legs in women. Nodular melanomas comprise 15% to 30% of melanomas and are often dome-shaped and dark. They quickly develop a vertical growth phase. Lentigo maligna melanoma typically develops as a brown macule in sun damaged skin of older individuals and may grow radially for years before vertical growth develops. Acral lentiginous melanoma is the rarest melanoma in caucasians but is the most common type in Asians and dark-skinned people. They are aggressive and commonly arise on palmar, plantar, subungual, and mucosal surfaces. Desmoplastic melanoma is a rare variant that may be mistaken for a scar, fibroma other benign lesion and should be referred to an experienced dermatopathologist for evaluation.

2. **C.** Wide local excision is standard treatment for melanoma. Excision should be carried through skin and subcutaneous tissue down to muscle fascia. Current recommendation is for 0.5 to 1 cm margins for melanoma in situ, 1 cm margins for melanomas ≤1 mm thick, 1 to 2 cm for melanomas 1.01 to 2 mm thick, and 2 cm margins for melanomas > 2 mm. A randomized multicenter trial demonstrated no benefit to 4 cm versus 2 cm margins in patients with melanomas > 2 mm thick. Other trials have corroborated these results.

3. **D.** Evidence based prognostic indicators were carefully considered and integrated into the current AJCC staging system to provide staging that reflects disease biology. In 2001, Balch et al. published a prospective study of 17,600 melanoma patients to determine factors that were predictive of melanoma-specific survival. The investigators determined that patients with melanomas of the head, neck, or trunk had a significantly worse survival rate than patients with melanomas of the extremities. Males had a poorer prognosis than females. Increasing Breslow thickness was predictive of lower survival.

Presence of ulceration was more frequent among patients with thick melanomas (63% ulceration, Breslow thickness < 4 mm) than among patients with thin melanomas (6%, Breslow thickness ≤ 1 mm). At all thickness levels, patients with ulcerated melanomas were found to have survival curves that were similar to patients with melanomas of the next higher Breslow thickness. The investigators found a significant step-wise decrease in survival based on increasing age. Patients with higher number of nodal metastases and patients with macrometastases (clinically palpable nodes) also had poorer survival. Seetharmu et al. (Oncology. 2011;81(5–6):403–9) found that elevated pre-treatment LDH was correlated with poorer 2 year survival in Stage IV melanoma patients. Tumor mitotic rate has also been determined to be a significant prognostic indicator.

4. **E.** Metastasis to regional lymph nodes is the most important prognostic factor in patients with early stage melanoma. The American Society of Clinical Oncology (ASCO), Society of Surgical Oncology Joint Clinical Practice Guideline, and the National Comprehensive Cancer Network (NCCN) Guidelines Version 4 (2014) recommend routine sentinel lymph node biopsy in patients with patients with intermediate thickness melanomas (Breslow thickness 1–4 mm). Although there is less data to support use of sentinel lymph node biopsy in thick melanomas (Breslow thickness > 4 mm), sentinel node biopsy is recommended to facilitate accurate staging. ASCO guidelines state that there is insufficient evidence to support routine sentinel node biopsy in thin melanomas (Breslow thickness < 1 mm), but it may be considered in patients with high risk features. NCCN guidelines state that sentinel lymph node biopsy is not generally indicated in patients with Breslow thickness ≤ 0.75 mm. However, consideration should be given to sentinel lymph node biopsy in patients with Breslow thickness 0.76–1 mm, especially if ulceration or mitotic rate ≥ 1 per mm is present. Completion lymph node dissection remains the standard recommendation for patients with tumor positive sentinel nodes. Current evidence suggests that completion lymph node dissection is effective at achieving local control. The ongoing Multicenter Selective Lymphadenectomy Trial II (MSLT II) is investigating whether completion lymph node dissection also improves survival. Current AJCC staging refined N categories to account for the prognostic difference between patients with clinically palpable (macrometastasis) and clinically negative but pathologically positive sentinel nodes (micrometastasis).
5. D. In appropriately selected patients with Stage IV melanoma, surgery should be considered as initial therapy. Analysis of MSLT-1 data demonstrated improved survival in patients with Stage IV melanoma who underwent surgery with or without systemic medical therapy compared with systemic medical therapy alone. Multiple sites of disease and even recurrent Stage IV disease are not contraindications to resection. The most important preoperative considerations include resectability of all known disease, tumor biology such as tumor volume doubling time, and patient comorbidities. The most common metastatic sites for melanoma are skin, lung, lymph nodes, brain, liver, and gastrointestinal tract.

In-transit metastasis is defined as intra-lymphatic tumor in skin or subcutaneous tissue more than 2 cm from the primary tumor but not beyond the nearest regional lymph node basin. The lung is a typical site of metastasis and good evidence for pulmonary metastatectomy exists. Melanoma is the most common metastatic tumor in the small bowel and may present as pain, obstruction, bleeding, palpable mass or weight loss. More than 50% of patients with Stage IV melanoma will develop brain metastasis. Because of this, NCCN Version 4 (2014) Melanoma recommends consideration of annual brain MRI in addition to more frequent whole body PET/CT as a part of routine surveillance in patients with Stage IV disease.

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SCENARIO 1
A 47-year-old female presents with a several months history of a slowly growing painless mass in her right thigh. On physical exam, she is noted to have a 5 cm firm, non-tender mass in the right lateral mid-thigh.

1. Which of the following is true?
   A. Routine imaging of the mass should include a PET scan.
   B. Incisional biopsy should be routinely performed in order to confirm the diagnosis and identify the histological subtype.
   C. The most common histologic subtypes for extremity sarcomas include liposarcoma and malignant fibrous histiocytoma.
   D. Staging includes an abdominal and pelvic CT scan to evaluate for metastatic disease in this lesion.
   E. Multidisciplinary evaluation is not needed for simple, early-stage sarcomas.

2. Regarding surgical management of this patient, which of the following is true?
   A. A functional outcome is the highest priority.
   B. Surgical margin of 1 to 2 cm should be sought whenever possible.
   C. Regional lymph node dissection is also required.
   D. Amputation should be strongly considered as the primary therapy for most extremity sarcomas.
   E. Histologic subtype has little impact on surgical planning.

3. Regarding neoadjuvant and adjuvant therapies for soft tissue sarcoma, which of the following is true?
   A. Chemotherapy is the most important therapeutic intervention for outcomes from sarcoma.
   B. Metastatectomy has no role in the management of sarcomas.
   C. Radiation therapy has been shown to be of benefit in the treatment of sarcomas.
   D. Local recurrence is rare after appropriate therapy.
   E. Gastrointestinal stromal tumors (GIST) are treated similarly to other sarcomas.

SCENARIO 2
A 26-year-old male presents with a painless mass in his left axilla that has been present for several months. Upon questioning, he endorses unexplained low-grade fevers, night sweats, and an unplanned weight loss of 10 lbs over the previous 3 months. On physical exam, he is noted to have a 2 cm firm, rubbery, non-tender mass in the left axilla.

4. Which of the following considerations is true for this patient?
   A. Observation is warranted.
   B. History of fever, chills, night sweats, and weight loss are considered A level symptoms.
   C. Physical examination should include thorough exam of all accessible lymph node basins as well as potential sites of a primary malignancy.
   D. Sexually transmitted diseases can be ruled out by physical exam in younger patients.
E. Fine-needle aspiration (FNA) biopsy of suspicious lymph nodes in this patient is usually adequate for diagnosis.

5. Regarding lymphoma, which of the following is true?
A. Surgeons play a major role in the treatment of lymphoma.
B. The hallmark of treatment is surgery and chemotherapy.
C. Staging for Hodgkin’s lymphoma is based upon a different staging system than is Non-Hodgkin’s lymphoma.
D. HIV infection has been shown to increase the incidence of lymphoma but other immunosuppressive states have not.
E. Mucosa-associated lymphoid tissue (MALT) lymphoma may be definitively treated with H. pylori eradication in its early stages.

ANSWERS

1. C. Regarding pre-operative imaging of the tumor, MRI is generally preferred for extremity sarcomas, while CT tends to be preferable for abdominal and retroperitoneal sarcomas. However, there has not been demonstrated a statistically significant difference between the two modalities. High quality cross sectional imaging is nevertheless critical for pre-operative evaluation and planning. PET can give information regarding the grade, prognostication, and response to chemotherapy in select high grade, large, deep sarcomas, and can be considered for use, but does not have a role in routine evaluation of all sarcomas.

Incisional biopsy may be required, but generally speaking, for both extremity and retroperitoneal sarcomas, needle core biopsy (with or without image guidance) provides adequate tissue sampling with good diagnostic correlation to final pathology. However, when unavailable or inadequate, incisional biopsy for extremity sarcomas remains a reasonable diagnostic option. Care should be taken if an incisional biopsy is necessary. Incisions should be oriented longitudinally and thoughtfully, as re-excision of biopsy site will be necessary with definitive operation. In some selected institutions with clinical and pathologic expertise, FNA may be adequate, but should probably not be considered adequate at low-volume centers.

2. B. Until the early 1980s, amputation remained a primary therapy for most extremity sarcomas. In 1982, Rosenberg and colleagues at the National Cancer Institute published a randomized trial of amputation vs. limb-sparing surgery plus radiation and demonstrated equivalent overall survival and acceptable local recurrence rate of 15% with limb-salvage versus 0% with amputation. Currently, limb salvage surgery can be safely performed in over 90% of patients with extremity sarcoma with excellent local recurrence rates. Proximity of critical structures (bone, nerves, blood vessels, etc.) should be considered carefully during pre-operative planning and the expected functional outcome assessed to assist in making the decision for limb salvage versus amputation.

Careful pre-operative planning is imperative for successful resection of these tumors. Failure to obtain a negative surgical margin is the most important risk factor for local recurrence. Careful scrutiny of pre-operative imaging can result in improved outcomes by allowing the surgeon to have a thorough understanding of the extent of the tumor and relationship to local structures. Functional outcomes are also improved by careful consideration of the extent of resection required. Similarly, this allows for appropriate consultation with subspecialists including plastic or vascular surgeons pre-operatively when anticipated being necessary.

Wide margins should be the goal of therapy. A margin of 1 to 2 cm of normal tissue can help to
minimize the risk of local recurrence. However, strong tissues such as fascia can severely limit the spread of most types of sarcoma into adjacent structures. Therefore, a narrow fascial margin may be acceptable where such a narrow margin of muscle or fat would likely result in an increased risk of recurrent disease. In some cases, such as retroperitoneal sarcomas, wide margins may not be feasible.

Resection of nerves and blood vessels is occasionally unavoidable, but can often be avoided by careful skeletonization of blood vessels and resection of the perineurium along with the tumor. The concept of “planned positive margin” is feasible in many cases with the use of adjuvant radiation therapy. As long as the structure of concern is not fixed to the tumor, this carefully planned positive margin provides similar outcomes to controls with negative margins. Neoadjuvant radiation has been advocated in this setting for “marginally resectable” tumors in order to allow a negative margin functional resection.

Histologic subtype does play an important factor in planning surgical intervention. Well-differentiated liposarcoma (formerly called atypical lipomas) have similar recurrence rate to other types of sarcoma, but metastatic disease is rare, so surgical resection can be less aggressive when necessary. Dermatofibrosarcoma protuberos (DFSP) and myxofibrosarcoma are particularly difficult due to the common finding of microscopic tentacles that extend laterally from these lesions. DFSP has a tendency to respect fascial borders, whereas myxofibrosarcoma often penetrates fascia and can have multifocal skip lesions, so these factors must be considered. Lymph node metastasis is rare in STS in general, but can be seen more commonly with epithelioid or clear cell variants. For this reason, sentinel lymph node biopsy can give prognostic information, so though no clear therapeutic benefit has been shown, it may be considered in this setting.

3. C. Radiation therapy has been repeatedly demonstrated to be of benefit in disease-free survival, though not significantly different overall survival. There remains some controversy regarding the optimal timing of the radiation therapy. When comparing neoadjuvant versus adjuvant therapy, local control rate is similar. However, preoperative radiation has been found to double wound complications in the months following surgery compared to increased rates of long-term complications such as fibrosis, edema, and joint stiffness with postoperative radiation. External beam, brachytherapy, and intraoperative radiotherapy have all been used with some success. Patients at low risk for recurrence (i.e., small (<5 cm) superficial tumors, low grade tumors, wide surgical margins) may not derive a significant benefit from radiation and may be treated with surgery alone.

Surgery is the dominant therapeutic modality for extremity, retroperitoneal, and visceral sarcomas. Complete surgical resection is the primary factor in outcomes. Only a few clinical trials have demonstrated a statistically significant improvement in outcomes with adjuvant chemotherapy. Specific histology-directed regimens have shown the most promise and have achieved excellent and sustained results in specific subtypes to include gastrointestinal stromal tumors (GIST), rhabdomyosarcoma, Ewing sarcoma, and osteosarcoma.

Patients with an isolated metastasis can be considered for metastatectomy if resection with or without chemotherapy or radiation may result in a cure. It is may include removal of limited disease in a single organ or regional node dissection if nodal metastasis is isolated. Specifically in the setting of isolated lung metastasis, median survival is lengthened from 11 to 33 months compared to observation. Patients with widely metastatic disease may be considered for palliation using a variety of modalities including surgery, chemotherapy, radiation, embolization, and ablation procedures.

Local recurrence rate varies with the site of the initial tumor and the adequacy of surgical resection, but is significant. Local recurrence after treatment for extremity soft tissue sarcoma approaches one out of three patients. The median disease-free interval is 18 months, but can be quite remote. Considerations for treatment of recurrent disease are similar to primary disease and can include reexcision, chemotherapy, and radiation, often with similar success to the primary tumors for extremity sarcomas. Recurrence of visceral and retroperitoneal sarcomas often is unable to be completely re-excised.

GIST is the most common mesenchymal tumor of the GI tract, and has gained significant interest in recent years. The discovery of the KIT proto-oncogene mutation present in the majority of GIST tumors led to the ability to specifically target GIST tumors at a molecular level with the tyrosine kinase inhibitor imatinib mesylate (Gleevec; Novartis Pharmaceutical, Basel, Switzerland).
specific molecular targeting. Surgery remains of vital importance, but several studies have demonstrated improved disease-free and overall survival for patients at significant risk for recurrence who are treated adjuvantly with tyrosine kinase inhibitors, so this has become an important, disease-specific therapy for these rare tumors.

4. C. In patients without a tissue diagnosis of malignancy, but concern for lymphoma, FNA is generally not considered to be adequate for diagnosis. FNA may be able to identify some cases of metastatic carcinoma (i.e., breast, lung, etc.) but is limited in hematologic malignancies (especially lymphoma) as lymph node architecture is a critical pathologic component of making these diagnoses. FNA may be useful in searching for recurrent disease. As knowledge and use of molecular markers is expanded in the future, FNA may become a viable alternative to open biopsy of suspicious nodes. When lymphadenopathy is generalized the largest, most suspicious, and accessible note is selected for biopsy. The diagnostic yield does vary by site with inguinal nodes having the lowest yield and supraclavicular nodes the highest. Careful and appropriate handling of tissue specimens is critical to allow pathologic diagnosis. Adequate tissue sampling is critical to allow assessment of nodal architecture. Specimens should be submitted to pathology dry or in saline, not formalin or other preservative, in order to allow flow cytometric and immunohistochemical studies to supplement traditional pathology.

The differential diagnosis for lymphadenopathy is extremely broad and includes malignancy (lymphoma, metastatic disease), infections (cat-scratch disease, HIV, mononucleosis, tuberculosis, etc.), autoimmune disorders, iatrogenic causes such as medications and unusual causes including sarcoidosis and Kawasaki’s disease. A thorough history and physical can be used to help narrow this broad differential. In patients without concerning signs or symptoms suggestive of malignancy or other severe disease (e.g., B symptoms, etc.) a period of observation of four to six weeks is appropriate. If the lymphadenopathy persists beyond this period of observation, further evaluation to include CBC and chest X-ray should be pursued. Other testing to include serology for CMV, heterophile testing (monospot), PPD, HIV testing, RPR, and so on may be utilized based upon the history and physical and specific concerns. Several non-specific laboratory tests reflecting inflammation to include ESR, CRP, and fibrinogen may be used, but do not typically help narrow the differential diagnosis. Lactate dehydrogenase (LDH) is often similarly non-specific though very high levels may suggest a lymphoid neoplasm. Ultimately, persistent lymphadenopathy without an obvious etiology warrants lymph node biopsy as discussed above.

Fever, chills, night sweats, and weight loss > 10% over 6 months are the classically described “B” symptoms associated with lymphoma and the presence of these findings should increase the suspicion of this diagnosis and prompt a more aggressive approach to diagnosis.

Careful physical exam should be an important part of the evaluation of every patient with lymphadenopathy. The differential diagnosis is highly dependent upon the presence of generalized versus isolated lymphadenopathy and the lymph node basin involved when localized. Examining sites of possible metastatic spread, for example breast, skin, oropharynx, and so on is important in narrowing the differential.

5. E. Lymphoma refers to a spectrum of diseases including Hodgkin’s and Non-Hodgkin’s (NHL) lymphomas with multiple subtypes within each group. The role of the surgeon in patients with lymphoma is limited. By far, the most important role of the surgeon is in assisting with the diagnosis by means of lymph node biopsy. Once the diagnosis has been made, the treatment of lymphoma is overwhelmingly the role of chemotherapy and radiation. Historically, surgery was more involved through the use of staging laparotomy, but this is now rarely indicated with the availability and use of PET/CT for staging purposes. Surgical intervention to include splenectomy is limited to significantly symptomatic situations such as anemia, thrombocytopenia, neutropenia and massive splenomegaly, and should be done only in close consultation with oncology.

Staging for lymphoma is based upon modifications of the original Ann Arbor classification, initially described for Hodgkin’s lymphoma, but now also used for NHL. Staging is based upon number and location of lymph node groups, extra-nodal involvement, and has modifiers to signify presence or absence of B symptoms.

Several risk factors for lymphoma have been identified. There has been a significant increase in incidence since the 1970s, which has been partially
explained by the HIV epidemic. Other contributors to the increase include other infections (i.e. Helicobacter pylori-induced mucosal associated lymphoid tissue (MALT) lymphoma), autoimmune diseases, immunosuppression (as with organ transplant), environmental factors including pesticides, and aging of the population (NHL increases in incidence with age and peaks during the fifth through seventh decades). Hodgkin's lymphoma is more common in higher socioeconomic groups and less common in Asian populations.

MALT lymphoma has been shown to be dependent on Helicobacter pylori infection. Gastric inflammatory response to this infection stimulates the acquisition of genetic abnormalities and malignant transformation of B cells. In the early stages of this disease, H. pylori eradication can reverse the disease process in as many of 77% of patients. However, in later stages of the disease, further genetic injury to these malignant cells make the tumor resistant to bacterial eradication, so more aggressive therapy including chemotherapy and radiation is indicated. Like other forms of lymphoma, surgery is generally reserved for rare situations with complication such as life-threatening hemorrhage.

**BIBLIOGRAPHY**


A 77-year-old male who is a former smoker (quit 10 years ago; smoked 1 pack per day for 50 years) with COPD, type 2 diabetes mellitus, and CAD status post CABG × 3 10 years ago, presents with a 4 month history of a non-productive cough and 10 pound weight loss in the past 3 months. A CXR and CT chest demonstrate a 2 × 3.1 cm mass in his right upper lung that was not present on a CXR taken 5 years earlier.

1. What is the best appropriate next step in the management of this patient?
   A. Positron emission tomography (PET) scan
   B. Cervical mediastinoscopy
   C. Right upper lobectomy
   D. Right upper lobectomy with mediastinal lymph node sampling
   E. Bone scan and abdominal CT scan

2. Assuming this patient was diagnosed with a primary non-small cell lung cancer (NSCLC) in the right upper lobe of his lung, which of the following is an absolute contraindication to surgical resection?
   A. A post-operative predicted FEV₁ of 45%
   B. A malignant pleural effusion in the right chest
   C. Tumor directly invading the chest wall
   D. Tumor directly invading the right main bronchus 0.5 cm away from the carina
   E. Tumor directly invading the mediastinal pleura

3. When performing a right upper lobectomy, after the pleura overlying the anterior hilum are divided from anterior to posterior, what is the order of structures that would need to be divided?
   A. Superior pulmonary vein/Upper lobe bronchus/Truncus anterior
   B. Truncus anterior/Superior pulmonary vein/Upper lobe bronchus
   C. Superior pulmonary vein/Truncus anterior/Upper lobe bronchus
   D. Upper lobe bronchus/Truncus anterior/Superior pulmonary vein
   E. Truncus anterior/Upper lobe bronchus/Superior pulmonary vein

4. After resection of his tumor by a right upper lobectomy, pathology demonstrated squamous cell carcinoma with negative margins. Lymph nodes sampled were also negative for malignancy. Which of the following is true?
   A. The patient will not need any further surveillance.
   B. The only surveillance needed will be a repeat CT chest in 2 years.
   C. The most common site of relapse for NSCLC is bone.
   D. The patient will require radiation therapy for 6 months post-operatively.
   E. Most recurrences occur within the first two years after surgery.

5. If another patient presented with significant hyponatremia and seizures and was incidentally found to have similar sized lung mass in the right upper lobe, the patient would most likely benefit from which of the following treatment modalities?
   A. Surgical resection of the tumor alone
   B. Single agent chemotherapy
C. Radiation therapy alone  
D. Combination chemotherapy alone  
E. Combination chemotherapy and radiation therapy

ANSWERS

1. A. PET scanning uses fluorodeoxyglucose (FDG) with radiolabeled fluorine to help detect malignant cells. Malignant cells metabolize glucose at a higher rate than normal cells, resulting in a radiolabeled metabolite of FDG, which results in a visual marker to help identify malignant cells, nodal stage, and metastases. Surgical resection at preoperative staging is not appropriate. Although cervical mediastinoscopy may be an important step in assessing the stage of this patient's lung cancer, PET scanning may identify suspicious nodes and distant metastasis and helps guide the surgeon on where to obtain the appropriate tissue for diagnosis.

2. B. Surgery is contraindicated for Stage IIIB and IV lung cancer. T4 lesions are classified as stage IIB if they are associated with N2 disease. Tumors of any size are T4 if they invade the heart, great vessels, trachea, esophagus, vertebral body, or carina. Tumors associated with malignant pleural or pericardial effusions are considered to have M1A disease, which precludes surgical intervention. T3 tumors include tumors of any size that directly invade any of the following: diaphragm, chest wall, mediastinal pleura, parietal pericardium, or a tumor invading the main bronchus less than 2 cm from the carina (without involvement of the carina). Depending on nodal and metastatic involvement, T3 tumors may not result in a staging level of IIIB or IV. Thus, surgery may be appropriate in select patients presenting with T3 tumors.

Preoperative testing of pulmonary functional reserve is essential prior to determining whether a patient is a candidate for surgical resection. In general, a predicted post-operative FEV\textsubscript{1} less than 40% is thought to be a contraindication to surgical resection. Although a post-operative predicted FEV\textsubscript{1} of 45% is not an absolute contraindication to surgical resection, it certainly merits thorough preoperative patient assessment (including evaluation of comorbidities, and predicted lung diffusion capacity). It is also important to remember that if the lung to be resected is not actually functional (secondary to collapse or bronchial obstruction) than the post-operative predicted FEV\textsubscript{1} should not be expected to change significantly from the preoperative FEV\textsubscript{1}. Conversely, if the lung to be resected happens to be functional, but the patient has other areas of lung that are non-functional, than the FEV\textsubscript{1} will actually decrease more dramatically when this functional lung is resected.

3. C. Structures that would be need to be divided for a right upper lobectomy from anterior to posterior are the superior pulmonary vein, truncus anterior, and upper lobe bronchus. T is is a simplified description of the most commonly encountered anatomy for the main structures seen. During dissection the surgeon must be mindful of aberrant anatomy (often noted on preoperative imaging) and more commonly branching vessels, which may appear in different planes than listed above.

4. E. NSCLC is most likely to relapse within the first two years after resection (over 60%). Thus, oncologic surveillance should be done every 3 to 4 months during this time. T ough there is no single recommendation for surveillance beyond 2 years, coordinated oncologic surveillance should be performed long-term. T ough relapse of NSCLC is common in the bone, the most common site of relapse for all stages of NSCLC is the brain. Other sites of relapse include the lung (ipsilateral or contralateral), liver, and adrenal glands. T ere is no indication for radiation therapy post-operatively.

5. E. Paraneoplastic syndromes develop in as many as 40% of patients with newly diagnosed lung cancers. Significant hyponatremia in the setting of a newly diagnosed lung mass is highly suspicious of syndrome of inappropriate antidiuretic hormone (SIADH). It is important to recognize that SIADH is most commonly associated with small cell lung cancer (SCLC). In addition to hyponatremia, the diagnosis of SIADH is confirmed by demonstrating a serum osmolarity $< 275 \text{mOsm/kg}$, urine osmolarity $> \text{serum osmolarity}$, and urine sodium $> 25 \text{meq/L}$. Associated symptoms may include lethargy, nausea, vomiting, altered mental status, and seizures.

SCLC account for 20% of all lung cancers. T ese tumors are known for rapid growth, and thus often present with necrosis. T ey commonly invade vascular and lymphatic tissue, and metastasize early. Up to 70% of patients present with metastasis at the time of diagnosis. Given that SCLC is a systemic disease, chemotherapy is the primary medical treatment. Combination chemotherapy with the addition
of radiotherapy for locoregional control has been shown to improve survival. Additional prophylactic cranial irradiation has been shown to decrease the incidence brain metastasis, but has not been shown to improve overall survival.

Other paraneoplastic syndromes associated with hormone alterations should also be recognized. Often Patients with SCLC may exhibit elevations in adrenocorticotropic hormone (ACTH). This may manifest with hypokalemia, hyperglycemia, and metabolic alkalosis. Diagnosis can be confirmed by measuring elevated ACTH in the blood or elevated 17-hydroxycorticosteroid levels in the urine.

BIBLIOGRAPHY


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Abdominal Wall, Abdomen, and Gastrointestinal Tract

Robert B. Lim, Ronald A. Gagliano, Jr., and Richard Smith
A 53-year-old female presents to your clinic with complaint of abdominal bulge and occasional discomfort. She tells you that the bulge is worse when she stands and causes pain throughout the day and when she is active, and it seems to be getting bigger over the past year. She has no obstructive symptoms at this time. She has a history of a midline laparotomy for trauma when she was younger. She had a ventral hernia repair 6 years ago and thinks they put a synthetic mesh in at that time. She had an episode of cellulitis 1 year after the hernia repair that was treated with antibiotics. She has diabetes, which is controlled by oral medications but is otherwise healthy. On exam she has a large palpable defect and on CT scan she has a 6 cm defect in the midline containing omentum and small bowel as well as two additional 1cm defects superior to the larger hernia without evidence of obstruction.

1. What grade would this hernia be considered based on The Ventral Hernia Work Group (VHWG) classification?
   A. Grade 1
   B. Grade 2
   C. Grade 3
   D. Grade 4

2. Regarding ventral hernia which of the following is correct?
   A. Primary suture repair has the same recurrence rate as does mesh repair.
   B. The type of suture used for closure of a midline incision has been clearly defined as a determinant of postoperative hernia.
   C. Secondary ventral hernias are thought to be related to an abnormal ratio of type I and III collagen.
   D. Ventral hernia repair is the most common procedure performed by general surgeons.

3. Of the following positions of mesh placement for hernia repairs, which has the highest rate of recurrence?
   A. Underlay repair
   B. Onlay repair
   C. Retro-rectus inlay repair
   D. Interpositional repair

4. Regarding complications of hernia repair, which of the following is true?
   A. Surgical site infection rates range from 0% to 12% for clean cases and up to 34% for clean-contaminated and contaminated cases.
   B. The Centers for Disease Control (CDC) defines mesh infections as occurring up to 6 months after implantation of prosthetic mesh.
   C. Seroma formation is common postoperatively despite drain placement and therefore drains should be removed within 1 to 2 weeks to prevent retrograde infection.
   D. The most common organisms identified in mesh infections are gram-negative organisms such as Klebsiella and Proteus spp.
5. Which of the following is true with respect to biologic and synthetic mesh materials?
   A. Use of biologic mesh material in a contaminated field has around a 30% surgical site infection rate.
   B. Recurrence rates after biologic mesh can be as high as 30% in contaminated fields.
   C. Advanced age is associated with an increased risk of complications after abdominal wall reconstruction.
   D. Synthetic mesh infections have been successfully treated using a vacuum-assisted closure (VAC) technique without the need for mesh explantation.

ANSWERS

1. C. A grading system was created to help identify the risk of morbidity from a ventral hernia repair and to help decide which type of mesh, biologic or synthetic, would be best utilized. The patient would be considered a Grade 3 because of her history of previous infection despite not requiring mesh removal. If there was no previous infection then she would be considered a Grade 2.

   Grade 1 (low risk) would mean no comorbidities (i.e., a young healthy individual).

   A Grade 2 (comorbid) consideration means finding comorbidities (e.g., smoking, diabetes, or malnutrition) that increase the risk of surgical site infections (SSIs). There was no evidence of wound contamination or active infection.

   Grade 3 (potentially contaminated) shows evidence of wound contamination (e.g., seroma, violation of the GI tract, or history of wound infection). This includes patients with active or suspected wound contamination.

   Grade 4 (infected) would be considered if active infections such as infected synthetic mesh or a septic dehiscence was found.

2. C. It has long been established that direct suture repair for ventral hernia has an unacceptably high
   recurrence rate with the exception of small 1 to 2 cm primary hernias. There has been speculation that at the time of primary operation the type of suture used for closure correlates with rate of incisional hernia formation; however, there is no conclusive evidence to support this notion. Primary ventral hernias are thought to have a genetic predisposition, while secondary or incisional hernias are likely related to abnormal ratios of Type I and III collagen as well as the amount of metalloprotease expression. An average of 150,000 to 250,000 ventral hernias are performed each year making it the fifth most common procedure.

3. D. Interpositional repair where the mesh is sutured directly to the fascial edge in a bridging fashion has largely been abandoned due to the extremely high recurrence rates. Onlay mesh repair places the mesh above the rectus sheath. There are several types of inlay repair. In the retrorectus repair, the mesh is placed between the rectus abdominis muscle and the posterior rectus sheath. Alternatively the mesh can be placed preperitoneal between the posterior rectus sheath and the preperitoneal fat. An intraperitoneal or underlay type repair places the mesh underneath the peritoneum. This type of repair is used for laparoscopic repairs. Because the mesh is placed under the peritoneum, intraperitoneal repair is thought to have higher rates of adhesions and erosion of the mesh into the bowel. In general, the type of repair is surgeon preference.

   Advances in mesh products such as composite mesh with anti-adhesive barriers have been developed to decrease complications. Onlay type mesh repairs have more potential for seroma formation because a large subcutaneous dissection is required and is also more susceptible to contamination from infection because of its superficial location. Inlay mesh repairs are generally preferred because of their ability to distribute intra-abdominal wall pressure and decrease overall tension. Also underlay and retrorectus repairs have been shown to have the lowest recurrence rates of all types of mesh repair with the highest being interposition and onlay.
4. A. Surgical site infections are common after ventral hernia repair and are defined as superficial, deep, and organ space infections. Intraoperative level of wound contamination based on CDC criteria include clean, clean-contaminated, contaminated and dirty correlates with rate of surgical site infections. Clean cases have an infection rate of 0% to 12% while clean-contaminated and contaminated have infection rates at high as 34%. The CDC defines mesh infections as occurring up to 1 year after implantation of prosthetic mesh. The most common organism cultured from infected mesh is *Staphylococcus aureus* and is seen in up to 81% of cases. This suggests a possible skin flora contamination at the time of mesh implantation. While gram-negative organisms are presents in mesh infections, they only occur about 17% of the time. Seromas are common after ventral hernia and drains are recommended to decrease the dead space. While they can cause retrograde bacterial contamination, there is no definitive recommendation of time for removal and are often necessary for up to 4 to 6 weeks.

5. D. Prolonged operative time and American Society of Anesthesiologists (ASA) > 2 have been associated with major operative complications, but advanced age has not been shown as a predictor of morbidity. Particular comorbidities identified were obesity, smoking, hypertension, diabetes and anemia. Berrevoet et al. showed that use of vacuum-assisted closure (VAC) techniques can be successful in treating surgical site infections, including synthetic mesh infections. A meta-analysis by Bellows et al. including 60 studies showed a 17% surgical site infection and 15% recurrence rate in Grade 3 contaminated fields after biologic mesh repair.

**BIBLIOGRAPHY**


A 44-year-old male presents to the emergency department. He has had complaints of abdominal pain over the last several days. Today he was bending over to pick up something off of the floor and he felt a sudden sharp pain at his belly button. He states the area is now very tender and achy. He has felt some nausea for the last hour or two. No change in bowel habits prior to this episode. His past medical history is significant for an umbilical hernia, hypertension and cirrhosis. Past surgical history is for an appendectomy when he was 27. He smokes ½ ppd and has 2–3 drinks per day. He denies any drug use. When pressed he states that his doctors told him his liver problems are because he “drinks too much”.

Vital signs are: HR 105, BP 140/91, RR 18, Pulse Ox 98% on RA. On exam there is no evidence of jaundice. He is noted to have tenderness directly at the umbilicus with a protuberant abdomen. It is dull to percussion. There are skin changes noted at the umbilicus, specifically an area of ulceration and a non-reducible hernia is noted.

Labs:

WBC: 13.1; Hgb/Hct: 13.5/40; Platelets: 202
Na: 138; K: 3.7; BUN/Cr: 23/1.4; TBili: 1.7; INR: 1.6

1. Which of the following negatively affects the patient’s perioperative mortality risk specifically due to his cirrhosis?
   A. White blood cell count of 13.1
   B. Hypertension
   C. Alcohol consumption
   D. Smoking
   E. INR

2. Which of the following factors is associated with increased incidence of abdominal wall hernias in patients with cirrhosis?
   A. Increased clotting time
   B. Single episode of ascites formation
   C. Rising creatinine
   D. Recanalized umbilical vein
   E. Decreased mobility

3. Which of the following relates to worse outcomes in the setting of emergent repair of an umbilical hernia in the cirrhotic patient?
   A. Mesh insertion
   B. Smoking
   C. Omentectomy
   D. Small bowel resection
   E. Anemia

4. Best management of an umbilical/ventral hernia in a patient with cirrhosis and ascites would include which of the following?
   A. Elective repair rather than emergent management
   B. Preoperative ascites control only
   C. Postoperative ascites control only
   D. Primary repair of the hernia
   E. Intra-operative drain placement only
ANSWERS

1. E. In a cirrhotic patient, the extent of the cirrhosis affects the perioperative mortality; but the etiology of cirrhosis does not have to be taken into consideration. To determine the patient’s 90-day mortality, the Model for End Stage Liver Disease (MELD) score can be used. The MELD score is calculated by the equation:

\[
\text{MELD} = 3.78 \times \ln[\text{serum bilirubin (mg/dL)}] + 11.2 \times \ln[\text{INR}] + 9.57 \times \ln[\text{serum creatinine (mg/dL)}] + 6.43
\]

As such, the patient’s bilirubin, INR, and creatinine affect his survival chances. This system was developed to determine outcomes for patients having undergone transjugular intrahepatic portosystemic shunt (TIPS) procedures. It has now become the standard for determination of severity of liver disease (having replaced the Childs Classification) and based on the new criteria as outlined by the United Network for Organ Sharing (UNOS), frequency of dialysis was applied to the formula. In addition the etiology of the cirrhosis (or end-stage liver disease) was not found to be a significant prognostic indicator and was removed from the original MELD score. In our particular patient the MELD score is 17, which correlates with a 6% 3-month mortality.

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<th>MELD Scores</th>
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<tr>
<td>40 or more</td>
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2. D. Patients with liver cirrhosis and ascites have a risk of developing an umbilical hernia that approaches 20%. A single episode of ascites is not highly associated with abdominal wall hernia formation. However as the number of episodes of ascites increases, so does the incidence of hernia formation, such that by the third episode about 70% of patients will have developed an umbilical hernia. The other factors, which include increased intra-abdominal pressure, muscle wasting and weakening of the abdominal fascia related to malnutrition and recanalization of the umbilical vein, are all contributing factors to the development of umbilical hernias in the cirrhotic patient. The decreased functional status, rising creatinine from kidney dysfunction, and the increased platelet dysfunction due to uremia do not influence the development of a hernia.

3. E. In the setting of emergent repair of abdominal wall/umbilical hernia in the cirrhotic patient, preoperative anemia was the only preoperative predictor of complicated outcome. The other factors that were found to be statistically significant and related to major complications were age greater than 65 and higher Model for End Stage Liver Disease (MELD) score. Additionally, the authors in this study noted that small bowel obstruction in this setting had a ninefold increase in risk for postoperative complications. However, smoking, omentectomy, mesh insertion and small bowel resection were not found to be significant factors in the development of postoperative complications.

4. A. In a randomized controlled trial of 80 patients having repair with or without mesh by Ammar, the author found that primary repair of an umbilical/ventral hernia in the setting of cirrhosis and ascites has a significantly higher recurrence rate than when a mesh repair is performed (14.2% vs 2.7%, p < 0.05). Most authors now advocate for more aggressive elective repair of hernias in patients with cirrhosis and ascites even in the setting of Class B and C cirrhosis. In the study by Carbonell et al they found that elective surgical morbidity in cirrhotics was no different from non-cirrhotics (15.6% vs. 13.5%, p = 0.18). Emergent surgery morbidity was statistically significant between the 2 groups (17.3% vs. 14.5%, p = 0.04). While differences in elective surgical mortality in cirrhotics approached significance (0.6% vs. 0.1%, p = 0.06), mortality was 7-fold higher in emergency surgery (3.8% vs. 0.5%, p < 0.0001). In addition the opportunity to utilize laparoscopy in the elective setting in this patient population has the ability to mitigate postoperative complications and decrease length of hospitalization. Medical diuresis, postoperative paracentesis and drain placement at time of surgery are all factors that improve the postoperative course after hernia repair in these patients. Odom et al noted a significant increase in major complications when no invasive measure was used to control the ascites.

BIBLIOGRAPHY

Online MELD calculator: http://www.mayoclinic.org/medical-professionals/model-end-stage-liver-disease/meld-modelunos-modification
An otherwise healthy 31-year-old male presents with a painless bulge in his right groin. Although it does not bother him or limit his daily activities, he notices fluctuation in its size, from being absent when he lies flat for a few minutes, to a golf-ball sized mass upon coughing or strenuous exercises. Physical examination confirms the presence of a right inguinal hernia. No abnormalities were noted on the contralateral side.

1. Regarding the management and indications for surgical intervention of asymptomatic inguinal hernias, which of the following is correct?
   A. Observation is not recommended, as the incidence of inguinal hernia strangulation is greater than 10% after 5 years.
   B. Elective surgical repair is advised for otherwise healthy patients, as procedure is fairly low-risk and post-operative complications are always minor, if any.
   C. Both watchful waiting and surgical repair are safe as treatment options, however most patients will develop symptoms over time and require an operation.
   D. The type of inguinal hernia, whether direct or indirect, heavily dictates the management approach, as incarceration is at least ten times more often in the case of direct hernias.
   E. As emergency and elective inguinal hernia repairs share similar morbidity and mortality rates, watchful waiting is always considered a safe option.

2. Which of the following is considered the most common early complication after open inguinal hernia repair?
   A. Surgical site infection
   B. Hematoma/seroma
   C. Urinary tract infection
   D. Small bowel obstruction
   E. Recurrence

3. Which of the following is true regarding laparoscopic inguinal hernia repair?
   A. It is generally less expensive than the open repair.
   B. Potential complications are similar, or less severe, to those seen with open repair.
   C. Procedure is limited to the repair of only one defect in the inguinal region given poor visualization of the anatomy.
   D. Although patients have a faster return to daily activities, they are associated with greater persistent pain and numbness compared to the open approach.
   E. It is usually the favored approach in special situations such as in recurrent or bilateral inguinal hernias.

4. After an open inguinal hernia repair, which symptom is likely to appear as a result of the most commonly injured nerve in this type of approach?
   A. Numbness on ipsilateral upper lateral thigh
   B. Numbness on ipsilateral medial thigh
   C. Hyper response of the cremasteric reflex
   D. Hyperesthesia of the ipsilateral hemiscrotum
   E. Numbness of the suprapubic region
5. Which of the following is true regarding femoral hernias?
   A. Watchful waiting or surgical repair are both reasonable options to consider in otherwise healthy patients diagnosed with asymptomatic femoral hernia.
   B. The mesh plug repair is the preferred approach in emergent cases.
   C. Rate of incarceration and strangulation is reported as greater than 40%.
   D. Men are more likely than women to experience this type of hernia.
   E. Its sac protrudes through the femoral canal, bounded medially by the femoral vein.

**ANSWERS**

1. C. As one of the naturally weak points in the abdominal wall, the groin area is prone to the protrusion of peritoneal sac. When this occurs in the presence of minor symptoms or in the absence of symptoms altogether, the condition is known as asymptomatic inguinal hernia. One-third of patients with inguinal hernias fall within this category, presenting with a non-tender bulge in the area.

   The inferior epigastric vessels, as well as the internal and external inguinal rings, provide anatomic landmarks that help in distinguishing direct and indirect inguinal hernias. The sac of a direct hernia protrudes outward and forward, medial to the internal inguinal ring and the inferior epigastric vessels. On the other hand, indirect hernias pass from the internal ring obliquely toward the external ring, lateral to the vessels. A pantaloon-type hernia occurs when both of these features are present. Regardless, the anatomic distinction between these is of little importance given the similarities in the approach for operative repair. More traditional descriptions of inguinal hernias are made on the basis of its contents (e.g., sliding, Richter’s, Littre’s), or the status of the contents (e.g., sliding, incarcerated, strangulated).

   With more than 20 million operations performed annually around the world, inguinal hernia repair is the most common elective procedure performed in the United States and Europe. There is a well-documented debate as to what the best management is for asymptomatic inguinal hernias, that being between the operative and the watchful waiting approach. The rationale of repairing all inguinal hernias, whether symptomatic or not, lies on their risk of incarceration and strangulation. Elective repairs are considered relatively safe with low short-term morbidity, mortality, and recurrence rates. It is different from emergent operations, which carry higher morbidity and mortality rates given the additional risks of gangrene, perforation, and infection of the peritoneal cavity. Nonetheless, watchful waiting spares the patient from the complications of elective surgery such as surgical site infection, hematoma, urinary retention, and more in the long-term, chronic groin pain, neuralgia and recurrence.

   Studies by Fitzgibbons et al. and O’Dwyer et al. have been key in addressing the differences between elective surgery and watchful waiting. Although they both show no difference in terms of discomfort and pain across groups, there is a rate of conversion driven mainly by pain of 54% and 72% after 5 and 7.5 years, respectively, in those managed non-operatively. A more recent systematic review of the evidence by Mizrahi et al. (Arch Surg. 2012;147:277–81) shows that the rate of strangulation in those who do not pursue surgery is quite low at less than 1% after a two- and a four-year follow-up period. On the other hand, the range of operative complications in those undergoing elective surgery goes from 0% to 22.3%, with a recurrence rate of 2.1%. Both treatment options are thus considered safe, although most patients will progress to develop symptoms and eventually require an operation.

2. B. The overall risk of complications following open inguinal hernia repair is low, and fortunately, these are oftentimes transient and easy to manage. Several factors play a role in the occurrence of complications, including the surgical technique, surgeon experience, and anesthetic choices. Wound and scrotal hematomas are amongst the most common early postoperative complications, with reported rates of 6.1% and 4.5%, respectively. Neumayer L et al. compared open mesh versus laparoscopic inguinal hernia repair and reported a combined incidence of hematoma or seroma of 13.6% in open cases, and 16.4% in those performed laparoscopically. Other less common adverse events seen in the immediate postoperative period include urinary retention, orchitis, pain, and urinary tract and wound infections. As for long-term complications, chronic pain tops the list, with a reported rate of 14% to 19% following open repairs with some series reporting frequencies as low as 6% or as high as 75.5%. The risk is lower following laparoscopic cases, with rates ranging between 9.8% to 13.8%. Orchitis, infection, and hernia recurrence are amongst other common late complications.
3. E. The approach and operative technique for the repair of inguinal hernias has evolved throughout the years. Repairs can be either done open or laparoscopically. The open approach can be either a tissue repair or a prosthetic (tension-free) repair. Although the former might be of historical interest, there are some situations in which these may be indicated such as in a contaminated field, in pediatric patients, or in those places where access to prostheses is limited. By identifying increased tension as the main cause of recurrence, Lichtenstein popularized the use of a synthetic mesh to bridge the hernia defect and provide a tension-free repair. This approach is the gold standard of open hernia repairs, as it has proven to decrease the rates of postoperative discomfort, duration of hospital stay, and recurrence. The laparoscopic approach also offers a tension-free repair. Those who support this technique emphasize the quicker time to recovery, less pain, better visualization of the anatomy, and the ability to repair all the defects in the inguinal region. On the other hand, critics insist on the longer operative times, technical challenges, risk of recurrence, and increased costs. A meta-analysis study by Voyles et al. (Am J Surg. 2002;184:6–10) compared the two approaches and showed that both provide equivalent outcomes, with open repairs being lower in cost, and entailing a lower risk of severe postoperative complications. Those unique to the laparoscopic approach include small bowel obstruction, internal hernia, bladder perforation, infarcted omentum, and port-site hernia.

Special situations may favor the use of the laparoscopic approach. In the setting of bilateral inguinal hernias, the ability to use the same access sites evidently translates into faster recovery and less postoperative pain. However, whether done open or laparoscopically, the simultaneous repair of bilateral hernias does not increase the risk of re-operation for recurrence. Another typical challenge for the surgeon is that of recurrent hernias. These may be caused by either technical problems (e.g., knot slipped, crushed suture, inadequate bites of fascia), or patient factors such as malnutrition, steroid use, and smoking. A second groin exploration entails cutting through scar tissue that in itself adds a certain degree of difficulty and additional trauma with increased risk of damage to the testicular blood supply and sensory nerves. Access through virgin territories through a posterior approach explains the advantage of laparoscopic repairs in these situations.

4. B. Depending on the approach used, specific nerves in the area will be more prone to injury. For example, in open hernia repairs, the ilioinguinal nerve can be most commonly injured at the external ring where it runs on top of the cord. This results in loss of the cremasteric reflex and numbness to the ipsilateral penis, scrotum, and thigh. On the other hand, the posterior approach used in laparoscopic surgery can result in injuries to the lateral femoral cutaneous, femoral branch of the genitofemoral (sensory, upper lateral thigh), and rarely, the femoral nerves. Hyperesthesia
of the hemiscrotum and numbness of the suprapubic region are not complications of nerve injury from inguinal hernia repairs.

5. C. Rate of incarceration and/or strangulation is reported to be greater than 40%. Another potential defect where hernias can occur is that of the femoral canal, bounded superiorly by the iliacus muscle, inferiorty by the lacunar ligament, laterally by the femoral vein, and medially by the junction of the iliopectineal tract and lacunar ligament. Its difficult diagnosis and treatment pose a challenge to even the more experienced surgeon. Added to this, a large proportion of patients with this type of hernia present late to medical care, oftentimes requiring emergent interventions that translate in higher risk of adverse postoperative events. Women are more likely to experience this type of hernia than men, comprising about 30% of their groin hernias (versus only 2% in men). As they are usually associated with incarceration and strangulation (reported rates between 44% and 86%), the most adequate treatment once diagnosed is surgery. All femoral hernias should be repaired, and in the presence of incarcerated contents, the sac should be assessed for viability. Delayed diagnosis will lead to higher morbidity and mortality. Different repair techniques are available and mainly depend on the clinical presentation. Many consider the mesh plug repair as the technique of choice in elective and non-infected cases. In contrast, the tissue repair (i.e., McVay operation) should be preferred in strangulated cases in which severe infection is present.

BIBLIOGRAPHY


A 65-year-old female is seen in your clinic for a “lump” in her groin. She states the lump has been present for a few years and intermittently becomes larger in size. On exam, there is no evidence of adenopathy or venous thrombosis. A reducible hernia is palpated. You perform an uncomplicated McVay repair and she is seen in follow up one year later with a recurrence.

1. Regarding femoral hernias, which of the following is true?
   A. It is an acquired defect.
   B. It has a male preponderance.
   C. It is more common than inguinal hernias.
   D. The incidence of incarceration is lower than inguinal hernias.

2. Regarding the McVay technique for hernia repair, which answer choice displays the key steps in order?
   A. Expose Cooper’s ligament, suture transversus abdominus aponeurosis to Cooper’s ligament beginning at the pubic tubercle towards the femoral sheath, place transition stitch containing transversus abdominus, Cooper’s ligament, femoral sheath medial to femoral vein, and inguinal ligament (iliopubic tract), approximate the conjoint tendon to the inguinal ligament laterally to the internal ring.
   B. Expose Cooper’s ligament, make relaxing incision on anterior rectus sheath, suture transversus abdominus aponeurosis to Cooper’s ligament beginning at the pubic tubercle towards the femoral sheath laterally to the internal ring.
   C. Expose Cooper’s ligament, make relaxing incision on anterior rectus sheath, suture transversus abdominus aponeurosis to Cooper’s ligament beginning at the pubic tubercle towards the femoral sheath laterally to the internal ring.
   D. Expose Cooper’s ligament, suture transversus abdominus aponeurosis to Cooper’s ligament beginning at the pubic tubercle towards the femoral sheath laterally to the internal ring.

3. Regarding recurrence of this patient’s hernia, which of the following is the most likely etiology?
   A. Congenital collagen disorder
   B. Wound infection
   C. Tension on suture line
   D. Postmenopausal

4. Regarding repair of groin hernias, which of the following techniques will fix a femoral hernia?
   A. Bassini repair
   B. Marcy repair
   C. Shouldice repair
   D. Preperitoneal repair
   E. Lichtenstein tension free with mesh repair

**Answers**

1. A. Femoral hernias are acquired hernias and NOT of congenital origin. They are more common in females
and more common in older women who are multiparous, as laxity of the abdominal wall and stretching of the femoral ring with aging or pregnancy is felt to be an etiology. Given the mostly fixed, confined spaces of the femoral canal, these hernias are notorious for incarcerating leading to emergent/urgent hernia repair.

A study from the Swedish Hernia Register showed an incidence of 2 to 4 percent of all groin hernias over a 14 year period. Of these hernias, 35.9% of femoral hernias were found to present as an emergency (incarceration) needing surgery, and of these, 22.7% required bowel resection. This is compared to only 4.9% needing emergency surgery in the inguinal group. It is seen more commonly in women, roughly 2:1 female: male.

2. **B.** The McVay repair, aka the Cooper’s Ligament repair, is a tissue repair that is effective in repair of all three groin hernias (indirect, direct, and femoral). It is performed with non-absorbable sutures in an interrupted fashion. Sutures are placed to sew the transversus abdominis aponeurosis to Cooper’s ligament beginning at the pubic tubercle towards the femoral sheath. Once this is reached, place a transition stitch containing transversus abdominis, Cooper’s ligament, femoral sheath medial to femoral vein, and inguinal ligament (iliopubic tract), then approximate the transversus abdominal aponeurosis to the inguinal ligament laterally to the internal ring. Exposure of Cooper’s ligament is done prior to suturing. Additionally, to avoid tension, a curvilinear relaxing incision is made through the anterior rectus sheath starting 1cm cephalad of the pubic tubercle to near its lateral border.

3. **C.** Tension on the suture line is felt to be the most common cause of hernia recurrence in general and especially in tissue repairs. This is why an adequate relaxing incision is necessary in the McVay repair. Most likely, there was some tension on the repair despite the relaxing incision.

A shift has been made to tension free repairs with the usage of mesh. Tissue vs mesh repair was compared in a large meta-analysis containing over 11,000 patients specifically looking at recurrence rates after hernia surgery. Findings of this show the odds of developing a recurrent hernia with mesh repairs were reduced by about half, though recurrence rates were relatively small with each repair. Other factors can contribute to recurrence such as wound infection, but are not the primary/most common cause. Congenital collagen disorder is a rare disorder and is not likely to be seen in this patient.

4. **D.** Lichtenstein tension free hernia repair with mesh is the most common hernia repair done at most institutions. It requires little suturing, does not need a relaxing incision, and does not need general anesthesia. Unfortunately, the drawback of this repair is that it does not close, nor cover, the femoral ring. Therefore, it is not used for repair of femoral hernias.

The Marcy repair only repairs the deep inguinal ring and is mostly used in pediatric patients. The Bassini and Shouldice repairs only repair the inguinal floor and will not treat a femoral hernia.

The preperitoneal repair, a variation known as the Kugel repair, involves placing mesh in the preperitoneal space and suturing this from the pubic tubercle to Cooper’s ligament. Bi-layer mesh repair, in theory is a combined preperitoneal and Lichtenstein repair with mesh and is used for femoral hernia repair. Plug and patch repair can be utilized to obliterate the femoral canal in femoral hernia repair. Laparoscopic repair, as with the above repairs, is a described technique for repair of femoral hernias and utilizes the preperitoneal space.

**BIBLIOGRAPHY**


A 35-year-old male presents to clinic three months after an uncomplicated open right inguinal hernia repair with mesh for a chronic, minimally symptomatic, indirect inguinal hernia. During the operation, the ilioinguinal nerve was intentionally divided. He reports continued right-sided, sharp, episodic groin pain radiating to his testicle that is worse than the symptoms he had prior to repair. He took ibuprofen and acetaminophen for 6 weeks after the surgery with minimal relief. The pain is beginning to limit his activities at work. He now complains of worsening pain.

1. Regarding the pathophysiology of chronic groin pain after hernia surgery, which of the following is correct?
   A. Most commonly, it is felt to be neuropathic and due to primary nerve injury during the operation.
   B. It is felt to be due to inflammatory mechanisms from the operation and healing.
   C. It is nociceptive.
   D. Tacking mesh to nerves in a laparoscopic repair is an uncommon cause.
   E. Secondary nerve injury from either inflammation or nerve degeneration from mesh contact is the most common cause.

2. Regarding the management of chronic groin pain after hernia surgery, which of the following is correct?
   A. Imaging studies (ultrasound, CT scan, and/or MRI) are suggested to rule out underlying causes.
   B. Peripheral nerve block should be attempted to confirm diagnosis.
   C. Referral to a pain management specialist is recommended.
   D. Triple neurectomy is recommended only after failing less invasive treatments by a pain management specialist.
   E. All are correct.

3. Regarding nerve injuries in hernia repair, which of the following is correct?
   A. Injury to the ilioinguinal nerve causes loss of cremasteric reflex, and numbness to the ipsilateral scrotum, penis, and medial thigh.
   B. Injury to the femoral branch of the lateral femoral cutaneous nerve causes loss of sensation to the medial thigh.
   C. Tack placement inferior to the iliopubic tract and medial to the spermatic cord is avoided to minimize nerve damage in laparoscopic hernia repair.
   D. Injury to the genital branch of the genitofemoral nerve results in loss of sensation of the entire scrotum and lack of cremestric reflex on the contralateral side.

4. Regarding surgical management of post-herniorrhaphy neuralgia, which of the following is correct?
   A. Tailored neurectomy is more effective than triple neurectomy at decreasing symptoms postoperatively.
   B. Triple neurectomy is effective at eliminating pain in upwards of 80% of patients, making this the most effective surgical therapy.
C. Mesh explantation alone is an effective strategy and has been shown to be superior to neurectomy with or without mesh explantation.
D. Patients with pre-existing pain hyper-sensitization are ideal candidates for neurectomy.

5. Regarding intentional division of the ilioinguinal nerve at time of initial herniorrhaphy, which of the following is correct?
A. There is no difference in sensory loss between division and preservation of the nerve.
B. A significant decrease in postoperative chronic pain is seen when the ilioinguinal nerve is intentionally divided during initial surgery.
C. There is no significant difference in decreasing chronic postoperative groin pain.
D. There is less debilitating pain with routine division of the ilioinguinal nerve.
E. There is less pain if the nerve is clipped versus being divided by electrocautery.

ANSWERS

1. A. Chronic postoperative groin pain is felt to be secondary to neuropathic pain from aberrant nerve conduction as a result of either primary or secondary nerve injury. Typically, it is ongoing pain, which is difficult to manage. Initial postoperative pain is due to inflammatory cytokine release and nociceptive mechanisms. Nociceptive pain is pain felt via neural pathways in which tissue damage surrounding the nerves is the stimulus. This type of pain typically resolves over 6 weeks and is amendable to anti-inflammatory medications such as NSAIDS.

Primary nerve injury is defined as direct nerve injury and can occur during hernia repair in multiple ways. During dissection, complete or partial nerve transection can occur later forming a neuroma. Additionally, handling of the nerve can result in crushing, stretching or burns from cautery. Most commonly, the nerve is incidentally entrapped with mesh, suture and/or staple.

Secondary nerve injury is defined as nerve degeneration/demyelination from an inflammatory process. It is not as common as primary nerve injury in the pathogenesis of postherniorrhaphy neuralgia. Secondary nerve injury is felt to be from meshoma, excessive scar tissue or contact with mesh not involving entrapment.

2. E. Chronic groin pain, or chronic postherniorrhaphy inguinal pain, after hernia surgery is diagnosed by chronic pain at site or region of prior hernia repair that persists postoperatively for over three months that cannot be attributed to another cause. The prevalence of postoperative chronic groin pain varies from study to study. A large Swedish survey including 2500 patients, noted 14% of patients had lifestyle limiting groin pain, and 30% chronic pain that didn’t hinder their lifestyle. A smaller series noted 1.5% of patients had moderate to severe pain at five years. Interestingly, it is more common in younger patients, with persistent pain in 58% of patients under the age of 40 and only 14% of those older than age 40.

Upon presentation of a patient you suspect has chronic postoperative groin pain, anti-inflammatory treatment should be attempted but usually has little effect on neuropathic pain. In this instance, an ilioinguinal nerve block can help confirm diagnosis and is indicated. Additionally, nerve ablation with phenol or radiofrequency ablation is used. Patients who fail less invasive means of treatment should undergo triple neurectomy.

Non-neuropathic pain must be excluded. This is done with history, physical, and imaging studies. The ideal imaging study has not been determined by randomized trials. In general, ultrasound is the least expensive test with minimal risk to the patient. However, CT and MRI can provide a better representation of the location of mesh, location of neuronal structures, and presence of recurrent hernias.

3. A. An injury to the femoral branch of the lateral femoral cutaneous nerve causes lack of sensation to the lateral thigh and not the medial thigh as mentioned in the answer. T is nerve is seen in laparoscopic hernia repairs and is not encountered during open inguinal hernia repair. Other nerves encountered laparoscopically include the lateral femoral cutaneous nerve, the ilioinguinal nerve lateral to the internal ring, the iliohypogastric (which cannot be seen but could be injured with mesh fixation), the genital branch of the genitofemoral nerve, and the femoral nerve. T e so called “triangle of pain” is defined as the iliopubic tract superiolaterally, the spermatic vessels posterioromedially, and the reflected peritoneal edge laterally. T is contains the genitofemoral nerve and the lateral femoral cutaneous nerve. Minimization of nerve injuries laparoscopically is achieved by avoiding
tack placement inferior to the iliopubic tract laterally beyond the external iliac artery.

For open inguinal hernia repairs, the ilioinguinal nerve is the most common cause of pain. Injury to this nerve can also cause ipsilateral scrotal, thigh, and penis numbness as well as loss of the cremasteric reflex. Injury to the genital branch of the genitofemoral nerve can less commonly cause pain. More commonly, scrotal sensation and lack of cremasteric reflex on the ipsilateral side are seen.

4. B. Given the significant morbidity and difficulty of the operation, neurectomy is reserved for patients who fail pain management strategies. Patients with pre-existing pain syndromes or hyper-sensitization are not ideal surgical candidates. Of the operative strategies, triple neurectomy of the ilioinguinal, iliohypogastric and genital branch of the genitofemoral nerve has been shown to be the best at a surgical cure. There have been a few small trials studying success rates for triple neurectomy, the largest looking at 225 patients. Of these, 80% reported resolution of pain, 15% had transient pain, and only 2 patients reported no improvement.

Tailored neurectomy could be beneficial as it is less morbid, leaving the patient with less sensory loss. Although tailored neurectomy has not been compared to triple neurectomy, and only been studied in small studies, it was found to provide complete pain relief in only 54% of patients, giving partial relief in 24% of patients and leaving 24% with no benefit.

Mesh explantation alone is not likely to be an effective strategy for the treatment of chronic post-herniorrhaphy neuralgia unless secondary nerve injury either by excessive scar formation over the mesh or nerve contact with the mesh not associated with entrapment, or meshoma by imaging is suspected. No randomized controlled trials have compared triple neurectomy with and without mesh explantation; but if mesh removal alone does not relieve the pain then proceeding with a third operation in the inguinal region may result in a very difficult dissection, inability to identify all 3 nerves, and worsening pain.

5. C. Intentional ilioinguinal nerve division during herniorrhaphy has been postulated to decrease chronic groin pain. Its benefits have been studied in multiple randomized control trials. It is clear that operative division will decrease sensation along the
distribution of the nerve (the groin and hemiscrotum). However, no statistically significant advantage at decreasing post-herniorrhaphy neuralgia at 1 month, 6 month, and 1 year follow ups has been shown in large studies and meta-analysis of over 1200 patients.

BIBLIOGRAPHY


A 63-year-old female presents with a history of gastroesophageal reflux disease (GERD). She takes a PPI twice daily and complains of having more regurgitation over the past 6 months. She has a history for diabetes mellitus and hypertension. She has no history of alcohol or tobacco use. She is otherwise in good health with no other problems. Her BMI is 38 kg/m².

1. What is the most likely cause of her symptoms?
   A. Gastroparesis
   B. Esophageal cancer
   C. Gastric ulcers
   D. Hiatal hernia
   E. Obesity

2. What should be the next appropriate test?
   A. CXR
   B. Manometry
   C. pH monitoring
   D. Endoscopy

3. What is the most common type of hiatal hernia?
   A. Type I
   B. Type II
   C. Type III
   D. Type IV

4. Regarding the etiology of hiatal hernias most are?
   A. Congenitally acquired
   B. Have no familial hereditary pattern
   C. Similar to a Bochdalek hernia
   D. Result from a weakening of the phrenoesophageal ligament

5. The patient undergoes an uneventful diaphragm repair and a Nissen fundoplication. Two years postoperatively the patient presents with a recurrence of her symptoms. On evaluation, it is noted that the Nissen fundoplication is slipped. What is an alternative for repair?
   A. Colles gastroplasty
   B. Roux-En-Y gastric bypass
   C. Ivor-Lewis esophagectomy
   D. Esophagomyotomy

ANSWERS

1. D. Hiatal hernia is quite common in the population with up to 60% of the population having such hernias. Approximately 9% are symptomatic. Regurgitation can be the only symptom but at times some will have cardiac and pulmonary symptoms. Esophageal cancer must be on the differential diagnosis with anyone presenting with regurgitation and a history of GERD. It is unlikely to be cancer as the patient has not had any dysphagia or weight loss. Gastric ulcers are associated with GERD but will usually present with abdominal pain. Diabetic neuropathy can affect the intestinal tract and can cause gastroparesis. Patients with this condition can have regurgitation, abdominal fullness, and pain. The patient has no other symptoms consistent with diabetic periperal neuropathy. Obesity is a risk factor to reflux disease but the most common cause in this patient is likely a hiatal hernia.

2. D. The workup has to exclude other pathologies. Endoscopy is essential to the evaluation of patients.
presenting with GERD, to determine the extent of esophagitis, and to determine the extent of a hiatal hernia, to rule out malignancy. Manometry can be used to evaluate the LES and look for motility disorders. pH monitoring is the gold standard for diagnosing and quantifying acid reflux. Impedance pH can also be performed to discern the difference between non-acid and acidic reflux. Additionally, the use of either CT or a swallow study can be used for evaluation of the motility of the stomach and can help decipher if there is a need for pyloroplasty or pyloromyotomy.

3. A. Type I (sliding) hernia: Upward herniation of the cardia in the posterior mediastinum, the GE junction migrates above the diaphragm. Type I hiatal hernias are the most common at 90%.

Type II (paraesophageal) hernia: The GE junction remains in the normal anatomical position, the fundus herniates through the hiatus.

Type III (mixed) hernia: Characterized by an upward herniation of both the cardia and the gastric fundus.

Type IV hiatal hernia: An additional organ, usually the colon but could involve the spleen or liver, herniates as well.

4. D. Cephalad migration of the gastroesophageal junction may result from weakening of the phrenoesophageal ligament. Depletion of elastin fibers leads to stretching of the ligament and proximal displacement of the gastroesophageal junction. Most cases of hiatal hernia are acquired rather than congenital. A small number of cases of familial hiatal hernias have been shown. Bochdalek hernias are congenital hernias involving the right posterior diaphragm usually found in children, it is extremely rare to find in the adult population with less than 100 published cases.

5. B. A good alternative for failed fundoplications is a Roux-En-Y Gastric Bypass. Kim et al. showed that at 11 months, 93.3% of patients were symptom-free. Colles Gastroplasty is used as a lengthening procedure and has no role in the management of revision on its own. Esophagectomy has no role in the revision of slipped fundoplication. Esophagomyotomy is used to treat achalasia to release the pressure on the LES. A slipped Nissen refers to the stomach that slips under the wrap creating a hourglass shape deformity that can be seen on UGI. This is different from a recurrence where the stomach re-herniates into the chest.

BIBLIOGRAPHY
A 42-year-old male for whom you recently performed a successful inguinal hernia repair, presents to your clinic with a chief complaint of increasing difficulty swallowing some solids and occasionally liquids. He reports this has been worsening for the last 5 months. He has been treated by his primary care physician with daily omeprazole, but this does not seem to be improving his symptoms. Since you did such a good job in repairing his hernia, he is now coming to you for advice on this problem. He appears healthy, his vital signs are normal, and he is maintaining his normal weight.

1. The most appropriate initial study to help you sort through the differential diagnosis of this patient's dysphagia is?
   A. Contrast esophagram
   B. Esophageal manometry
   C. Esophagogastroduodenoscopy
   D. H. pylori testing
   E. Chest X-ray

2. A contrast esophagram image is shown to the right. What additional study or studies should be ordered next in the diagnostic workup of this patient?
   A. Esophageal manometry
   B. Esophagogastroduodenoscopy (EGD)
   C. 24-hour pH monitoring
   D. 24-hour pH monitoring and EGD
   E. Esophageal manometry and EGD

3. Upper endoscopy reveals no evidence of esophagitis, but some food is present in the distal esophagus. Manometry shows aperistalsis and a non-relaxing LES. Which initial treatment offers the patient the best chance of long term-relief?
   A. Pneumatic dilation of the LES
   B. Calcium channel blocker therapy
   C. Esophageal myotomy with fundoplication
   D. Botulinum toxin injection at LES
   E. Esophagectomy
4. Suppose in this same patient, that the results of the manometry do not show achalasia. Instead, the standard esophageal manometry shows 10/10 normal propagated swallows with a mean distal esophageal amplitude pressure of 293 mm Hg. The lower esophageal sphincter pressure is normal and relaxes completely. The results of ambulatory pH monitoring and EGD were both normal. What is the most likely diagnosis?

A. Achalasia  
B. Pseudoachalasia  
C. Diffuse esophageal spasm  
D. Nutcracker esophagus

**ANSWERS**

1. **A.** Contrast esophagram offers the most useful information in initially sorting through this differential. The esophagram shown essentially eliminates diverticula and a hiatal hernia.

2. **B.** This esophagram would typically be followed up with an EGD. While the esophagram shown makes the diagnosis of a diverticula or a hiatal hernia less likely, there are still several diagnoses that are not ruled out or confirmed. An EGD would be needed to exclude anatomical causes for dysphagia, such as neoplasm or stricture. The EGD would also be used to document any evidence of reflux or eosinophilic esophagitis. If there is no reflux seen on EGD, a 24-hour pH study could confirm the presence of functional reflux disease. If the 24-hour pH study is normal, then a manometry study could be done to rule out motility disorders like achalasia, diffuse esophageal spasm, connective tissue disorders, and nutcracker esophagus. Even if the 24-hour pH study is confirmatory, though, an esophageal manometry should be done to rule out a concomitant underlying motility disorder. By skipping the EGD and proceeding directly to manometry, a diagnosis, such as pseudoachalasia secondary to a distal anatomic partial obstruction, may be missed.

<table>
<thead>
<tr>
<th>Differential Diagnosis</th>
<th>Confirmatory Test</th>
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<tbody>
<tr>
<td>Neoplasm</td>
<td>Esophagram</td>
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<tr>
<td>Diverticulae</td>
<td></td>
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<tr>
<td>Hiatal Hernia</td>
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</table>

3. **C.** This patient has achalasia. In the absence of an obstructing entity (neoplasm, hiatal hernia, diverticula) retained food in the esophagus is suspicious for achalasia. The diagnosis is confirmed by manometry. In patients with achalasia, the manometry demonstrates an esophagus in which there is complete absence of peristalsis and an LES pressure that is normal to moderately elevated, but fails to completely relax. Although a hypertensive LES and an LES that fails to completely relax are often associated with achalasia, only the complete absence of peristalsis is required for the diagnosis. The pathophysiology of achalasia is loss of ganglion cells in the myenteric plexus and interruption of inhibitory vagal nerve innervation.

The treatment for achalasia requires relaxing the hypertensive smooth muscles of the LES. In general, that can be done surgically by dividing the muscles of the LES, injecting botulinum toxin endoscopically, or dilating the LES using a balloon. This is also done endoscopically. Surgical treatment with myotomy provides long-term treatment of achalasia with a high success rate. Calcium channel blockers have shown inconsistent success and do not have a role in achalasia treatment. Botulinum toxin usually requires repeated interventions every 6 to 12 months, as does dilation. Both eventually become less effective. These may be good options in persons who are poor operative risks or in those who do not want surgery.

Esophagectomy would be required in the setting of cancer and is indicated as a last resort if multiple myotomies fail. The POEM or per oral endoscopic myotomy technique involves dividing the LES muscle endoscopically. This has the advantage of
avoiding most surgical risks. The long-term success rate, though, is unknown and is not yet considered the equivalent of a surgical myotomy.

4. D. Manometry is used to rule out esophageal motility disorders. Not only does it measure how well food travels down the esophagus into the stomach, it also measures the pressure inside the esophagus and the LES. The normal pressure of an LES is 10 to 15 mm Hg. Patients with GERD will often have a hypotensive LES with a pressure of around 5 to 8 mm Hg and normal to moderately abnormal peristalsis. The low LES pressure is thought to allow gastric contents to reflux back into the esophagus.

Twenty-four-hour ambulatory manometry can be used to diagnose spastic disorders such as Diffuse Esophageal Spasm (DES), nutcracker esophagus, or hypercontractile esophageal motility disorder is a rare cause of dysphagia. The nutcracker esophagus is characterized by very high LES pressures (> 50 mm Hg) during swallowing with otherwise normal peristalsis. DES would be characterized by high pressures throughout the esophagus (25–50 mm Hg) and poor peristalsis. Pseudoachalasia would show a slightly hypertensive but relaxing LES and abnormal but not absent peristalsis. Connective tissue disorders, like scleroderma, would be hallmarked by poor peristalsis and a normal LES.

BIBLIOGRAPHY


A 68-year-old male with a history of hypertension and hypercholesterolemia presents to his primary care physician’s office with a chief complaint of worsening epigastric pain and weakness. The pain is improved with oral intake, especially milk-based products. The patient has been treating his pain with naproxen. In the office, the patient is non-toxic with normal vital signs. His physical examination reveals mild epigastric tenderness with deep palpation. Serum hemoglobin was 8.3 g/dL. Fecal occult blood testing was positive. The patient underwent colonoscopy, which was normal. Esophagogastroduodenoscopy (EGD) revealed a 2.5 cm ulcerated lesion with elevated, irregular borders 5 cm distal to the gastroesophageal junction.

1. Appropriate management of the ulcer includes?
   A. Observation
   B. Cessation of naproxen and begin sucralfate and a proton-pump inhibitor with repeat EGD in 3 months
   C. Biopsy the ulcer
   D. Proximal gastrectomy
   E. Total gastrectomy

2. Final pathology reveals a poorly differentiated adenocarcinoma. The most sensitive preoperative examination to determine T and N stage is:
   A. Positron emission tomography (PET) scan
   B. Endoscopic ultrasound (EUS)
   C. Magnetic resonance imaging (MRI) with gadolinium
   D. Diagnostic laparoscopy
   E. Triple-phase helical computed tomography (CT) scan

3. The EUS suggests a T3N0 lesion. The most appropriate next step would be:
   A. Neoadjuvant therapy
   B. Proximal gastrectomy with negative margins (R0) only
   C. Total gastrectomy
   D. Total gastrectomy with splenectomy and distal pancreatectomy
   E. Esophagogastrectomy with colonic interposition graft

4. The final pathology revealed a T4N1 lesion with negative margins. The patient should next receive:
   A. No additional therapy
   B. Imatinib
   C. External-beam radiation only
   D. Fluorouracil-based chemotherapy only
   E. External-beam radiation and fluorouracil-based chemotherapy

5. Which of the following describes the association between Irish’s node and gastric cancer?
   A. An anterior mass palpable on digital rectal examination
   B. A metastatic left supraclavicular lymph node
   C. An ovarian mass from metastatic tumor
   D. Metastatic left axillary lymph node
   E. Umbilical mass suggestive of metastatic gastric cancer
ANSWERS

1. C. Historically, biopsy of gastric ulcers was uniform practice throughout medical and surgical disciplines since there was a 5% to 11% attendant risk of malignancy. However, data now suggest that the incidence of gastric cancer is decreasing, thereby rendering mandatory biopsy of all gastric ulcers unnecessary. When gastric ulcers have features suggestive of malignancy such as elevated irregular folds, association with a polypoid or fungated mass, and abnormal adjacent mucosal folds, then biopsy is warranted (Fig. 23-1). Several biopsies, typically 6 or more, are necessary to minimize the false negative risk. If benign ulcers are diagnosed, then EGD is repeated in 6 weeks to ensure resolution. All ulcers should be followed and biopsied until complete resolution occurs. If malignancy is detected, then further work-up with potential operative intervention is pursued.

Ulcers with a diameter of 3 cm or greater are termed giant gastric ulcers (Fig. 23-2). These large ulcers harbor an underlying malignancy in 30% of lesions. Given the higher incidence of malignancy, perforation, and bleeding surgical treatment is warranted.

2. B. EUS is important in preoperative locoregional staging for gastric cancer. It is currently the best imaging modality for assessing both tumor depth and nodal invasion. Spatial resolution of 0.1 mm can be achieved with EUS. T staging accuracy ranges from 60% to 90%, whereas N staging accuracy ranges from 50% to 80%. EUS is better at identifying T1 (80%) and T3 (90%) lesions as opposed to T2 (38.5%). EUS is not reliable at delineating between individual benign and malignant lymph nodes. Increasing T stage directly correlates with increased risk of nodal and distant metastasis (> 80% likelihood of nodal metastasis in T3 disease versus < 5% in stage T1 m).

CT remains an important preoperative tool to evaluate for metastatic disease. If metastatic disease is present, an unnecessary operation can be avoided. T staging accuracy with CT approaches 80% (66% to 77%). N stage determination is variable with a wide range of 25% to 86%. Small gastric tumors and metastases less than 5 mm can be missed on CT. CT, MRI, and PET scanning show promise for preoperative staging, but have yet to become standard of care.

Routine diagnostic laparoscopy to minimize unnecessary operations has become a less popular pre-resection strategy. However, diagnostic laparoscopy still has a role in advanced gastric cancer. Power et al., in 2009, evaluated patients with known gastric cancer without obvious metastatic disease and stratified them into low-risk (T1–2, N0) and high-risk (T3–4, N+, or both) groups based on EUS. Both groups underwent diagnostic laparoscopy, which identified M1 disease in 20.5% of the high-risk patients and 4% of the low-risk patients. The study concluded that laparoscopy can be avoided in patients with EUS early stage cancer, whereas more advanced gastric cancers would benefit from diagnostic laparoscopy to rule out occult metastatic disease. When diagnostic laparoscopy is performed, peritoneal lavage cytology should be obtained as positive results.
can alter further therapy. Diagnostic laparoscopy, however, does not address the T or N stage.

3. A. Although the patient will ultimately need an operation, the MAGIC trial demonstrates that the patient will benefit from neoadjuvant therapy instead of proceeding straight to the operating room, unless the patient is hemorrhaging from the mass resulting in hemodynamic instability. Neoadjuvant therapy consisting of epirubicin, cisplatin, and fluorouracil is recommended for patients with T2 lesions or higher. The benefits from the preoperative therapy are to reduce tumor size and stage, eliminate micrometastases, improve tumor-related symptoms, and determine whether tumors are sensitive to chemotherapy.

Gastric adenocarcinoma exists as two distinct entities: diffuse and intestinal type. Table 23-1 summarizes these distinct subtypes. Controversies surrounding the surgical management of gastric adenocarcinoma include: adequacy of surgical margins, need for resection of adjacent structures (i.e. spleen and distal pancreas), and extent of lymphadenectomy. Diffuse type gastric adenocarcinoma spreads in the submucosa, thereby increasing the risk of microscopic residual positive margin (R1 resection). In order to minimize the risk of leaving microscopic disease or recurrence, a 5 to 6 cm margin is considered acceptable for an R0 resection. Newer studies emerging from Japan suggest that smaller proximal resection margins of 2 to 3 cm are adequate for T1 lesions. If the patient went straight to surgery, total gastrectomy is preferred as the tumor is within 5 cm of the gastroesophageal junction. Esophagogastrectomy is unnecessary when the gastroesophageal junction has no direct tumor involvement and surgical margins exceed 5 cm.

Assessing nodal disease at the time of operation can be difficult. A minimum of 15 lymph nodes is recommended for staging. Most surgeons tend to remove the perigastric lymph nodes (D1 resection). In countries like Japan where gastric cancer has a higher prevalence, a more aggressive D2 lymphadenectomy is frequently employed harvesting lymph nodes along the celiac trunk and its named branches, the middle colic artery, the superior mesenteric artery, and the periaortic area. Several studies have demonstrated prolonged survival with the more aggressive (D2) lymphadenectomy. It is thought to be related to better locoregional disease control. A recent randomized trial comparing D1 versus D2 lymphadenectomy did not reveal a significant difference in long-term survival. Accordingly, more studies regarding the extent of lymphadenectomy are required before a long-term endorsement of this more aggressive strategy can be made.

Removal of adjacent structures (i.e., distal pancreas and spleen) confer no survival benefit and actually increase morbidity and mortality. Resection of these adjacent structures should be reserved for primary tumor invasion.

4. E. The final pathology revealed Stage III gastric cancer. Given the high rate of locoregional failure (40% to 70%) and a 5-year survival rate of 20% to 28%, adjuvant therapy is recommended. This recommendation originates from the Intergroup Trial 0116, which demonstrated a benefit for those patients with advanced gastric cancer undergoing curative resection combined with postoperative fluorouracil-based chemotherapy and radiation. The CLASSIC trial demonstrated survival advantages using an adjuvant chemotherapy therapy regimen of capecitabine and oxaliplatin.

Resection without adjuvant therapy resulted in decreased survival when compared with those who

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<tr>
<th>Characteristic</th>
<th>Intestinal</th>
<th>Diffuse</th>
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<tr>
<td>Age</td>
<td>Older</td>
<td>Younger</td>
</tr>
<tr>
<td>Gender</td>
<td>Male &gt; Female</td>
<td>Male = Female</td>
</tr>
<tr>
<td>Metastatic route</td>
<td>Hematologic</td>
<td>Lymphatic, submucosal spread which can result in a thickened, non-distensible stomach known as linitis plastica</td>
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<tr>
<td>Site of metastasis</td>
<td>Liver</td>
<td>Peritoneum</td>
</tr>
<tr>
<td>Risk factors</td>
<td>Atrophic gastritis, intestinal metaplasia, Helicobacter pylori infection, and diet high in salt, smoked, and preserved foods</td>
<td>CHD-1 mutation, obesity</td>
</tr>
<tr>
<td>Cellular etiology</td>
<td>Glandular gastric mucosa</td>
<td>Lamina propria</td>
</tr>
<tr>
<td>Prognosis</td>
<td>Better</td>
<td>Poor</td>
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received postoperative chemoradiation. Palliation can be achieved with either external-beam radiation or chemotherapy, but local control and long-term survival are poor. Imatinib is a tyrosine-kinase inhibitor currently used for gastrointestinal stromal tumors and other malignancies.

5. D. In general, physical findings portend advanced disease. Patients are typically cachectic and jaundiced when nodal metastatic disease obstructs the common bile duct. Irish's node is an enlarged lymph node within the left axilla. A prerectal mass palpable on digital rectal examination is a Blumer's shelf suggestive of a drop metastasis. Virchow's node, also known as Troisier's sign, refers to carcinomatous involvement of the left supravacular lymph nodes at the junction of the thoracic duct with the subclavian vein. Krukenberg tumors are ovarian masses from metastatic gastric cancer. The Sister Mary Joseph node is a periumbilical nodule suggestive of carcinomatosis. It reflects tumor extension from the falciform ligament.

BIBLIOGRAPHY
Shin D, Park SS. Clinical importance and surgical decision-making regarding proximal resection margin for gastric cancer. WJGO. 2013;5:4–11.
A 62-year-old man with hypertension was referred to the general surgery clinic for further evaluation of chronic abdominal pain, bloating, and early satiety, which had been worsening over several months. He was previously healthy except for hypertension controlled with metoprolol and a history of inguinal hernia repair. His last screening colonoscopy performed 2 years ago was negative. On review of systems, he endorses significant fatigue. Laboratory results are consistent with mild anemia. An abdominal CT scan was obtained for further evaluation and revealed a large tumor of gastric origin (pictured below).


1. The best next step to definitively diagnose this lesion is:
   A. Abdominal MRI
   B. Endoscopic ultrasound with FNA
   C. Percutaneous image-guided biopsy
   D. Diagnostic laparoscopy with biopsy and peritoneal washings

2. Biopsied tissue is positive for KIT (CD117) upon immunochemical staining. Which of the following is true of this type of tumor?
   A. Gastrointestinal stromal tumor (GIST) most commonly arises from the stomach.
   B. The most common subtype is epithelioid.
   C. A positive stain for KIT (CD117) is required to make the diagnosis of GIST.
   D. The most common site of metastatic spread is the peritoneum.
   E. All tumors >1 cm should be considered potentially malignant.

3. Further review of the CT scan raises concerns that this 6-cm tumor may involve the neck of the pancreas. There is no evidence of distant metastatic disease. Further therapy in this case should include:
   A. Surgical resection with en-bloc removal of the involved pancreas to achieve 1 cm negative margins.
   B. Neoadjuvant imatinib prior to surgical therapy.
   C. Avoidance of pancreatectomy by enucleation of the tumor.
   D. An open rather than laparoscopic approach should be used.
   E. An extended lymphadenectomy should be performed.
4. After appropriate therapy, final pathology returns with a GIST of gastric origin, 6 cm in greatest dimension with 15 mitoses per high-power field. Which of the following is true regarding this patient?

A. Adjuvant therapy with imatinib will increase his chance of recurrence-free and overall survival at 5 years.
B. If this lesion were in the small bowel, the prognosis would be better.
C. This patient is at low risk of tumor recurrence.
D. Five year overall survival for all GIST patients is about 50%.

5. Which of the following is true of gastrointestinal stromal tumors?

A. Because they arise from the mucosa, GISTS are easily identified at endoscopy.
B. Surgical resection is often appropriate for patients with recurrent or metastatic GIST.
C. These tumors arise from the smooth-muscle cells of the intestinal wall.
D. GIST tends to arise as a solitary lesion.
E. Abdominal pain is the most common clinical manifestation of GIST.

ANSWERS

1. B. The CT slice shown demonstrates a large, well-demarcated, heterogeneously enhancing mass that appears to grow outward from the wall of the stomach. These findings are characteristic of gastric GIST, although the differential diagnosis includes gastric adenocarcinoma, carcinoid, lymphoma, or leiomyosarcoma, as well as tumors of pancreatic, renal, or adrenal origin. GIST is a relatively uncommon neoplasm, with an incidence of about 7 per million population in the United States and Europe. The benefits of EUS include defining the layer of stomach wall from which the tumor originates, delineating its relationship to surrounding structures, and obtaining a tissue diagnosis transluminally, which avoids the risk of seeding a percutaneous biopsy tract. Percutaneous image-guided biopsy may result in intraperitoneal tumor spillage or hemorrhage as a result of the friable, vascular nature of these tumors and is therefore less desirable. MRI offers no additional benefit over CT diagnostically, though it may provide more information regarding the tumors relationship to surrounding tissues. Diagnostic laparoscopy with peritoneal washings for cytology has a prognostic role in gastric adenocarcinoma, but a similar role has not been established in GIST. Laparoscopic excision of the lesion may be performed without a tissue diagnosis for a small tumor, but the goal in this case is resection to clear margins, rather than simply to obtain tissue for diagnostic purposes and therefore, endoscopic ultrasound is the best choice.

2. A. The presence of the c-kit receptor tyrosine kinase on tumor cells, as in this case, is diagnostic of GIST. However, it is noteworthy that about 5% of gastrointestinal stromal tumors are KIT-negative and only about 80% have a KIT mutation. Other useful histologic markers include CD34 and smooth-muscle actin, if KIT negative GIST is suspected. The most common histologic subtype is the spindle-cell variety (70%), followed by epithelioid (20%) and mixed subtypes (10%). All tumors greater than 2 cm in size should be considered malignant, even in the absence of metastases on initial work-up. The most common site of metastatic spread of GIST is the liver, followed by the omentum and peritoneum. If present, these metastases are often identified by contrast-enhanced CT scanning. Metastasis to the lymph nodes, lung, or other distant sites may occur, but this is quite rare. Thus, extended surgical lymphadenectomy is not indicated for these tumors. Over half of all GISTs arise from the stomach, making it the most common primary site.

3. B. When surgical morbidity can be reduced by its use, preoperative therapy with imatinib, a receptor tyrosine kinase inhibitor, should be strongly considered. In this case, tumor down-staging could potentially eliminate involvement with the pancreas and obviate the need for pancreatectomy. For localized GIST, surgical resection is indicated and is curative for low risk lesions. If necessary to achieve an R0 resection, en-bloc removal of involved organs outside the primary site is indicated. However, there is no additional survival benefit to resection beyond microscopically negative margins. An extended lymphadenectomy also offers no benefit to the patient, as nodal metastasizes are uncommon with GIST occurring about 1% of the time. Enucleation of the tumor risks violating its pseudocapsule which may result in intraoperative tumor spillage, resulting in recurrence rates approaching 100%. Though laparoscopic surgery for GIST has not been prospectively evaluated, there is good retrospective evidence to show adequate oncologic outcomes with this approach. Rates of R0 resection between 97% and 100% and disease free survival
and overall survival rates of over 90%. In the past, an open approach for tumors larger than 5 cm has been recommended. Current guidelines indicate that laparoscopy is appropriate for larger tumors, providing sound oncologic principles are maintained.

4. A. Tumor size, mitotic rate, and location are important prognostic factors in GIST. Tumors with a size < 5 cm have a 5-year overall survival of about 70%. T is drops to about 45% when tumor size is > 10 cm. Similarly, about 75% of patients with < 5 per high-power field will survive 5 years, only 20% of those with more than 5 per high-powered field are alive at 5 years. Tumors of gastric origin are more favorable than those originating in the small bowel, with survival rates of approximately 75% and 50%, respectively, after 5 years. Tumor rupture before or during surgery also portends a poor prognosis, as discussed above. Given the mitotic rate of the tumor in this case, the patient has a relatively poor prognosis. Adjuvant therapy with imatinib for 1 year has been shown to increase recurrence-free survival by 15% and, if continued for 3 years, improve 5-year overall survival by 10%. However, about half of all patients will develop resistance to the drug within 2 years of its initiation. For these patients, other tyrosine kinase inhibitors (i.e. sunitinib) remain effective second line therapy. Historically, the overall survival for all patients with GIST at 5 years has been about 50%. However, in the era of imatinib, the 5-year OS has improved to 84%, though survival varies markedly between patients with Stage 1 tumors (nearly 100%) versus more Stage 3 and higher tumors (22%).

5. D. Gastrointestinal stromal tumors are more likely to be solitary than multiple. T is stands in contrast to carcinoid tumors, which often occur multiply. T ey arise from the muscular layer of the intestinal wall, but from the interstitial cells of Cajal, not the smooth muscle cells. T eir location in the muscular layer can make small GISTs somewhat difficult to detect and lead to underestimation of tumor extent by endoscopy.

At presentation, GIST is frequently found to be metastatic, most commonly to the liver or peritoneum. Presenting symptoms may include abdominal pain, dyspepsia, or early satiety, but gastrointestinal bleeding is the most common occurrence, leading to the eventual diagnosis of a GIST: Life-threatening hemorrhage from intra-abdominal rupture of these highly vascular tumors may also occur. Generally speaking, imatinib chemotherapy is considered first line therapy for metastatic or recurrent GIST and surgical resection is often inappropriate due to high rates of recurrence. However, some patients with tumors response to imatinib and lesions that are felt to be completely resectable may benefit.

BIBLIOGRAPHY


A 56-year-old man with a 4-month history of vague epigastric abdominal pain, decreased appetite and weight loss presents to his local gastroenterologist for evaluation. An esophagogastroduodenoscopy (EGD) reveals non-specific gastritis and a polypoid lesion in the region of the antrum. Laboratory findings note mild anemia, elevated LDH, and H. pylori positive samples from the EGD.

Follow-up endoscopic ultrasound (EUS) notes a thickened antral wall, and multiple biopsies obtained reveal an extra-nodal marginal zone B cell lymphoma of mucosa (gut)-associated lymphoid tissue (MALT) type (MALT lymphoma). Computed tomography of the chest, abdomen, and pelvis reveals thickening of the distal half of the stomach with no evidence of adenopathy. Bone marrow biopsy reveals no evidence of disease dissemination.

1. After the patient has undergone a complete staging work-up as noted above, what stage low-grade gastric MALT lymphoma does this patient have?
   A. Stage I
   B. Stage II
   C. Stage III
   D. Stage IV
   E. Unknown

2. The proper surgical management of this patient with gastric lymphoma is:
   A. Total gastrectomy with D2 lymph node dissection
   B. Total gastrectomy with D1 lymph node dissection
   C. Partial gastrectomy with D1 lymph node dissection
   D. Partial/total gastrectomy with no lymph node dissection
   E. Surgical resection is not warranted in most cases

3. First line therapy for a MALT lymphoma as noted in the patient above would consist of which of the following?
   A. Surgical resection
   B. Radiation therapy
   C. Chemotherapy
   D. H. pylori eradication
   E. Watchful waiting

4. What is the management for persistent, localized, MALT lymphoma following repeatedly failed efforts at H. pylori eradication therapy?
   A. Radiation therapy
   B. Surgical resection
   C. Chemotherapy
   D. Rituximab
   E. Bevacizumab

5. How does the treatment strategy change in patients with high-grade gastric lymphoma (advanced MALT lymphoma or diffuse large B-cell lymphoma)?
   A. Surgical resection
   B. Radiation therapy alone
   C. Chemotherapy alone
   D. H. pylori eradication
   E. Combined chemotherapy with or without radiation therapy
ANSWERS

1. A. The staging of gastric lymphoma is paramount in the proper management of the disease. Although often indolent, approximately 10% of patients with gastric lymphoma will present with advanced disease. EGD allows for visualization of the lesion and often tissue sampling as well as H. pylori diagnosis. Endoscopic ultrasound is also an important diagnostic procedure that can determine extent of disease, depth of invasion, and often allows more complete tissue sampling. EUS also allows for accurate estimates of depth of invasion, which is an important prognostic marker for disease recurrence. CT of the chest, abdomen, and pelvis is important to assess for disseminated disease while a bone marrow biopsy will detect evidence of distant disease in up to 15% of patients. Standard laboratory testing includes complete blood count and LDH, as well as other standard chemistries.

Based on the National Comprehensive Cancer Network (NCCN) Clinical Practice Guidelines, the Lugano Staging System for Gastrointestinal Lymphoma is adequate. It is modification of the Ann Arbor Staging System is noted below, directly compared with the Ann Arbor Staging System. Utilizing either staging system is appropriate. Based these staging systems, the above patient has Stage I disease.

2. E. Gastric lymphoma is the second most common gastric malignancy (behind gastric adenocarcinoma) and the most frequent cite of extra-nodal non-Hodgkin's Lymphoma. For decades, surgical resection was considered appropriate therapy for all stages of "resectable" gastric lymphomas. Although surgical resection has provided outstanding results and excellent long-term survival, stomach preserving methods have provided equivalent results without the morbidity associated with gastrectomy (partial or total) for both low-grade and high-grade B-cell lymphomas. A prospective trial by the German Multicenter Trial group in 2005 examined 185 patients with Stage I and II low-grade gastric lymphoma and noted no difference in survival between those patients treated surgically and those receiving no surgical intervention. A follow-up study by the same group examined an additional 393 patients and provided similar results. The results are similar for high-grade gastric lymphomas, where survival rates between primary surgery and primary chemotherapy and radiation therapy groups is equivalent. Surgical intervention for gastric lymphoma is largely reserved for rare cases of perforation, or hemorrhage that cannot be controlled endoscopically. Stomach preserving treatment strategies are now the standard of care in the management of gastric lymphoma.

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<tr>
<th>Lugano Staging System</th>
<th>Ann Arbor Staging System</th>
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<tr>
<td><strong>Stage I</strong> - The tumor is confined to the gastrointestinal tract. It can be a single primary lesion or multiple, noncontiguous lesions.</td>
<td><strong>Stage I</strong> - Involvement of a single lymph node region (I) or of a single extralymphatic organ or site (IE)*</td>
</tr>
<tr>
<td><strong>Stage II</strong> - The tumor extends into the abdomen. It is further subdivided based upon the location of nodal involvement:</td>
<td><strong>Stage II</strong> - Involvement of two or more lymph node regions or lymphatic structures on the same side of the diaphragm alone (II) or with involvement of limited, contiguous extralymphatic organ or tissue (IIE)</td>
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<tr>
<td>• <strong>Stage IIa</strong>: Involvement of local nodes (paragastric nodes for gastric lymphoma or para-intestinal nodes for intestinal lymphoma)</td>
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<tr>
<td>• <strong>Stage IIb</strong>: Involvement of distant nodes (para-aortic, para-caval, pelvic, oringuinal nodes for most tumors; mesenteric nodes in the case of intestinal lymphoma)</td>
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<tr>
<td>• <strong>Stage IIIE</strong>: The tumor penetrates the serosa to involve adjacent organs or tissues</td>
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<td><strong>Stage IIIa</strong> - There is no stage III disease in this system.</td>
<td><strong>Stage III</strong> - Involvement of lymph node regions on both sides of the diaphragm (III), which may include the spleen (IIIS) or limited, contiguous extralymphatic organ or site (IIIIE) or both (IIIES)</td>
</tr>
<tr>
<td><strong>Stage IVa</strong> - There is disseminated extranodal involvement or concomitant supra-diaphragmatic nodal involvement.</td>
<td><strong>Stage IV</strong> - Diffuse or disseminated foci of involvement of one or more extralymphatic organs or tissues, with or without associated lymphatic involvement</td>
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3. **D.** Gastric MALT lymphomas arise from B-cells and constitute approximately 50% of gastric lymphomas, with the diffuse large B-cell lymphoma making up the other large proportion of gastric lymphomas. Although surgical therapy was considered the mainstay of therapy for decades, in the late 1980s, a connection between Campylobacter (later Helicobacter) pylori, chronic gastritis and mucosal associated lymphoid tissue (MALT) was suspected. By the early 1990s, the connection between the two was firmly established and the treatment of gastric MALT lymphoma with H. pylori eradication was instituted. A meta-analysis of 34 studies with 1271 patients noted an overall H. pylori eradication rate of 98.3%, associated with a complete remission of gastric lymphoma in 77.8% of patients. The relapse rate for patients was 2.2% per year, and only 0.05% of patients had transformation of low-grade lymphoma into an aggressive, high-grade lymphoma. Frequent endoscopic monitoring (3 month intervals initially) is paramount to assess for treatment response. Patients with pathology revealing clearance of H. pylori and resolution of lymphoma will require continued surveillance. These patients with persistent H. pylori should receive additional eradication therapy. If gastric lymphoma persists despite multiple rounds of anti-H. pylori therapy, the addition of external beam radiation and/or chemotherapy is warranted.

Patients with H. pylori negative gastric MALT lymphoma often have a documented translocation t(11;18), and thus eradication therapy is often not effective. These patients are treated with radiation therapy as first-line therapy. Rituximab has shown some effectiveness in these patients as well, and is currently considered in those patients with persistent localized disease and a contraindication to radiotherapy.

4. **A.** The management of persistent, localized, early stage gastric MALT lymphoma is radiation therapy. Although there are various approaches taken in the management of these patients, radiation therapy (external beam, 30–40 cGy) has shown excellent results and is the recommended treatment by NCCN guidelines. In general, first-line salvage therapy provides remission rates of 90.1%. Radiation therapy was superior to chemotherapy or surgery, with a 97.3% remission rate versus 92.5% for surgery, and 85.3% for chemotherapy. In fact, radiation therapy as a sole therapy was found to be superior to even combined modality approaches.

Further support for radiation therapy is provided by Goda, et al. who noted an overall remission rate of 92% with excellent long-term (10-year) survival data. Additional studies show long-term remission rates of 88% to 97% (5 to 7.8 years). For some patients with Stage I disease, chemotherapy may be added to radiotherapy, but this is not considered the standard approach. Chemotherapy for low-grade gastric MALT lymphoma is typically reserved for persistent Stage II disease or patient presenting with more advanced disease (Stage IIIe or IV). The exact chemotherapeutic regimen for advanced stage gastric MALT lymphoma is not well established, but is often treated with agents utilized against follicular lymphomas.

5. **E.** As addressed earlier, surgical therapy has been largely abandoned as the primary treatment of gastric lymphoma, including patients with advanced gastric MALT lymphoma and gastric diffuse large B-cell lymphoma (DLBCL). A study examining the long-term outcomes in patients treated with surgery alone, surgery followed by radiation therapy, surgery followed by chemotherapy and chemotherapy alone noted that complete response rates were similar in the 4 arms. But, survival was significantly improved in patients receiving chemotherapy, with no clear benefit to combined modality therapy with surgery and chemotherapy. In fact, late toxicity was more frequent and severe in patients who had surgery.

In terms of H. pylori eradication, studies are ongoing. It was once thought that there was little benefit in treating H. pylori in these patients, since there was no MALT component in most patients. Although there are cases exhibiting both gastric MALT lymphoma and DLBCL, first-line therapy was typically targeted at the more aggressive entity. Recently, there has been some success noted with H. pylori eradication in early stage DLBCL patients that are H. pylori positive. In comparing patients with pure gastric DLBCL and mixed (MALT and DLBCL), H. pylori eradication rates were 100% and 94.1%, respectively. Remission rates were 68.8% for pure DLBCL and 56.3% for the mixed gastric DLBCL. Prospective studies are ongoing. Currently, chemotherapy, with or without biologic therapy, is considered first-line therapy for gastric DLBCL, which is considered the more aggressive of the two most common gastric lymphomas.
NCCN clinical practice guidelines note that Stage I and II disease are treated with chemotherapy with localized radiation therapy added in certain cases. The chemotherapeutic regimens utilized vary, but the most common regimen combines cyclophosphamide, doxorubicin, vincristine, and prednisone (CHOP) and often the addition of a biologic agent (rituximab) (R-CHOP). The CHOP regimen shows complete remission (CR) rates of 87% to 100% with good long-term survival. An examination of the R-CHOP regimen reveals similar statistics with a CR rate of 87%, with the remaining 13% exhibiting a partial remission. The addition of radiation therapy for early stage disease has been examined and there was a notable decrease in local recurrences in those patients treated with radiation therapy. But, radiation therapy did not add to overall survival when compared with chemotherapy alone. Overall, radiation therapy is selectively added to chemotherapy in patients with gastric DLBCL, specifically for local control.

For patients with more advanced disease (specifically Lugano Stage IV), chemotherapy alone is utilized with radiation therapy reserved as needed for local control of symptoms.

**BIBLIOGRAPHY**


**SCENARIO 1**

A 58-year-old male presents to your clinic with upper abdominal pain and heartburn after meals. He occasionally relieves symptoms with chewable antacids (calcium carbonate). He denies other problems except for gaining 5 lbs over the last year with decreased exercise. He has no surgical history, takes no medications, and has no significant family history. He used to smoke, but quit 15 years ago and drinks 2 glasses of red wine each night.

1. Other than improving his diet and decreasing his alcohol intake, what medication would you prescribe to best limit his esophageal acid exposure?
   A. Proton pump inhibitor (PPI)  
   B. H2 receptor antagonist (H2RA)  
   C. Calcium carbonate  
   D. Sucralfate as needed

2. He is started on the medication and experiences relief. He returns to your clinic 1 year later, but now the medication is no longer relieving his symptoms. He also reports occasional cough and the sensation that he has to clear his throat. What should be your next step?
   A. Esophagogastroduodenoscopy (EGD)  
   B. Perform barium swallow  
   C. Perform 24 hr ambulatory pH monitoring  
   D. Perform pulmonary function tests

3. He follows up in 3 weeks with a barium swallow, pH monitoring, and an EGD from an outside provider. He provides a copy of the 24 hr ambulatory pH monitoring report to you, which can be viewed below. He has a sliding (Type I) hiatal hernia, and no evidence of intestinal metaplasia or ulcers.

<table>
<thead>
<tr>
<th>Acid Reflux Composite Score Analysis (Johnson/DeMeester) (pH)</th>
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<tbody>
<tr>
<td>Tr eshold</td>
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<tr>
<td>Upright time in reflux</td>
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<tr>
<td>Recumbent time in reflux</td>
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<td>Total time in reflux</td>
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<tr>
<td>Episodes over 5 min</td>
</tr>
<tr>
<td>Longest episode</td>
</tr>
<tr>
<td>Total episodes</td>
</tr>
<tr>
<td>Composite score</td>
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NOTE: Composite score patient values are normalized for 24 Hours.
CHAPTER 26 GASTROESOPHAGEAL REFUX DISEASE

4. **What is the intervention would you offer him at this time?**
   A. Esophagectomy
   B. Nissen fundoplication
   C. Heller myotomy with Dor fundoplication
   D. Botulinum toxin injection

3. **A small intrathoracic perforation is confirmed. In your determination of a management plan, which of the following is an absolute contraindication to non-operative management?**
   A. Time of perforation > 72 hrs
   B. A history of Barrett's esophagus with low grade dysplasia
   C. Perforation contained in the mediastinum
   D. Evidence of SIRS (systemic inflammatory response syndrome)

5. He undergoes a Nissen fundoplication without complication and is discharged the following day. Five days after surgery, he returns for follow up appointment reporting left upper quadrant pain. He is hemodynamically normal and has a hemoglobin one point lower than his preoperative values. CT scan of the chest, abdomen, and pelvis shows a heterogeneous left upper quadrant fluid collection without rim enhancement and an associated small left pleural effusion.

   **What is the most appropriate initial management for this patient?**
   A. Admit for fluids and observation
   B. Admit for antibiotics and total parenteral nutrition
   C. Return to the operating room
   D. Percutaneous drainage

**SCENARIO 2**

A 63-year-old female with a long history of gastroesophageal reflux disease presents to your clinic after a gastroenterologist performs an EGD. She is diagnosed with Barrett's esophagus without evidence of dysplasia based upon the results of several biopsies.

1. **When should her next EGD with biopsy be performed for appropriate surveillance?**
   A. 3 months
   B. 6 months
   C. 1 year
   D. 3 years

2. Her follow-up EGD demonstrates Barrett’s esophagus with low-grade dysplasia on multiple biopsies, so she is scheduled for follow up EGD in 6 months. She presents to the ER 12 hours later with rapid respirations, tachycardia, fever, and elevated WBC. Based upon your clinical suspicions, what is the best initial diagnostic test?
   A. Gastrografin esophagography
   B. T in barium esophagography
   C. CT with IV contrast for PE/DVT protocol
   D. EGD

**ANSWERS TO SCENARIO 1**

1. A. The mainstay of medical treatment of GERD is acid suppression. Patients with persistent symptoms should be given PPIs, such as omeprazole. In doses as high as 40 mg/d, they can effect an 80% to 90% reduction in gastric acidity. In patients with reflux disease, esophageal acid exposure is reduced by up to 80% with H$_2$RAs and up to 95% with PPIs. Despite the superiority of the latter class of drug over the former, periods of acid breakthrough still occur.

   B. If after a year of successful symptom relief, the symptoms are no longer controlled by a single medication and he has developed extraesophageal symptoms (cough and sensation of postnasal drip) of GERD, then consideration should be given to
prescribing another PPI. It is important, though, to rule out ulcers, malignancy, a hiatal hernia, esophagitis or other esophageal, gastric, or duodenal erosive pathology. Therefore, EGD is the best option for direct mucosal visualization.

If no other pathology can account for the symptoms, a 24-hour pH monitoring would be the next step in diagnosis. This would determine if acid reflux is the cause of the patient’s symptoms. A barium swallow could add some more information but is not diagnostic. Halitosis would be an indicator of a diverticulum (Zenker’s) or possibly achalasia in which food is retained within the esophagus. A better study to evaluate these pathologies is barium swallow esophagram. Pulmonary function tests are not indicated for evaluation of the patient’s cough.

3. B. The acid reflux composite score analysis shown is consistent with the diagnosis of GERD. Therefore, a Nissen fundoplication is an appropriate surgical choice for this patient with refractory GERD and a sliding hiatal hernia. Since the patient does not have high-grade dysplasia or evidence of esophageal cancer, esophagectomy would not be the correct choice. The patient has a type I sliding hiatal hernia, not a paraesophageal hernia (Types II, III, and IV), therefore answer C would not be correct (see diagram).

Botulinum toxin and Heller myotomy with Dor fundoplication are used in the treatment of achalasia, but would not be indicated in a patient with GERD.

4. D. Early complications of Nissen fundoplication: gastroesophageal leak, pneumothorax, abscess, and hematoma. Of these, the most common is dysphagia. Late complications of Nissen fundoplication: stricture, gas bloat syndrome, wrap disruption, wrap herniation, and dysphagia.

5. A. Development of fluid collection postoperatively without instability in vital signs, fever, WBC or other evidence of infection is most suspicious for hematoma. The development of the collection of five days postoperatively would indicate a slow bleed, not requiring urgent reoperation. Percutaneous drainage would increase the risk of introducing bacteria and infecting the fluid collection. Conservative management including hydration and observation is recommended for a small, stable hematoma. Antibiotics are not indicated without evidence of infection.

ANSWERS TO SCENARIO 2

1. C. Barrett’s esophagus without dysplasia has a risk of 0.1% to 1% rate of progression to adenocarcinoma and initial surveillance should be with annual EGD with biopsy. Low grade dysplasia requires surveillance every 6 months until no dysplasia is found. If no more dysplasia is found, surveillance can be extended to once every 3 years. High-grade dysplasia has a 5-year risk of adenocarcinoma of 30% and must be intervened upon with excision or ablation or undergo endoscopic surveillance every 3 months.

2. A. The patient has suffered an iatrogenic esophageal perforation. The best initial test for diagnosis of this is esophagram with water-soluble contrast such as gastrografin. If this does not demonstrate leak, thin barium should be used next. The WBC elevation and acute nature of the presentation in relationship to the EGD procedure makes PE less likely than esophageal perforation. EGD would not be recommended in this scenario as it could enlarge the perforation.

3. D. Operative management is imperative in the patient who is becoming unstable (developing a SIRS response) as it may become life-threatening. It should be considered if the perforation is not well-contained, in the acute time period after the procedure, or there is associated malignancy. In contrast, non-operative management should be considered if the time of perforation > 72 hrs, there is no evidence of associated malignancy, or the perforation is well-contained.

4. B. The surgical approach to the distal esophagus is a left posterolateral thoracotomy. Any esophageal injury should be buttressed with other tissue like
nearby pleura, a pericardial fat pad, pedicled intercostal muscle, or the diaphragm.

BIBLIOGRAPHY


A 78-year-old female with arthritis and asthma presents to the emergency room with an acute onset of epigastric pain a couple of hours ago. Her pulse is 104, her blood pressure is unchanged from her baseline of 110/74 mm Hg, and her temperature is 98.2 Fahrenheit. Her medications include occasional naproxen and prednisone for occasional exacerbations of her asthma. On physical exam, her abdomen demonstrates significant epigastric tenderness with rebound. She has a mild leukocytosis of 12.5 cells/mcL. Her acute abdominal series demonstrates a small amount of free air.

1. What is the most reasonable current treatment option for this patient as the next step?
   A. Laparoscopic highly selective vagotomy without resuscitation
   B. Nasogastric tube insertion, cessation of all oral feeds, & intravenous fluid initiation for the next 24 hours
   C. Open truncal vagotomy with pyloroplasty
   D. Open Graham patch with parietal cell vagotomy despite laparoscopic experience and resources
   E. Laparoscopic Graham patch with parietal cell vagotomy

2. If she does not demonstrate improvement during the 12 hours after onset of symptoms, what is the most reasonable and expedient next step?
   A. Truncal vagotomy with antrectomy and a Billroth II reconstruction
   B. Continued observation
   C. Selective angioembolization
   D. Laparoscopic Graham patch only and H. Pylori testing with possible treatment
   E. Emergent anterior seromyotomy

3. What testing should be done for follow-up?
   A. Secretin stimulation test
   B. H. pylori stool antigen testing
   C. Emergent urea breath testing
   D. Colonoscopy
   E. Both A and C

4. What further follow-up is necessary if she has no further symptoms?
   A. Long-term intravenous pantoprazole
   B. Nothing
   C. Chronic suppressive antibiotics
   D. Serum gastrin level
   E. Esophagogastroduodenoscopy with biopsy of ulcer if still present

**Answers**

1. B. Of all the listed options, nasogastric tube insertion with NPO status and initiation of IV fluid is a very reasonable first step in the modern era of H. pylori detection and treatment, especially in a stable patient. Graham patch with parietal cell vagotomy is also a very reasonable option but an open approach is more problematic if laparoscopic experience and resources are available. The verification of resuscitation is required prior to going to the operating room for patients. The verification in this patient can simply be assessing volume status (e.g., urine output of 0.5 cc/kg/hour or normal heart rate
for a patient not on a beta-blocker. Truncal vagotomy with pyloroplasty is not a first-line treatment in the modern era of H. Pylori. Anterior seromyotomy, division of the seromuscular layer of the lesser curvature in order to achieve a highly selective vagotomy effect, is a reasonable approach but not as a first option.

2. D. Laparoscopic Graham patch with H. Pylori testing and subsequent testing is the best choice of those presented. Truncal vagotomy with antrectomy is no longer a first-line option in the modern era of H. Pylori detection and treatment. Observation is not reasonable if the patient is not improving and a more aggressive management choice is most likely necessary. Angioembolization may be considered for bleeding peptic ulcer disease in selective cases but not for perforation of an ulcer. Parietal cell vagotomy is no longer considered one of the early line treatments but to be reserved as a treatment option for refractory peptic ulcer disease.

3. B. H. Pylori stool antigen testing is a very reasonable approach and can even be ordered semi-emergently in the emergency room at some institutions to help in decisions with early treatment options. Secretin stimulation test is utilized for gastrinoma work-up, which is not yet necessary during this part of the work-up for this patient since recalcitrant peptic ulcer disease is not yet identified. Urea breath testing for H. pylori is reasonable but is not an emergent process as obtaining this test requires a clinical lab. Colonoscopy is reasonable in a patient over the age of 50 who has not had a screening process done but is not required to address the follow-up for peptic ulcer disease perforation.

4. E. Esophagogastroduodenoscopy (EGD) is necessary to rule out a gastric carcinoma that caused the perforation, especially in older patients. Pantoprazole, another proton-pump inhibitor, or H2 blockers are reasonable to start on admission for perforated peptic ulcer disease but long-term treatment is not absolutely necessary, especially after treatment for H. Pylori. Treatment of H. Pylori with a course of antibiotics but chronic suppression should not be necessary. Serum gastrin level can be checked for a patient who is suspected of gastrinoma but is not necessary if the patient's peptic ulcer is healed.

BIBLIOGRAPHY


A 51-year-old female presents to the emergency department. She complains of abdominal pain that has gotten worse over the last several days. The pain is sharp and located right under her “breast bone.” It seems to happen right after she eats or drinks and this morning it doubled her over. She relates that she has had this feeling before, but it was never this bad. She has some nausea but no vomiting. Past medical history is significant for hypertension, obstructive sleep apnea on CPAP, hypercholesteremia, and type 2 diabetes (which she states has been normal since her one month post op visit). Her surgical history is significant for one C-section about 15 years ago and a laparoscopic gastric bypass 9 months ago. She denies any drug use. She drinks a glass of red wine most evenings to “help her heart.” After much probing she relates that even though she quit smoking 6 months prior to surgery, she resumed smoking about 6 months ago and is back up to one pack per day. She relates that at the time of her surgery she weighed 345 lbs with a BMI of 59 kg/m² and now has lost 120 lbs with a BMI of 38.6 kg/m². She hasn’t seen a bariatric surgeon since her 3 month postoperative visit, mostly because she is embarrassed that she started smoking again. She stopped taking her omeprazole 4 months ago when her prescription ran out. She also started taking 81 mg aspirin after watching a documentary on heart disease and obesity.

Vital signs are: HR 115, BP 97/62, RR 18, Pulse Ox 98% on RA. Her exam is noted to have diffuse abdominal tenderness, significant tenderness in the epigastrium, with voluntary guarding. Bowel sounds are absent. Hemoccult testing is positive.

1. Which of the following is a factor that is potentially contributing to this patient’s current problem?
   A. Hypercholesterolemia
   B. Active smoking
   C. Obstructive sleep apnea
   D. Increase in carbohydrate intake
   E. Age > 50

2. Which of the following is the most common complication (early or late) following laparoscopic gastric bypass?
   A. Internal hernias
   B. Small bowel obstruction
   C. Marginal ulceration (anastomotic/gastro-jejunal ulcer)
   D. Gastrojejunal leak

3. Which of the following statements is true with regards to marginal ulcer following gastric bypass?
   A. Most marginal ulcers are asymptomatic.
   B. Over one-third of patients with marginal ulcer formation smoke.
   C. Active H. pylori infection is an independent risk factor for ulcer perforation.
   D. Use of proton pump inhibitors is not protective of ulcer formation in the setting of nonsteroidal anti-inflammatory drugs (NSAID) use.
   E. Suture material or type of anastomosis performed does not relate to ulcer formation.
4. Regarding treatment of marginal ulcers (MU) following gastric bypass:
   A. The majority can be successfully managed medically.
   B. Nearly half of patients will require revision of the gastrojejunostomy for persistent and/or recurrent ulcers.
   C. Late MU are self-limiting and rarely require treatment.
   D. H. pylori infection pre-operatively or persistence postoperatively increases perforation rates.
   E. Endoscopy is of limited value in the treatment of marginal ulcer.

5. Which of the following is true regarding perforated marginal ulcers following gastric bypass:
   A. About 40% of patients with marginal ulceration will develop a perforation.
   B. May be managed operatively (open or laparoscopically) with oversewing of the ulcer and omental patch.
   C. Most commonly occurs after 18 months from surgery.
   D. Develops in about 10% of all patients that undergo gastric bypass.

ANSWERS

1. B. T is patient most likely has a marginal ulcer, which, at a rate of about 5% after Roux-en-Y gastric bypass, is one of the more common complications. Risk factors associated with the development of marginal (gastrojejunostomy/anastomotic) ulcers include environmental (smoking and alcohol), medication (NSAIDs), anatomical (gastro-gastric fistula or an enlarged gastric pouch), and technique (use of non-absorbable sutures). T ere is no link associated with specific food types and ulcer formation. Other risk factors that are associated with marginal ulcer (MU) are increased acid exposure via a gastro-gastric fistula (not confirmed in this patient but more commonly seen with patients that have had an open gastric bypass versus laparoscopic), hypertension, and use of non-absorbable suture in the anastomosis and recent surgery.

2. C. Marginal ulcers are a late complication of gastric bypass surgery. Along with gastrojejunostomy (GJ) stricture they are one of the most common complications (early or late) of gastric bypass surgery. Reported rates of MU range from 1% to 25%, with most series indicating 5% incidence. GJ stricture rates are reported between 3% to 27%. T e incidence of internal hernia after gastric bypass is nearly non-existent in the open gastric bypass, but after laparoscopic gastric bypass occurs in approximately 2.5% of patients. Small bowel obstruction is linked to internal hernia formation and the rates are equivalent. GJ leaks are an early complication after gastric bypass. In the laparoscopic approach, rates are reported at about 1% to 1.8%.

3. B. Of patients presenting with MU, over 30% are found to be smoking at the time of diagnosis. Most MU are symptomatic (72%). T ese symptoms that are most common after surgery that lead to the diagnosis of MU are: pain (34%), dysphagia (17%), weight gain (13%), nausea and vomiting (8%), and GI bleed (3%). Active H. pylori infection has not been determined to be an independent risk factor in the development of perforated MU. T ere is data that suggests that in the setting of patients that must use NSAIDs following gastric bypass that proton pump inhibitors (PPIs) are protective of MU formation. While there is still debate as to whether hand-sewn gastrojejunostomy (GJ) versus stapled anastomosis is better with relationship to post operative outcomes, the data clearly relates that non-absorbable suture material at the anastomosis has a high association with MU formation. Because of this fact, the use of non-absorbable suture at the GJ anastomosis has essentially ceased.

4. A. T e treatment of MU is largely medical. T e standard of treatment is PPI therapy initiation/continuation and cytoprotective agents (i.e., sucrafate or carafate). Additionally cessation of smoking and/or NSAID use is critical, as recurrence is high in patients that continue with these high level risk factors. Studies report the incidence of surgical intervention for MU to be 4% to 10%. T is usually occurs in this subset of MU for recalcitrant and/or recurrent ulcers. Continued smoking and NSAID use were found to be independent risk factors for continued non-healing ulcers. Late ulcers (those that occur after 30 days) are rarely self-limiting. In a study by Csendes they did a prospective evaluation of patients and performed endoscopy at 1 month and at 1 to 2 years. T ey found a 12% rate of MU
at 1 month. Many authors believe this to be part of the natural progression and healing process of the anastomosis within such a short time frame. Most clinicians advocate for PPI use in the immediate postoperative period because of this. Clinically apparent MU is unlikely to heal without intervention (as mentioned above). While the data is not completely clear about the role of H. pylori infection and ulcer formation, the risk of perforation of MU is not increased by the presence of H. pylori. One study found that in patients that were H. pylori positive and eradicated prior to surgery, the rate of MU after surgery with short term PPI use was significantly reduced. Endoscopy should be part of the armamentarium of diagnosing and treating MU.

5. B. Most ulcers become apparent within the first 12 months following surgery. While they can develop beyond 18 months following surgery this is not the most common time frame that they are seen. The incidence of perforation in all patients undergoing laparoscopic gastric bypass is approximately 1% and the incidence of MU on average is 5% (range 1% to 16%), therefore the rate of perforation of MU is 20%. Felix et al. in 2008 found that many cases could be managed laparoscopically. In their series, over 30% were managed by oversewing of the ulcer and utilizing an omental patch. Other series have confirmed similar treatment strategies for MU perforation utilizing the omental patch. Times when it may be necessary or more appropriate to consider revising the G-J may include MU with bleeding, with or without perforation; recurrent ulceration, when a gastro-gastric fistula is present; or when the pouch is greatly enlarged.

BIBLIOGRAPHY


A 37-year-old female presents to the emergency department. She complains of abdominal pain that awoke her from sleep and has been persistent over the last 3–4 hours. She can’t get comfortable, is experiencing nausea, and some emesis. She relates that she has had similar episodes in the past couple of months about 1 to 2 times per week, but it was usually self-limited, but this is the worst she has felt. Her surgical history is significant for two C-sections about 4 and 6 years ago, a laparoscopic gastric bypass a little over 2 years ago, and an open appendectomy when she was 12. She denies any drug use, alcohol use, or smoking. She relates that at the time of her surgery she weighed 290 lbs with a BMI of 53 kg/m² and now has lost 155 lbs with a BMI of 24.7 kg/m². She hasn’t seen a bariatric surgeon in over a year since she just moved here for her new job 11 months ago.

Vital signs are: HR 102, BP 138/67, RR 20, Pulse Ox 99% on RA. Her exam is noted to have diffuse abdominal tenderness, with the area tender in the mid abdomen. Bowel sounds are present and high-pitched.

1. Which of the following would be the next most appropriate step in this patient’s management?
   A. Upper endoscopy (EGD)
   B. Nasogastric tube decompression
   C. Abdominal X-ray
   D. CT scan of abdomen and pelvis

2. Which of the following statements is true regarding laparoscopic gastric bypass?
   A. Internal hernias after laparoscopic gastric bypass are far less common than those seen with open gastric bypass.
   B. Small bowel obstruction after laparoscopic gastric bypass can be conservatively managed in about 80% of cases.
   C. Intussusception at the jejunojejunostomy (JJ) can be a source of abdominal pain.
   D. A dilated gastric remnant is a normal finding on CT scan in post gastric bypass patients.
   E. Large defects like the Petersen’s hernia as seen in a retrocolic gastric bypass do not need definitive closure.

3. Small bowel obstruction after a laparoscopic gastric bypass:
   A. Requires emergent exploration.
   B. Can be managed conservatively in 80% of cases.
   C. Is often caused by adhesions from the original surgery.
   D. Should never be evaluated laparoscopically.

4. The most common cause of abdominal pain after an Roux-en-Y gastric bypass (RYGB) is?
   A. Internal hernia causing a small bowel obstruction
   B. Marginal ulcer (ulcer at the gastrojejunostomy)
   C. Gastrojejunostomy stricture
   D. Intussusception of the jejunojejunostomy
   E. Biliary colic or dyskinesia

5. When evaluating a patient for intermittent abdominal pain in your office after laparoscopic gastric bypass:
   A. UGI should be considered to evaluate for marginal ulcer.
B. CT scan should be performed to definitively rule out an internal hernia.
C. The patient should be offered psychological counseling since most pain after a laparoscopic gastric bypass is psychosomatic.
D. Diagnostic laparoscopy should be considered to evaluate for potential sources of internal hernia.

ANSWERS

1. D. In this scenario, nasogastric tube (NGT) decompression is insufficient to treat a patient that has had a gastric bypass and bowel obstruction. These patients require an operative intervention as conservative management can have catastrophic consequences. Bowel obstruction after laparoscopic gastric bypass is often associated with an internal hernia. In the setting of an open gastric bypass the obstruction is more likely adhesions versus an internal hernia (typically less adhesion formation after laparoscopic gastric bypass). Conservative management of bowel obstruction after gastric bypass can be dangerous as the bowel will need to be manually decompressed and conservative management is rarely successful. The rate of internal hernia after laparoscopic gastric bypass is about 2.5% with studies ranging between 0.2% to 8%.

2. C. Intussusception of the JJ can lead to chronic intermittent abdominal pain. Possible causes of intussusception can be related to stricture of the JJ or a dilated JJ pouch, either of which can serve as a lead point during peristalsis and subsequent intussusception. Internal hernia after laparoscopic gastric bypass are more common than open gastric bypass (this relates to more adhesions in the open gastric bypass and hence greater likelihood of the closure of the potential spaces by adhesion formation). Small bowel obstruction after laparoscopic gastric bypass is rarely successfully managed conservatively, with most cases requiring operative intervention. Delay in getting to the operating room can lead to significant loss of small bowel. A dilated gastric remnant is not a normal finding on a CT scan after gastric bypass. A dilated remnant strongly suggests obstruction of the biliopancreatic limb. Stricture of the JJ, intussusception of the JJ, or internal hernia are all sources of obstruction that can lead to gastric remnant dilation. Petersen’s hernia in a retrocolic gastric bypass is a small defect and therefore must be closed. The small size of the defect can lead to incarceration and strangulation of bowel. There are also reported cases of strangulation of bowel in the Petersen’s hernia of an antecolic gastric bypass, but this space is larger and therefore theoretically less likely to have strangulation of bowel.

3. A. Small bowel obstruction after laparoscopic gastric bypass requires emergent exploration. The most likely source is an internal hernia either occurring at the JJ mesenteric defect (50% to 62%) the transverse mesocolon (23% to 46%) or the Petersen’s hernia (12% to 15%). Most surgeons close these defects at the time of surgery, but as patients lose weight (estimated greatest incidence after >50% of excess weight lost) or other sources of increased intra-abdominal pressure such as pregnancy with an enlarged uterus can lead to a weakening of the original repair. Bowel...
obstruction secondary to adhesions after laparoscopic gastric bypass is fairly uncommon. Small bowel obstruction even in non-bariatric surgery cases reportedly is non-operatively managed in about 40% of cases. Laparoscopic evaluation of internal hernia after laparoscopic gastric bypass is well documented and safe. The clinician’s comfort with laparoscopy versus open surgery should be the defining factor regarding exploration as either can provide good outcomes. The key component is defining the anatomy. It is recommended that reduction of the internal hernia begin with identification of the ileocecal valve and following the bowel proximally. This will serve to both reduce the hernia on the appropriate side of the defect and will facilitate the identification of the anatomic landmarks of the JJ, biliopancreatic limb, and Roux limb.

4. A. Internal hernia is often associated with pain, with or without nausea and emesis. This can be acute onset or it can be intermittent and chronic warranting further workup and ultimately surgical intervention. It is the most common cause of abdominal pain after RYGB. Symptoms of a gastrojejunostomy stricture are rarely related to pain. The most common presentations are dysphagia and food intolerance. These symptoms typically occur about 6 to 8 weeks following surgery with a gradual regression of food tolerance from having been advanced to solid foods and then noting difficulty, followed by inability to tolerate solids and only able to tolerate liquids. Marginal ulcer following gastric bypass is also associated with pain. This usually occurs immediately after eating or drinking. Risk factors for developing a marginal ulcer are use of NSAIDs, smoking, gastro-gastric fistula formation, and foreign body (i.e., suture/staple).

Intussusception also presents with pain and is similar to that of an internal hernia. It is commonly intermittent and often unseen on CT scan unless the event is occurring during the imaging study. Biliary colic or dyskinesia is also source of abdominal pain following weight loss surgery. Gallstone formation occurs as a result of rapid weight loss and may become symptomatic. A standard of practice is not to remove the gallbladder at the time of laparoscopic gastric bypass. The incidence of symptomatic gallstone formation after surgery approaches 8%. In the study by Caruana et al. (Surg Obes Relat Dis. 2005; 1(6):564–7), they also determined that it was not cost effective to utilize ursodeoxycholic acid (Ursodiol) as a prophylactic treatment modality for gallstone formation prevention.

5. D. Patients that present with abdominal pain after laparoscopic gastric bypass warrant a full evaluation. It is rarely a psychological source and as such appropriate history should be taken. If the patient still has complaints of abdominal pain after a negative full evaluation, including upper endoscopy to rule out gastrojejunal ulcer, gastro-gastric fistula, a CT scan, colonoscopy to rule out a colonic source, a right upper quadrant ultrasound to rule out gallstone diseases and a HIDA scan to rule out biliary dyskinesia, then diagnostic laparoscopy is the next step in management. Since upwards of 20% of CT scans will not have evidence of an internal hernia, visual evaluation of the potential internal hernia spaces is imperative. Postoperative internal hernia formation occurs in approximately 2.5% of patients, with approximately 50% to 60% of hernias at the JJ mesenteric defect, 20% at the transverse mesocolon mesentery and 12% to 15% of hernia’s at the Petersen’s hernia. An upper GI fluoroscopic study may provide information about pouch size, absence or presence of a hiatal hernia, stricture and sometimes ulcer, however, it is not a first choice for evaluation. Given the higher specificity of an EGD evaluation, this study would yield far less information in lieu of the other choices offered.

BIBLIOGRAPHY
A 42-year-old female with a body mass index of 42 kg/m² along with diabetes mellitus, hypertension, hyperlipidemia, and obstructive sleep apnea (OSA) has completed her preoperative evaluation for surgical management of her obesity and weight related co-morbidities. She uses Continuous Positive Airway Pressure (CPAP) nightly for her OSA. She is felt to be a good candidate for surgery and she opted for a Sleeve Gastrectomy (SG).

1. Regarding the immediate postoperative management, which of the following is correct?
   A. Use of CPAP is contraindicated for the first postoperative week for fear of it causing a leak.
   B. Sustained tachycardia is the most reliable indicator of a leak.
   C. The most likely cause of death after bariatric surgery is a myocardial infarction.
   D. The patient should have had an IVC filter to prevent a pulmonary embolus.
   E. The leak rate from a SG is less than that of a Roux-en-Y gastric bypass (RYGB).

2. Regarding intra-operative factors that affect staple line leaks after SG, which of the following is correct?
   A. Staple line buttressing has conclusively shown to decrease the incidence of staple line leak.
   B. Over-sewing of the staple line has been shown to decrease the incidence of staple line leak.
   C. Performance of sleeve gastrectomy over a smaller diameter bougie decreases the likelihood of staple line leak.
   D. Treatment of the staple line with fibrin glue has been shown to decrease the staple line leak rate.
   E. Choice of staple height does not have an effect on staple line leak rates.

3. The patient presents with fever, abdominal pain, and sustained tachycardia on postoperative day 4. Which of the following is correct?
   A. A normal upper gastrointestinal contrast series rules out a staple line leak.
   B. Operative management of a staple line leak is more likely to be successful in this patient than in patients whose leaks present 10 days or more after operation.
   C. If a closed suction drain is left at the initial operation and the drain amylase level is the same as the serum amylase level, this finding reliably rules out a staple line leak.
   D. A positive preoperative H. Pylori test increased this patient’s chance of having a staple line leak.
   E. Endoscopic therapies should be the first approach to gain control of a staple line leak.

4. The patient undergoes operative repair of the staple line leak on postoperative day 4. A closed suction drain is left. Which of the following is correct?
   A. If this patient develops a gastro-cutaneous fistula controlled by the closed suction drain, endoscopic treatment with a covered stent, clipping, and/or fibrin glue should be considered an experimental option and discouraged unless the patient’s condition is severe.
B. The median time for staple line leaks to heal is less than 2 weeks.

C. If an endoscopic stent is placed across the leak, the biggest problem that can occur is stent erosion.

D. If the patient develops a controlled gastrocutaneous fistula, drainage alone is still an acceptable option for treatment.

E. Chronic leaks/fistulae can be managed with late surgical therapy, such as Roux-en-Y anastomosis to the fistula site.

5. Which of the following is correct regarding staple line leaks after sleeve gastrectomy?

A. Leaks >10 days after operation are more likely to occur after gastric bypass than sleeve gastrectomy.

B. Leaks most commonly occur in the distal third or antral staple lines.

C. Patients whose sleeve leaks are treated by endoscopic stenting still must be restricted from taking nutrition by mouth until the leak heals.

D. Non-operative management of leaks is unacceptable in any sleeve patient.

E. Patients with fistulae that fail to close may require conversion to gastric bypass or gastrectomy.

ANSWERS

1. B. Sustained tachycardia greater than 120 is the most reliable indicator of a postoperative leak from bariatric surgery. Other complications that can lead to tachycardia like myocardial infarction, pulmonary embolism, bleeding, hypovolemia, and respiratory insufficiency should also be ruled out but unanswered and sustained tachycardia should prompt an intervention to find and treat a leak, which includes operative exploration. The leak rate of a SG (2.4%) is higher than that of a RYGB (0.8%).

CPAP is not contraindicated after a SG, or a RYGB for that matter, and should plan to be used in the postoperative period for people who suffer from OSA. There is no data that suggests it increases the risk of a leak. While people who have a respiratory complication after bariatric surgery are at an increased risk of mortality, the most common cause of death after bariatric surgery is sepsis, followed by myocardial infarction, then a pulmonary embolism.

The recommended venous thromboembolic (VTE) prophylaxis for this patient is mechanical prophylaxis, ambulation on the night after surgery, and chemical prophylaxis with low molecular weight heparin or unfractionated heparin. There is no absolute indication for preoperative IVC filter placement but it can be considered, along with mechanical and chemical prophylaxis in high risk patients, especially if the risk of a VTE is higher than that of a filter related complication.

2. E. Multiple intra-operative techniques have been employed and studied to attempt to reduce staple line leak rates after sleeve gastrectomy. Although there is some evidence that the use of buttressing material can reduce bleeding from the staple line, there are no conclusive data that staple line leak rates are reduced. Similarly, choice of staple height and over sewing of the staple line did not show any benefit in reducing staple line leak.

The use of a bougie >40 French in diameter has been shown to decrease the leak rate without a discernible impact on weight loss at up to 3 years compared to smaller bougies (<40 French). Distance from pylorus that the staple line was begun also did not affect leak rates. Finally, treatment of the staple line with fibrin glue did not conclusively demonstrate any benefit in reducing staple line leak in gastric bypass patients and little data exist to suggest it has any benefit in sleeve gastrectomy patients.

3. B. Staple line leaks after sleeve gastrectomy present challenging problems in terms of both diagnosis and management. Surgical treatment of staple line leaks that occur early (<10 days) after operation are more likely to be successful than surgical treatment of late (>10 days) leaks. Although clinical signs can be subtle, upper gastrointestinal (UGI) series have been noted to be unreliable. Closed suction drain amylase has been suggested as a reasonable adjunct to clinical suspicion of a leak, but patients with leaks and normal drain amylase levels have been demonstrated. Therefore, a normal drain amylase or a negative UGI should not prevent a surgeon from returning a patient to the OR if clinical suspicion for a leak remains.

Although pre-operative detection and eradication of H. Pylori infections has been advocated to reduce post operative dyspepsia or ulceration, the presence of H. Pylori does not appear to impact staple line leak rates. Although endoscopic therapies provide a useful adjunct in the treatment of gastric sleeve staple line leaks, they generally should not be
used as the initial or primary therapy. Resuscitation, intravenous hydration and antibiotics, and either early surgical or interventional radiologic drainage of intra-abdominal fluid collections to control sepsis should be first line therapies.

4. **E.** One of the largest reviews of staple line leaks after sleeve gastrectomy demonstrated that the median time for leak healing was 40 days (range 2 to 270). Endoluminal therapies for staple line leaks show a fairly high rate of success at resolving leaks and fistulas, with the main problem being stent migration. Although endoluminal therapies are useful adjuncts, standard fistula management with drainage is still an acceptable option but it also mandates nutritional support. Chronic fistulae that develop can be successfully managed by late surgical therapy.

5. **E.** Late leaks (>10 days after initial surgery) are more likely to occur in sleeve gastrectomy patients than in gastric bypass patients. The majority (89%) of leaks occur in the proximal third of the stomach. Non-surgical therapy is clearly an appropriate option in selected patients with leak, and endoluminal stenting has the specific advantage of allowing patients to take food by mouth. Total gastrectomy with esophagojejunostomy, conversion to gastric bypass, and lateral Roux-en-Y gastrojejunostomy all have been described as surgical therapy for sleeve fistulae that fail to heal.

**BIBLIOGRAPHY**


A 34-year-old morbidly obese female with a current body mass index (BMI) of 55 kg/m² is being evaluated for potential bariatric surgery. She has tried numerous diet and exercise programs, including a medically supervised program for 12 months and has failed to maintain any significant weight loss. She has type 2 diabetes, gastroesophageal reflux disease (GERD), hypertension, and sleep apnea. She has had two prior c-sections and a laparoscopic cholecystectomy but no other surgeries. She has done independent research on the internet and is interested in getting more information about the “duodenal switch” procedure.

1. Which of the following statements about bariatric surgical procedures is correct?
   A. All true bariatric surgery achieves weight loss through restrictive effects and malabsorptive effects.
   B. The duodenal switch is the most malabsorptive of the currently performed bariatric procedures.
   C. The duodenal switch is the most restrictive of the currently performed procedures.
   D. Candidates for the duodenal switch must have a body mass index above 55 kg/m².
   E. This patient’s medical comorbidities disqualifies her for bariatric surgery.

2. The patient is confused about the anatomic difference between the duodenal switch and the gastric bypass. Which of the following statements is correct about the duodenal switch versus gastric bypass anatomy?
   A. Both the duodenal switch and the gastric bypass involve the creation of a small proximal gastric pouch.
   B. The duodenal switch involves a sleeve gastrectomy and preservation of the pylorus.
   C. The duodenal switch creates less bypassed intestine than the gastric bypass, resulting in less malabsorption.
   D. The alimentary limb of the small intestine is anastomosed to the stomach in both operations.
   E. The amount of malabsorption with the duodenal switch is primarily a function of the length of the biliopancreatic limb.

3. The patient is interested in knowing about the potential benefits of surgery, and whether she is a candidate for a laparoscopic or open surgery. Which of the following statements are correct regarding the duodenal switch?
   A. The patient is not a candidate for a laparoscopic approach due to her prior abdominal surgery.
   B. The surgery has a 50% chance of improving her diabetes, but only after she has achieved significant weight loss.
   C. The surgery has a near 100% likelihood of curing her gastroesophageal reflux disease.
   D. She can expect to lose 40% to 50% of her excess body weight in the first year after surgery.
   E. The duodenal switch is associated with an 80% to 90% rate of resolution for her hypertension, sleep apnea, and diabetes at one year after surgery.

4. The patient also wishes to know about the risks of surgery and common complications associated with the duodenal switch. Which of the following statements is correct?
A. Unlike the gastric bypass, there is no postoperative risk of an internal hernia after the duodenal switch procedure.
B. Chronic diarrhea and steatorrhea may be a complication of this procedure.
C. Protein and calorie malabsorption, that requires parenteral nutrition or surgical revision, only occurs in less than 1% of patients.
D. Fat malabsorption may result in deficiencies of vitamins B6 and C.
E. Symptoms of dumping syndrome after a duodenal switch are likely.

5. The patient undergoes an uncomplicated laparoscopic duodenal switch procedure and is discharged home on postoperative day 3. On postoperative day 5 she presents to the emergency department with worsening abdominal pain, distension, fevers, and emesis. She is febrile to 102.7°F, tachycardic to 125, tachypneic, and has a systolic blood pressure of 80. Her abdomen is diffusely tender. She states that she has had diarrhea for the past 3 days and has not been able to tolerate oral intake. Which of the following statements about the evaluation and management of this patient is correct?

A. Intravenous fluid resuscitation should not be given due to the concern for possible volume overload and pulmonary edema.
B. A normal upper GI series with oral contrast (swallow study) will rule out an abdominal source of pathology.
C. An urgent CT Pulmonary Angiogram must be obtained to rule out a pulmonary embolus.
D. The patient will likely require emergent surgical exploration to identify the cause of her symptoms.
E. The most likely cause of her symptoms is an internal hernia.

ANSWERS

1. B. All currently performed bariatric procedures achieve weight loss primarily through either restriction, malabsorption, or both. Restriction is achieved by reducing the volume capacity of the stomach through reduction in size or external compression. The Sleeve Gastrectomy and Adjustable Gastric Band are the only endorsed restrictive procedures. Malabsorption is achieved through re-routing of the small intestine and digestive enzymes to decrease the length of intestine available for absorption. The duodenal switch (also known as the biliopancreatic diversion with duodenal switch) involves the longest length of bypassed intestine, and thus is more malabsorptive than other procedures such as the gastric bypass.

The restrictive component of the duodenal switch involves formation of a gastric sleeve, which achieves moderate restriction. Other procedures such as the gastric bypass and adjustable gastric band are more restrictive than the duodenal switch. Candidacy for a duodenal switch is the same as for any bariatric procedure (BMI > 40 or > 35 with obesity-related co-morbidities), although most surgeons reserve this option for higher BMI patients. Medical comorbidities related to obesity are not contra-indications to surgery, and improvement or resolution of these comorbidities is the primary goal of bariatric surgery.

2. B. The gastric bypass involves creation of a small proximal gastric pouch that is highly restrictive. In contrast, the duodenal switch involves creation of a vertical sleeve gastrectomy (see Figure 31-1) and division of the duodenum just past the pylorus, resulting in a greater gastric capacity and less restriction than the gastric bypass. The duodenal switch operation preserves the pylorus and at least part of the antrum, which provides the advantage of controlled gastric emptying and avoidance of the “dumping syndrome” that is frequently seen with the gastric bypass. The duodenal switch results in MORE bypassed intestine than the gastric bypass and is the most malabsorptive bariatric procedure currently in use.

The final anatomy of the duodenal switch is as shown in Figure 31-1: The alimentary limb (AL, and analogous to the “roux” limb in gastric bypass) is typically 150 to 200 cm long and the proximal end is anastomosed to the duodenum just past the pylorus. The biliopancreatic limb (BPL) is typically long and unmeasured. The small intestine distal to the junction of the AL and BPL is called the common channel or common limb (CL), and is typically 50 to 150 cm in length from the ileocecal valve. The amount of malabsorption is primarily a function of the length of the common channel, as this is where nutrients are mixed with the biliopancreatic digestive enzymes. A shorter common channel will result in greater malabsorption, and vice-versa.

3. E. Among the currently performed bariatric procedures, the duodenal switch has been associ-
Biliopancreatic diversion with duodenal switch

Figure 31-1 Diagram of the duodenal switch anatomy including the alimentary limb (AL), the biliopancreatic limb (BPL), and the common limb or common channel (CL). Reprinted with permission (Gagner M et al. 2009).

associated with the greatest absolute and relative weight loss (Figure 31-2), as well as the highest rates of improvement or resolution of obesity-related comorbidities. The duodenal switch can be performed as an open or a laparoscopic procedure, although it is arguably the most technically challenging bariatric procedure to perform laparoscopically. This patient would be an excellent candidate for laparoscopic surgery, and prior pelvis or laparoscopic abdominal surgery is not a contraindication to a laparoscopic approach. The duodenal switch has been reported to achieve an average 80% to 100% rate of improvement or resolution of type 2 diabetes and normalization of HgBA1C levels (Figure 31-3).

Figure 31-2 Average weight loss (percent BMI lost) at 4 years for duodenal switch (BPD/DS) versus gastric bypass (RYGB) patients in a prospective randomized study. Figure reproduced with permission (Hedberg J et al. 2012).

Figure 31-3 Average change in glycolated hemoglobin (HgBA1C) levels at 1 and 3 years postoperatively in a prospective randomized study of duodenal switch versus gastric bypass. Despite starting at a higher HgBA1C level at baseline, patients undergoing duodenal switch demonstrated lower levels at 1 and 3 years. Figure reproduced with permission. (Hedberg J et al. 2012).
In addition, there is often a marked improvement in diabetes immediately after surgery and this has been attributed to both the marked change in dietary intake as well as the bypass of digested food away from the duodenopancreatic complex. One caveat to the high rates of improvement of obesity-related comorbidities is that gastroesophageal reflux disease may not improve, or may even worsen, after converting the stomach to a sleeve gastrectomy configuration. The percent of excess weight loss seen with the duodenal switch is typically in the 60% to 80% range at one year, and has been shown to be superior to gastric bypass or sleeve gastrectomy alone in multiple series. Resolution rates of 80% to 100% for other weight related comorbidities including hypertension, sleep apnea, hyperlipidemia, and hypertriglyceridemia have been demonstrated, and the duodenal switch has been shown to result in superior reduction in cardiovascular risk profiles.

4. B. An internal hernia can occur following any surgery that involves division of the small intestine and then performance of an anastomosis, and is one of the most feared late complications of the duodenal switch or gastric bypass. Any acute small bowel obstruction or chronic abdominal pain syndrome in these patients should prompt immediate evaluation for an internal hernia. The duodenal switch primarily affects absorption of fats and proteins, and the fat malabsorption may result in significant diarrhea and steatorrhea postoperatively. The duodenal switch carries the highest risk of protein/calorie malnutrition due to the high degree of malabsorption, with approximately 5% of patients requiring parenteral supplementation or surgical revision.

Surgical revision for this problem usually involves lengthening of the common channel to reduce the degree of malabsorption. The high degree of fat malabsorption affects the absorption of the fat soluble vitamins (A, D, E, and K), and these should either be routinely supplemented or closely monitored and selectively supplemented. Dumping syndrome is thought to be due to rapid passage of high-carbohydrate and high-osmolar nutrients directly into the jejunum and is commonly seen after gastric bypass surgery. It is cause immediate symptoms (“early” dumping) of abdominal pain, bloating, diarrhea, flushing, nausea, and emesis and then delayed symptoms (“late” dumping) of sweating, weakness, and dizziness due to hypoglycemia. Dumping syndrome is very uncommon after the duodenal switch as the pylorus is preserved and gastric emptying should be more controlled compared to the gastric bypass.

5. D. Bariatric surgical patients are at risk for a number of potential perioperative complications in the early postoperative period. These include surgical site infections, venous thrombosis, pulmonary embolus, anastomotic or staple line leaks, bleeding, iatrogenic bowel injury, and early postoperative bowel obstruction. The patient’s presentation is extremely concerning due to her abnormal hemodynamics, abdominal pain, and fever. The primary concerns in a patient presenting like this after a duodenal switch are for an anastomotic leak, staple line leak (from the sleeve gastrectomy or the duodenal stump), or an iatrogenic bowel injury. Initial management should focus on resuscitation of the patient, identification of the source of the problem (if possible), and preparation for likely operative intervention. A normal “swallow” or upper GI study does not definitively rule out an anastomotic leak, and does not evaluate the duodenal stump or the distal anastomosis.

Although a pulmonary embolus is possible, this patient’s constellation of symptoms are much more consistent with an acute abdominal pathology and intervention should not be delayed to obtain a CT scan for a less likely diagnosis. The patient most likely has a leak from a staple line or anastomosis resulting in peritonitis and sepsis. Immediate surgical exploration, either open or laparoscopically, is indicated to identify and correct the source of the problem. If the patient presented with minimal symptoms and normal hemodynamics then a thorough imaging evaluation would be indicated to identify or rule out a leak, and to direct possible nonoperative management with placement of an intraluminal stent. Although an internal hernia with incarcerated and compromised bowel is possible, these are typically seen much later in the postoperative period (months to years) after significant weight loss has occurred.

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A 35-year-old female with past medical history of hypertension, Type II diabetes mellitus, and morbid obesity recently underwent a gastric bypass surgery 8 months ago without complication. On her last visit office visit 2 months ago, no complications were noted and weight was found to be appropriate. She is currently mourning the loss of her grandmother who passed away 2 weeks ago. Today, her daughter noticed that her gait was very unsteady and she seemed to be confused. She also mentioned that she had very poor appetite and was very unclear if she has been taking her medications. There is no history of alcohol intake. She was taken to the emergency department for further evaluation.

1. What is the vitamin deficiency most likely associated with the above presentation?
   A. Vitamin D
   B. Folate
   C. Vitamin A
   D. Thiamine
   E. Cobalamine

2. What is the next step in management?
   A. CT scan of the brain
   B. Hydration and immediate administration of 100 mg of IV vitamin B1
   C. Hydration, thiamine, followed by glucose
   D. Hydration glucose follow immediately by thiamine
   E. Oral thiamine

3. What is the most common hematologic finding after Roux-en-Y gastric bypass (RYGB) gastric bypass?
   A. Iron deficiency anemia
   B. Megaloblastic anemia
   C. Spherocytosis
   D. Anemia of chronic disease

ANSWERS

1. D. Vitamin deficiency is a very common complication after bariatric surgery due to the bypass itself and the partial gastrectomy, which reduces the absorptive surface area of the stomach. Therefore, all patients post-surgery are discharged with multivitamins supplements for life that includes thiamine. This case describes the constellation of symptoms consistent with acute Wernicke encephalopathy (WE), which classically presents with the symptoms of dementia, ataxic gait, and ocular problems. There are many other micronutrient and vitamin deficiencies such as calcium, vitamin B12, fat-soluble vitamins (A,D,E,K), folate, and other minerals. Supplementation of these vitamins is essential post-op.

2. C. WE management requires prompt identification, hydration, and administration of IV thiamine only based on clinical grounds. The recommended regimen is 500 of IV thiamine over 30 minutes three times a day for 2 consecutive days or intramuscular for 5 days in combination with other vitamins that include B12 and folate. It important to administer glucose after thiamine deficiency and not before since it is known to worsen the WE symptoms.

3. A. Iron deficiency anemia is commonly seen in patients who have undergone RYGB secondary
to the decrease in pH in the gastric pouch, which affects absorption in the duodenum and proximal jejunum. The anemia is more evident in the menstruating female, therefore, prophylactic iron supplementation is shown to decrease the incidence of this presentation.

BIBLIOGRAPHY


A 45-year-old female with a history of type 2 diabetes, hypertension, sleep apnea on CPAP, hyperlipidemia, and a body mass index (BMI) of 42 presents to clinic with failure to lose weight after having a laparoscopic adjustable gastric band placed four years ago. She has been compliant with diet and exercise but has not been able to lose weight with the band. She is interested in the Roux-en-Y gastric bypass (RYGB) and would like to know her options for revisional surgery.

1. Who is the ideal candidate for bariatric surgery?
   A. A 50-year-old female with a BMI of 37 with no comorbidities.
   B. A 34-year-old male with history of GERD and a BMI of 34.
   C. A 19-year-old female with a history of type 1 diabetes, and a BMI of 32.
   D. A 48-year-old male with a history of hypertension, type 2 diabetes, and a BMI of 42.
   E. An 89-year-old male with a history of pulmonary embolus, pulmonary hypertension, and a BMI of 39.

2. In which scenario would a revisional weight loss surgery be most indicated?
   A. A 45-year-old female with a history of a lap band with poor results, a BMI of 44 and poor compliance with diet and exercise.
   B. A 38-year-old female with a history of lap band with poor results, persistent hypertension, a BMI of 39, and compliance with nutrition and exercise.
   C. An 87-year-old male with a history of RYGB with poor results, a BMI of 43, active smoker, and drinks alcohol on weekends.

3. An upper gastrointestinal series can be used as part of the preoperative work up to evaluate for revision surgery. What will an upper gastrointestinal series miss that will require a revision?
   A. Prolapse or slippage of adjustable gastric band
   B. Marginal ulcers
   C. Anastomotic leaks
   D. Gastro-gastric fistulae

4. Patients who have revisional bariatric surgery for weight recidivism:
   A. Have a higher risk of intra-operative and post-operative complications.
   B. Have a predictable amount of weight loss.
   C. Do not necessarily need consultation with behavior health and nutrition care providers.
   D. Usually do so due to a technical complication from surgery.

ANSWERS
1. D. Ideal candidates for bariatric surgery are those that have a BMI > 40, or a BMI > 35 and at least one weight-related co morbidity such as hypertension, hyperlipidemia, diabetes, sleep apnea, depression, arthritis, or pseudotumor cerebri. The National Institutes of Health (NIH) consensus guidelines for bariatric surgery are the most commonly used
criteria for identifying patients that will benefit most from weight loss surgery. Patient D clearly meets the NIH guidelines for bariatric surgery and represents the best candidate among these choices. However, it should be noted that recent evidence and consensus opinions support extension of bariatric candidacy in lower BMI patients, particularly in patients with a BMI of 30 to 35 and type 2 diabetes.

The importance of considering weight loss surgery is due to the widespread increase in obesity and associated co-morbidities in the population. There have been many studies showing that surgical therapy is more effective than medical intervention or supervised diet programs at achieving significant and sustained weight loss and resolution of associated co-morbidities.

These patients must undergo preoperative screening prior to surgery that entails psychiatric evaluation, nutritional counseling, and medical clearance. They must be educated very thoroughly on the realistic outcomes and work that is involved in undergoing weight loss surgery. The expected weight loss from these procedures range from 40% to 80% of their excess weight (calculated from ideal body weight).

2. B. Revisions are necessary for complications of the initial bariatric procedure or for failure of weight loss and/or control of weight-related comorbidities. Surgery is considered a failure if the postoperative BMI remains > 35 less than 50% excess weight loss achieved, the presence of persistent comorbidities, or there is significant weight regain. Complications from the initial procedure that might require surgical revision can include strictures, ulceration, fistulas, dysphagia, severe reflux, or nutritional deficiencies. These may require surgical revision, conversion to a different bariatric procedure, or in severe cases even reversal of the bariatric procedure.

Identifying the source of the complication is critical to determining candidacy for revision and deciding on the type of revisional procedure. Anatomic complications can be based on type of surgery. Common adjustable gastric band complications include band slippage or gastric prolapse through the band, band erosion, and pouch or esophageal dilation. In addition, the adjustable gastric band has the highest rate of failure of weight loss or requiring band revision or removal. Complications of RYGB include marginal ulcer, internal hernias, bowel obstructions, gastro-gastric fistulas, steatorrhea, inadequate or excessive weight loss, and nutritional deficiencies. It is crucial to identify the cause of failure prior to considering revision.

Another source of failure can be behavioral mal-adaptation or non-compliance. It is critical to have a standardized approach to the bariatric patient seeking revisional surgery, including complete evaluations of their understanding and compliance with the required diet and nutritional strategies to maximize the success of bariatric surgery. If this is the source than behavioral adjustment may be more beneficial as opposed to undergoing revision surgery. Patients who are compliant are probably the best candidates in which to consider a revision. Therefore, identifying the source of the failure is key to considering who will benefit from revision surgery.

3. B. Thorough evaluation of the source of the failure is important to decide which surgery would be most beneficial, or if revisional surgery is indicated at all. An upper gastrointestinal (UGI) series is usually used preoperatively to help clarify the anatomy of prior surgeries and identify the presence of complications. It can reliably help identify band slippage or prolapse, esophageal dilation, leaks or fistulae. A band that has slipped or caused a prolapse must be removed because the prolapse can cause an incarceration of the stomach leading to a surgical emergency. A gastro-gastric fistula may also be seen but not every fistula requires a revision. If the fistula is causing recurrent marginal ulcerations or weight regain then the patient can then be considered for a revision. It must always be appreciated that an UGI series may not identify small leaks or fistulae, and many centers now perform an UGI study followed immediately by a CT scan. This approach significantly increases the sensitivity for identifying smaller leaks, fistulae, or other anatomic complications. Small leaks seen on UGI can be controlled by drainage, TPN, NPO status, or with the adjunct of a stent or clip place endoscopically. An UGI study typically lacks the resolution to identify subtle mucosal problems such as a marginal ulcer. Diagnosis of marginal ulceration typically requires direct luminal visualization with flexible upper endoscopy.

4. A. Revisional surgery is significantly more complex than an initial bariatric procedure for multiple reasons, including the altered anatomy, presence of significant adhesions or inflammatory changes, and the need for
more complex surgical maneuvers and reconstructions. There have been several studies that have shown that patients who have undergone revision surgery have a higher short and long term complication rate. These rates range from 13% to 50% depending on the type of revision involved, most commonly being wound infections or surgical site infections. Significantly longer operative times and greater blood loss have also been noted. The mortality rate remains at less than 1%, similar to initial weight loss surgeries. The reported results of additional weight loss after revisional surgery are also significantly more variable than after an initial bariatric procedure.

There are multiple options for revision of a bariatric procedure, and the choice will depend on the current anatomy and the reason for the revisional procedure. There is also a significant current interest and developing technology in the field of endoluminal approaches to both primary and revisional bariatric surgery, most commonly to achieve reduction in the size of the gastric pouch or decrease the size of a dilated upper anastomosis to produce additional restriction. Weight loss results are more variable and less predictable compared to primary bariatric surgery, multiple studies have shown acceptable success rates with weight loss after revisional surgeries.

Weight regain after a primary bariatric procedure can be multifactorial but often is due to poor dietary and exercise habits and not due to a technical complication from the surgery. As such, all patients who being considered for revision need consultation with behavior health and nutrition services. Follow up after surgery should be life-long to help with long-term weight management control.

**BIBLIOGRAPHY**


A 37-year-old female presents to the general surgery clinic for pre-operative evaluation to undergo a laparoscopic adjustable gastric band placement. Her current weight is 220 lbs (99.8 kg) with a BMI of 35.5 kg/m². She was diagnosed with type 2 diabetes last year and her primary care physician is currently evaluating her for obstructive sleep apnea (OSA). The patient undergoes her surgery without intraoperative complications. Post-operatively she has a few episodes of emesis; however, she eventually is able to tolerate clear liquids and is discharged. Six months after the operation, the patient presents to the emergency room with intractable nausea and vomiting, intolerance to food intake. The patient is admitted for further evaluation and kept NPO with IV fluids. A swallow study was performed, results of which are shown.

1. With regards to outcomes from laparoscopic adjustable gastric banding (LAGB) placement, which of the following is true?
   A. Excess weight loss at 2 years is about 60% with a narrow range.
   B. Excess weight loss is about 50% with a wide range.
   C. Excess body weight loss is about 45% at 5 years.
   D. Inadequate weight loss at 2 years occurs 15% of the time.
   E. Hypertension and hyperlipidemia resolution is equivalent to the Roux-en-Y gastric bypass (RYGB).

2. Which of the following is the most common complication of LAGB placement?
   A. Gastric prolapse
   B. Tubing/access port problems
   C. Esophageal dilation
   D. IVC inclusion in the band
   E. Gastric erosion

3. The radiology study shown demonstrates:
   A. Gastric prolapse
   B. Gastric dilation
   C. Esophageal failure
4. Which of the following intraoperative or postoperative strategies described below could have the greatest impact on preventing this complication?

A. Small portion sizes
B. A rebuckling procedure
C. Pars flaccida technique
D. Remove all fluid from the band
E. Gastropexy

5. What is the ideal treatment for this complication?

A. “Unbuckling,” reduction, and “rebuckling” procedure
B. Removal with plans to perform an alternative weight loss procedure
C. Removal of all fluid in band port
D. Band deflation and begin proton pump inhibitor
E. Perform an esophagogastroduodenoscopy (EGD) and then remove band if indicated

ANSWERS

1. B. The Centers for Disease Control and Prevention (CDC) developed the BMI chart comparing an individual's height and weight to determine if they fall within a healthy range. The excess weight can be calculated by calculating the individuals current BMI and then determining what their weight should be at that height and subtracting it from the former. Expected excess weight loss after undergoing a gastric band operation at 2 years and 5 is 52% and 56% respectively with standard deviation that ranges from 2% to 15%.

2. A. In a review of 2283 patients, a total of 238 (8.5%) patients experienced a complication after placement of a LAGB. The most frequent was proximal pouch dilation and gastric prolapse (4.2%). The incidence of gastric prolapse has decreased since changing from the perigastric technique to the pars flaccida technique and adding a gastrogastric suture or gastroplexy technique. Tubing/access port problems were next at 1.2% as well as explantation. Erosion into the gastric lumen was the least frequent in this study at 0.5%. Inclusion of the IVC into the band can result in an intraabdominal or intrathoracic emergency and is a complication that is rare, but reported and described.

3. A. Band prolapse occurs when part of the stomach herniates under the band. Gastric prolapse symptoms include dysphagia, worsening Gastroesophageal Reflux Disease (GERD), nausea/emesis, and food intolerance. Patients are at an increase in risk for gastric prolapse if they have emesis immediately post-op, which can dislodge sutures that were placed using the gastroplexy technique to avoid this complication. A contrast or upper GI study is used to make the diagnosis. The study will likely show contrast pooling in the prolapsed stomach with the band in a horizontal position for an anterior prolapse (as is the case in the above scenario) or in a vertical position for a posterior prolapse. If the gastric wall remains prolapsed it can become strangulated and may result in gastric incarceration.

4. E. Restricting the patient to small portion sizes will prevent gastric dilation, which can lead to gastric prolapse, but this is not the most effective method in preventing this complication. Educating patients on the importance of portion size does play a large role in their post-op weight loss success. An unbuckling, reduction, and rebuckling procedure is performed by some surgeons to fix a gastric prolapse; however, recurrence is common with this procedure. Removing fluid from the port to a “zero” fill volume is the initial treatment for gastric prolapse and will not necessarily prevent gastric prolapse nor would it assist in weight loss with “zero” fill. Performing a pars flaccida technique has been shown to decrease the incidence of gastric prolapse when compared to the older perigastric technique; however placing gastrogastic sutures or performing a gastropexy is currently considered the most effective technique.

5. B. The unbuckling, reduction, and rebuckling procedure is used by some surgeons as a technique to repair gastric prolapse; however, recurrence rate has been found to be quite high. Removal of all fluid in the band port would be considered the nonoperative management for gastric prolapse. The patient may be able to consume food easier when fluid is removed completely from the band. Removing all fluid in the band port would be the treatment of choice for gastric pouch dilation, for which the band would be in normal position on the barium swallow if this was the diagnosis. Band deflation and
beginning a proton pump inhibitor would be the recommended treatment for a patient experiencing an exacerbation of GERD symptoms after band placement and may ultimately need a laparoscopic roux-en-y gastric bypass.

An EGD would be indicated to rule out the presence of a gastric erosion; and if one is seen then removal of the band and repair of the erosion is indicated. Gastric prolapse can result in a surgical emergency if strangulation or incarceration occurs. If the patient is hemodynamically stable, then an elective procedure can be performed. This patient would benefit from band removal initially to prevent the incarceration and plan for a future weight loss surgery if desired by the patient.

BIBLIOGRAPHY


A 66-year-old Japanese female is referred by her primary physician for long-standing biliary colic symptoms. She describes 10 to 15 years of intermittent right upper quadrant (RUQ) pain with nausea that typically resolves after 1 to 2 hours. She went to the emergency room once 6 years ago and had an ultrasound that showed gallstones. Her medical history is significant for hypertension and osteoporosis. Her vitals and exam are unremarkable. A repeat RUQ ultrasound ordered by her primary care physician now shows a large 3 cm gallstone, as well as a fixed mass in the fundus, 2 cm in diameter, that appears to originate from the gallbladder wall. The immediate surrounding gallbladder wall is thickened to 8 to 11 mm. A CBC, basic chemistry, and liver function tests are all within normal limits.

1. Which of the following is a risk factor for gallbladder carcinoma?
   A. Hemolytic anemia
   B. Biliary dyskinesia
   C. Clonorchis sinensis infection
   D. Anomalous union of the pancreaticobiliary ductal system or pancreaticobiliary maljunction (PBM)
   E. Auto-immune diseases

2. Which of the following radiographic findings is associated with the highest incidence of gallbladder carcinoma?
   A. Pancreaticobiliary maljunction (PBM) without biliary dilatation identified on magnetic resonance cholangiopancreatography (MRCP).
   B. Strongly enhancing thick inner layer and a weakly enhancing or nonenhancing outer layer of the gallbladder wall on the portal phase of a multi-detector CT scan (MDCT).
   C. Gallbladder polyp 10–20 mm on ultrasound.
   D. Gallbladder wall calcifications; “porcelain gallbladder”.
   E. Asymptomatic gallstone greater than 3 cm in size.

3. Review of all imaging studies shows a gallbladder tumor invades into the muscularis propria. There is no lymphadenopathy or distant metastases seen. What is the most appropriate next step in management?
   A. Referral for definitive treatment with chemotherapy and radiation.
   B. Referral for neoadjuvant chemotherapy and radiation.
   C. Schedule for cholecystectomy.
   D. Schedule for cholecystectomy with removal of regional lymph nodes and en-bloc hepatic resection.

4. The same patient with the same history of present illness and past medical history instead presents to the emergency room with RUQ pain. The ultrasound in this case is read as 2 large gallstones with diffuse gallbladder wall thickening up to 11 mm, pericholecystic fluid, and a normal common bile duct. Labs show white blood cell count of 13 and normal liver function. You take the patient for laparoscopic cholecystectomy.
   There was no concern for malignancy during the procedure. The gallbladder was removed without spillage and with a retrieval bag. You see her 2 weeks later in clinic, and review of the pathology report

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shows T2 adenocarcinoma. All surgical margins, including cystic duct margin, are reported as clear. What is the most appropriate course of action?

A. No additional surgery, surveillance with imaging every 6 months.
B. Staging with imaging followed by radical cholecystectomy to include: liver resection with at least 3 cm of margin around gallbladder bed and regional lymphadenectomy.
C. Staging with imaging followed by radical cholecystectomy and in addition, excision of the previous laparoscopic port sites.
D. Staging with imaging followed by radical cholecystectomy and in addition, excision of the common bile duct.
E. Staging with imaging followed by radical cholecystectomy and in addition, excision of both the common bile duct and the laparoscopic port sites.

5. Which of the following is true regarding the surgical management for T2 or T3 gallbladder cancers?

A. Formal segmentectomy (4b + 5) improves overall survival over wedge resection.
B. Formal segmentectomy reduces local recurrence rates compared to wedge resection, but overall survival is the same.
C. Formal segementectomy improves disease free survival, but not overall survival.
D. A clear survival benefit for formal segmentectomy over wedge resection has not been demonstrated.

ANSWERS

1. D. A history of gallstones is common, and 65% to 90% of those with biliary carcinoma, have a history of gallstones. The relation of gallstones to gallbladder cancer (GBC) is thought to be mediated by chronic inflammation. There is a relatively well-defined sequence of flat-epithelial premalignant changes leading to GBC. Chronic inflammation leads to intermediate low-grade dysplastic changes. Dysplastic progression over time leads to carcinoma-in-situ and finally invasive carcinoma. Anomalous union of the pancreaticobiliary ductal system, where the pancreatic duct and common bile duct merge outside the wall of the duodenum and form a long common channel, is also associated with an increased risk of GBC. This is pancreaticobiliary maljunction (PBM) leads to chronic reflux of pancreatic enzymes.

The progression to GBC is likely mediated through an epithelial hyperplasia with resultant papillary or villous epithelial changes progressing to GBC. Further evidence that this is a distinct pathway from chronic inflammation is that the gene alterations of cancers arising in the setting of cholelithiasis differ from anomalies of the duct system associated cancers. Adenomas do occur in the gallbladder and can progress to cancer. However, this likely occurs much less commonly than the other two pathways, given a lack of cancer-related molecular changes in most of these lesions. Inflammatory bowel disease is also associated with increased risk for gallbladder carcinoma. Clonorchis infection is associated with risk for cholangiocarcinoma, but it has not been linked to carcinoma of the gallbladder. Chronic Salmonella typhi or paratyphi infection is, however, associated with increased risk for gallbladder cancer. Hemolytic anemia may be a cause of bilirubin type gallstones but is not a risk factor for gallbladder cancer, neither is biliary dyskinesia or auto-immune diseases.

2. B. A recent retrospective study of findings on MDCT associated with gallbladder cancer found two patterns most associated with finding malignancy at the time of surgery. A strongly enhancing thick inner layer and a weakly enhancing or non-enhancing outer layer of the gallbladder wall on multi-detector CT scan was shown to have a 52% to 55% incidence for gallbladder cancer. A single thick layer with heterogenous enhancement on MDCT had an incidence of 35% to 38% for gallbladder cancer. Pancreaticobiliary malformation (PBM) without bile duct dilatation have an incidence of biliary tract cancer of 37.9%, of which 93.2% of these were gallbladder cancer. Based on this data, prophylactic cholecystectomy is recommended for these patients. The incidence rates of malignancy in gallbladder polyps varies widely in published reports but ranges from 9.6% to 40% for polyps 10 to 20 mm. The wide variance is related to various imaging modalities used and populations studied. Polyps ≥ 10 mm, sessile polyps and rapidly growing polyps are all recommendations for gallbladder removal.

The finding of gallbladder calcifications or a porcelain gallbladder was found to be associated with a malignancy in 6% of cases in a recent systematic literature review. This is a far lower number than the historically quoted figure of approximately 25%. Attempts in the review were made to limit inherent
biases in a review of retrospective studies that favor overestimation but this value likely still overestimates the true incidence. Given the incidence, the decision to perform a prophylactic cholecystectomy should not be absolute and should be weighed against the risks of surgery for the individual patient. The presence of gallstones is associated with an increased risk of gallbladder cancer. The size and volume of stone burden have been identified as potential risk factors for developing gallbladder cancer. However, there is no direct evidence of a causal relationship between gallstones and gallbladder cancer. The risk for gallbladder cancer development with a 3 cm or greater stone has been estimated to be a 2% risk over a 20 year period.

3. D. The patient has a T1b lesion or early gallbladder cancer. Surgical resection is the only curative therapy for gallbladder cancer. The general consensus is for radical cholecystectomy for T1b or greater lesions. T1b tumors have been shown to have lymph node metastasis in 24% of cases. Lower recurrence rates and improved survival have been observed with radical resection including lymph nodes when compared to simple cholecystectomy. A review of the SEER database showed that the evaluation of even a single lymph node improved overall survival and that radical resection without lymph node assessment was no better than cholecystectomy alone for early stage gallbladder cancer. Neoadjuvant therapy has been evaluated in the setting of borderline and unresectable extra-hepatic biliary malignancies with good results in survival and obtaining negative margins but none of these addressed gallbladder cancer specifically and were confined to advanced disease. Adjuvant chemoradiation does have a role in select gallbladder cancer patients, especially with positive nodes or margins to improve local control.

4. B. Prognosis of gallbladder carcinoma is determined by the depth of tumor infiltration and the ability to obtain a tumor-free resection margin (R0). For T2 or greater the definitive resection should include a minimal hepatic resection centered on the gallbladder bed and a regional lymphadenectomy. The majority of experts also extend this recommendation to T1b tumors but some controversy persists. There is uniform agreement that cholecystectomy alone is sufficient for Tis and T1a tumors. There is also general agreement regarding several other technical points, such as resection of the common bile duct, and the need for port site excision. Excision of the common bile duct is only necessary for a positive cystic duct margin or direct invasion of the hepatoduodenal ligament.

Regarding routine common bile duct excision with radical cholecystectomy unless there is direct invasion of the hepatoduodenal ligament and/or of the cystic duct, bile duct resection does not result in decreased recurrence or better overall survival and does not increase the number of nodes in the specimen. Peritoneal involvement with gallbladder cancer is common and there is theoretical adverse impact on this with pneumoperitoneum. However, the risk of port site recurrence is based on perforation of the gallbladder or extraction without a retrieval bag rather than the pneumoperitoneum. Port-site excision does not improve overall or disease-free survival in large retrospective series. Port site excision does not need be routinely performed during secondary procedures for gallbladder cancer discovered after laparoscopic cholecystectomy.

5. D. Although some studies have reported anatomic resection improves survival and R0 resection rate when compared to wedge resection, other reports have not demonstrated a benefit. The majority of these studies dealt with liver resection for liver metastases. There are a few studies looking at gallbladder cancer specifically. Pawlik et al. found that patients who underwent a major hepatic resection (e.g., formal segmentectomy of 4b + 5 or hemi-hepatectomy) had a similar risk of disease-specific death compared with patients who underwent a hepatic wedge resection. Horiguchi et al. found the overall survival rate and disease-free survival rate at 5 years did not differ significantly between wedge resection and 4a + 5 resection group for T2 tumors. The available evidence in gallbladder cancer does not show a clear benefit to anatomic resection. As such, the surgeon’s goal should be to resect all disease with negative histologic margins and chose the appropriate operation to achieve this with the fewest complications.

BIBLIOGRAPHY


A 67-year-old female presents with sharp, burning right upper quadrant abdominal pain that radiates to her back. The pain awakens her from sleep. She has experienced nausea and three episodes of emesis. She reports burning substernal and epigastric pain. She denies any fevers or chills. She is hemodynamically normal and afebrile. Laboratory workup reveals a normal hepatic function panel, a normal basic chemistry, and a normal white blood cell count. Her abdominal exam is remarkable for mild tenderness in the right upper quadrant without peritoneal signs. After three hours, her pain resolves.

1. What is the next best test in this patient’s scenario?
   A. Plain films of the abdomen
   B. Cholecystokinin stimulated cholescintigraphy
   C. Right upper quadrant ultrasound
   D. Computed tomography (CT) of the abdomen
   E. Esophagogastroduodenoscopy (EGD)

2. The appropriate imaging is ordered and shows no abnormality. Which is the next most appropriate step in management?
   A. Cholecystectomy
   B. Esophagogastroduodenoscopy
   C. Right upper quadrant ultrasound in two weeks
   D. Proton pump inhibitor administration
   E. Bile microscopy

3. The patient returns to the emergency department one month later with similar symptoms. A right upper quadrant ultrasound is performed that shows gallstones without signs of acute cholecystitis. Her pain again resolves and she is referred to your clinic the following week. You discuss performing a cholecystectomy with the patient, which she refuses. Which of the following is true regarding medical therapy of cholelithiasis?
   A. Ursodiol therapy typically resolves biliary symptoms within one month.
   B. Complete resolution of cholelithiasis is successful in less than 40% of patients.
   C. If biliary symptoms persist while on ursodiol, cholecystectomy is indicated.
   D. The mechanism of action of ursodiol includes reduction in bile synthesis.
   E. Extracorporeal shockwave lithotripsy (ESWL) has a symptomatic recurrence rate of 30%.

4. The patient’s ultrasound, in addition to cholelithiasis, is also notable for a 1.5 cm non-mobile polypoid lesion in the fundus of the gallbladder. Which of the following is true?
   A. Polyps greater than 5 mm are a risk factor for gallbladder cancer.
   B. Patients with large (> 2.5 cm) gallstones are more likely to develop gallbladder cancer than those without.
   C. Laparoscopic cholecystectomy should be performed, a frozen analysis should be done, and if positive, an oncologic resection should be done laparoscopically.
   D. Multiple pedunculated subcentimeter lesions are also a risk factor for gallbladder adenocarcinoma.
   E. Extended cholecystectomy is not required for gallbladder adenocarcinomas with up to T3 lesions.
ANSWERS

1. C. This scenario describes symptomatic cholelithiasis, or biliary colic. Plain films of the abdomen would not be a high yield study as less than 10% of gallstones are radio-opaque, nor would it offer specific imaging of the biliary system. Other yields from a plain film would be presence of nephrolithiasis or free air (Choice A). A hepatobiliary (HIDA) scan is the gold standard for the diagnosis of acute cholecystitis—a clinical scenario in which she does not fit criteria (Choice B). With the cholecystokinin injection, the nuclear imaging study can be diagnostic for biliary dyskinesia. C can often visualize gallstones but is not the recommended imaging modality of choice for cholelithiasis as the sensitivity is 55% to 80% (Choice D); cholelithiasis is often found incidentally on CT scan when the imaging is performed for other reasons.

Esophagogastroduodenoscopy could be helpful to rule out peptic ulcer disease that can sometimes mimic symptoms of biliary colic, but this test would not be the ideal next choice in this situation (Choice E). The most common initial imaging modality in biliary disease is the right upper quadrant ultrasound. Ultrasound has a sensitivity of 84% and specificity approaching 99% for the diagnosis of cholelithiasis (Choice C). Simultaneously, assessment for signs of acute cholecystitis, cholelothiasis, and hepatic pathology can be sought.

2. C. This patient should have had a right upper quadrant ultrasound performed in the first question above. If this imaging modality shows no abnormality, but the patient has biliary symptoms, she should have a repeat right upper quadrant ultrasound performed in 2 weeks with focus on areas that may have missed stones smaller than 3 mm (Choice C).

Esophagogastroduodenoscopy is an appropriate diagnostic modality to rule out peptic ulcer disease and can be utilized if the repeat ultrasound is still negative. Bile microscopy has been shown as an adjunct study to assess for microlithiasis and can be helpful (Choice E), although is not routinely performed; bile microscopy also requires endoscopy for collection. The sensitivity of bile microscopy for microlithiasis is 65% to 90%. Cholecystectomy is not recommended at this time as other causes of the patient's symptoms have not been ruled out.

Cholecystokinin stimulated cholescintigraphy can help identify a functional gallbladder problem that may warrant cholecystectomy if positive (Choice A). Proton pump inhibitor therapy may help with reflux symptoms but does not specifically address biliary symptoms (Choice D).

3. B. Ursodiol may take up to 3 months to show improvements in biliary symptoms, and can take up to 3 years to completely dissolve gallstones (Choice A). A meta-analysis of treatment with ursodiol showed that only 37% of patients had complete resolution of biliary symptoms; cholecystectomy remains the preferred choice in surgical candidates (Choice B). Many patients who undergo initial medical therapy with ursodiol do progress to surgical treatment, but they tend to show initial improvement in symptoms. If biliary symptoms progress while being treated with ursodiol, other causes must be ruled out, such as sphincter of Oddi dysfunction or peptic ulcer disease (Choice C). The mechanism of action of ursodiol involves reducing absorption in the duodenum, resulting in disruption of micelles and reduced cholesterol absorption, thereby decreasing cholesterol concentration; ursodiol is not involved with the synthesis of bile (Choice D). Extracorporeal shockwave lithotripsy can be utilized as nonsurgical therapy, but has a recurrence rate of approximately 20%. Indications include patients with single stones, between the sizes of 5 mm and 2 cm. ESWL is not commonly offered as medical therapy due to the efficacy and commonplace practice of cholecystectomy (Choice E).

4. B. This patient should undergo open cholecystectomy with a symptomatic, visualized preoperative intraluminal gallbladder lesion that is 1.5 cm in size. The open cholecystectomy is preferred, because gallbladder perforation or bile spillage during laparoscopic cholecystectomy can potentially seed the peritoneal cavity. Polypoid lesion size greater than 1 cm is an independent risk factor for gallbladder adenocarcinoma, along with stone size greater than 2.5 cm (Choice A, B). Gallbladder cancer has a 3:1 ratio of incidence in women and typically presents after age 60. Extended cholecystectomy is not indicated if the lesion is confined below the muscle layer of the gallbladder. If the lesion is T2 or greater, resection usually includes segments IVb and V of the liver (Choice E). Choice D is descriptive of cholesterol
polyps, which are not a risk factor for gallbladder adenocarcinoma.

BIBLIOGRAPHY


A 70-year-old male presents to the emergency department with altered mental status. Family reports he was complaining of right upper quadrant abdominal pain prior to becoming altered mentally. On arrival, he is found to have a temperature of 102.5°F, heart rate of 112, and systolic blood pressure of 80 despite 2 liters of crystalloid infusion. On exam, he is visibly jaundiced with tenderness in the right upper quadrant. He has 3 out of 4 systemic inflammatory response syndrome (SIRS) criteria. He is started on pipericillin/tazobactam and admitted to the intensive care unit for invasive monitoring and vasopressor support.

1. Regarding this patient's constellation of symptoms, what is the most common cause?
   A. Gallstones
   B. Biliary stricture
   C. Malignancy
   D. Genetic disorder

2. Regarding the pathophysiology of cholangitis, which of the following is correct?
   A. Increased biliary pressure leads to decrease in production of IgG in the biliary mucosa leading to increased translocation of duodenal bacteria.
   B. Intra-portal toxins and bacteria can cross through the biliary system due to stasis leading to infection.
   C. Stones do not colonize with bacteria.
   D. Biliary stents are not felt to contribute to or cause cholangitis as they help decompress the biliary tree.

3. Regarding the proper diagnostic workup, which noninvasive test has highest sensitivity and specificity for detecting the most common cause?
   A. Abdominal ultrasound
   B. Magnetic resonance cholangiopancreatography (MRCP)
   C. CT Scan
   D. Hepatobiliary (HIDA) scan

4. Regarding the management of septic cholangitis caused by choledocholithiasis, which of the following is correct?
   A. Urgent biliary tract decompression via endoscopic retrograde cholangiopancreatography (ERCP) is successful 60% of the time.
   B. Percutaneous transhepatic cholangiography (PTC) is feasible for stone extraction and stent placement.
   C. ERCP with a sphincterotomy is equivalent to cholecystectomy for reducing recurrence rates.
   D. Should ERCP and PTC fail or are not feasible, operative choledochotomy and T-tube placement should be avoided because of the risk of surgery.
   E. Broad spectrum antibiotic therapy alone will generally provide adequate treatment.

**ANSWERS**

1. A. Cholangitis is caused by obstruction of the biliary tree eventually leading to bile stasis and bacterial infection. The most common cause being gallstones, which account for around half of cases. Other causes
include stenosis/biliary stricture, malignancy and biliary stents. Stents can cause obstruction from migration, occlusion, or colonization by bacteria leading to bacterial overgrowth and translocation into the bloodstream.

2. B. Obstruction of the biliary tree via stricture/stenosis, stones, malignancy, or stent occlusion leads to increased biliary tract pressure. T is pressure promotes stasis of bile and decreases production of IgA in the bile tract mucosa. T e lack of continuous bile flow, coupled with decrease mucosal protection allows for bacterial translocation from the duodenum through the biliary tract. T is is static bile and gallstones provide a healthy growth medium for bacteria. T e elevated intra-biliary pressure allows for translocation of these pathogens into the systemic circulation causing septicemia. Less commonly, bacteria and toxins can enter through the portal circulation into the bile due to increased biliary pressure.

T e most common bacteria are gram negative enteric pathogens: E coli, klebsiella, and enterobacter. T ey carry LPS that promotes cytokine release and leads to septic shock. Enterococcus is seen in a smaller set of cases.

3. B. MRCP is the best non-invasive test to confirm the presence of choledocholithiasis due to its high sensitivity (some studies quoting 100%) and nearly 100% specificity. If the test is positive then this confirms diagnosis. It also is helpful in evaluating for stricture and ampullary masses. Ultrasound is a good screening tool and can evaluate for common bile duct dilatation to perhaps lend clinical suspicion to presence of biliary obstruction. It is best at identifying the presence of cholelithiasis/cholecystitis. However, it has lower accuracy in identifying the presence of a choledocholith, roughly 80%.

A CT scan is less useful than ultrasound in detecting cholecystitis/common bile duct dilatation, but is helpful at evaluating for ampullary masses as a cause of a dilated common bile duct.

HIDA scans are not useful in the setting of cholangitis as the biliary tract infection reduces secretion of the radio nucleotide labeled marker into the biliary tree. It may show, however, obstruction with lack of flow into the duodenum.

4. B. In cases of cholangitis without septic shock, a trial of antibiotic therapy is recommended as this can resolve symptoms and ensure stability in up to 80% of patients. Routine ERCP can be performed in this setting assuming the patient remains stable. T is patient displays Reynold’s pentad of fever, right upper quadrant pain, jaundice, altered mental status, and hypotension, the first three signs constituting Charcot’s triad. T is lends suspicion to suppurative cholangitis due to the patient’s state of septic shock. Antibiotics, though required as initial therapy, are unlikely to complete resolve this patient’s septic physiology. Emergent/urgent biliary tree decompression is warranted and must be performed to prevent excessive morbidity/mortality.

ERCP with sphincterotomy has shown upwards of a 95% success rate in stone extraction and decreasing the rate of recurrence of cholangitis. It is, however, not superior to cholecystectomy in decreasing rates of recurrence and thus cholecystectomy is recommended after the ERCP/sphincterotomy once the septic physiology has resolved. Arguments for early cholecystectomy have been made as waiting 6 to 8 weeks runs the risk of 20% recurrence rate of a gallstone related event.

Should ERCP fail, PTC is warranted as both these procedures decrease the morbidity/mortality risk of a common bile duct exploration. PTC can be challenging if there is little intra-hepatic ductal dilatation and it also does not allow sphincterotomy.

Common bile duct exploration is warranted should ERCP and PTC fail at decompressing the biliary tree. In the setting of a patient who is in septic shock, choledochotomy with stone extraction and T-tube placement is recommended as this allows for decompression of the biliary tree and allows for sepsis to resolve prior to performing cholecystectomy to limit the morbidity and mortality associated with both procedures. T e exploration is performed through a choledochotomy on the common bile duct distal to the insertion of the cystic duct. Stay sutures are placed on either side of the choledochotomy and using balloon catheters, fluoroscopy with basket retractors, and flushing, stone extraction is performed. In general, the choledochotomy should be roughly the size of the largest stone. It is best done in dilated ducts as the risk of stenosis is high in the setting of common bile duct size <6 mm.

A large bore T-tube is placed and the choledochotomy repaired over the T-tube with 4-0 absorbable sutures. T e tube is externalized and bile allowed to drain into an external bag. Due to lack of re-absorption of bile, a patient with this procedure is prone to being
deficient in fat soluble vitamins (A, D, E, and K). It is the vitamin K deficiency which is most worrisome as it can lead to a coagulopathy.

BIBLIOGRAPHY


A 32-year-old gravida 2 para 1 female at 28 weeks gestation presents with acute onset of right upper quadrant and right upper flank pain with associated nausea and vomiting over the preceding 24 hours. She has no significant medical or surgical history. She has had 1 uncomplicated vaginal delivery. At the time of her evaluation, her temperature is 99.8°F, heart rate is 110, and respiratory rate is 24. Her exam documents a positive Murphy’s sign and guarding in the right upper quadrant. Laboratory studies show the following: WBC – 20,000, H/H- 9/29, Platelets 130,000, ALT-60, and AST 90. Her bilirubin, lipase, and amylase levels are normal. Her urinalysis is within normal limits.

1. Which of the following diagnoses is the least common disease in pregnancy presenting with right upper quadrant pain?
   A. Acute fatty liver of pregnancy
   B. Cholecystitis
   C. Cholelithiasis
   D. HELLP syndrome
   E. Appendicitis

2. Which of the following statements is correct concerning Acute Fatty Liver of Pregnancy (AFLP)?
   A. AFLP presents most commonly in the second trimester of pregnancy.
   B. AFLP commonly presents with serum amino-transferase levels similar to those found in gallbladder disease.
   C. AFLP can present with hypoglycemia and occasionally renal failure which can help distinguish it from HELLP (hemoconcentration, elevated liver enzymes, low platelet) syndrome and gall bladder disease.
   D. In a preterm pregnancy, it is considered safe to continue the pregnancy in a patient who has been diagnosed with AFLP.

3. Which of the following statements regarding radiographic imaging of biliary disease in pregnancy is correct?
   A. Classic sonographic signs of biliary disease are altered in pregnancy.
   B. The risk of radiation exposure to the fetus with ERCP (endoscopic retrograde cholangiopancreatography) is high throughout pregnancy.
   C. The neuronal development of the fetus is most sensitive to radiation between 20 to 28 weeks gestation.
   D. Exposure to less than 5 rad of ionizing radiation has not been associated with an increased risk of fetal anomalies or pregnancy loss.
   E. MR imaging has a higher sensitivity and specificity in the diagnosis of cholecystitis than ultrasonography.

4. In this patient, acute cholecystitis is diagnosed by ultrasound. Which of the following is correct regarding treatment of this patient?
   A. The risk of adverse effects of laparoscopy is high even with maximal intra-abdominal pressures limited to 9 mm Hg.
   B. If left untreated, the most common complication of acute cholecystitis in pregnancy is gangrenous cholecystitis.
C. Available studies have shown significant differences regarding preterm delivery rates, birth weights or neonatal outcomes when comparing laparoscopic versus open cholecystectomies.

D. Nonsteroidal anti-inflammatory drugs (NSAID) treatment for pain expected to last more than 48 to 72 hours is the pharmacologic option of choice after 30 weeks gestation to avoid fetal complications.

E. Beta-lactam antibiotics such as ampicillin-sulbactam or piperacillin-tazobactam are contraindicated in pregnant patients.

5. This patient undergoes an uncomplicated laparoscopic cholecystectomy. On postoperative day 2, she develops increasing pain in her right upper quadrant (RUQ) with fever and recurrent leukocytosis as well as elevated total bilirubin, transaminase, lipase and amylase levels. RUQ ultrasound documents dilated biliary ducts. Which of the following would be the most appropriate next step?

A. MRCP (magnetic resonance cholangio-pancreaticogram)
B. ERCP
C. Continued observation with antibiotic therapy
D. Repeat surgery with bile duct exploration
E. Delivery of the fetus

ANSWERS

1. A. The most common surgical disease in pregnancy is appendicitis with an incidence of 1 in 1000 to 2000 pregnancies. Gall bladder disease is the second most common surgical disease in pregnancy with an incidence of 1 in 1200 to 1 in 10,000. Theoretically, the incidence of gall bladder disease including cholecystitis, choledocholithiasis, and cholangitis should be increased in pregnancy. The elevated level of serum estrogen seen in pregnancy increases cholesterol secretion, whereas the elevated level of progesterone reduces soluble bile acid secretion and slows emptying of gallbladder. Despite the predilection toward biliary sludge and stone formation, cholecystitis does not occur more frequently during pregnancy. Appendicitis occurs with equal frequency in each trimester and the incidence is not increased in the gravid patient.

The differential diagnosis for RUQ abdominal pain is expanded in pregnancy. It includes gastrointestinal disorders such as pancreatitis, peptic ulcer disease, hepatitis, and appendicitis, due to a superiorly displaced cecum, as well as pyelonephritis, nephrolithiasis, right lower lobe pneumonia, peptic ulcer disease, and myocardial infarction. Obstetric specific diagnoses must also be included in the differential to include preeclampsia, HELLP (Hemolysis, Elevated Liver enzymes, Low Platelets) syndrome and acute fatty liver of pregnancy (AFLP). HELLP syndrome is a severe form of preeclampsia occurring in up to 8 of 1000 pregnancies presenting most commonly in the third trimester of pregnancy. This syndrome generally involves the characteristic hypertension and proteinuria seen with preeclampsia with evidence of liver dysfunction and a consumptive coagulopathy which can rapidly progress to fulminant DIC. Patients with preeclampsia may present with right upper quadrant or epigastric pain due to liver involvement and in the most severe cases subcapsular hemorrhage or hepatic rupture. AFLP is a rare diagnosis, seen in 1:20,000 pregnancies.

This patient presents with findings consistent with an inflammatory intra-abdominal process. Cholecystitis, choledocholithiasis, and cholangitis lead the differential diagnosis. The physical exam findings are highly suggestive of gallbladder disease. WBC counts and alkaline phosphatase levels are routinely elevated during pregnancy and therefore may not be as specific for inflammation during the assessment of the gravid patient.

2. C. The AFLP syndrome almost always presents in the third trimester with serum aminotransferase elevations up to 1000 IU/L, which is generally higher than those found in gallbladder disease. AFLP can also present with hypoglycemia and renal failure, which is not characteristic of either HELLP or gallbladder disease. Findings of AFLP can still significantly overlap with those of HELLP, making it very difficult to distinguish these two syndromes. Treatment for both is the emergent delivery of the fetus.

3. D. Due to the acuity of presentation and the myriad of diagnoses in the differential, imaging is an essential component in the diagnostic evaluation. Risks of radiologic studies to the fetus must therefore be considered. Sonography is the appropriate first line diagnostic modality in pregnancy for both biliary disease and appendicitis as this modality has a high diagnostic accuracy (90% to 100% for both diagnoses) and
has no known risk to the fetus. Classic ultrasound (US) findings to include wall edema, pericholecystic fluid, calculi, and sonographic Murphy's sign maintain their sensitivity and specificity in pregnancy. If ultrasound studies are non-diagnostic, MR imaging without contrast has become the confirmatory test for appendicitis. For biliary disease, an MRCP can be used in equivocal cases or in suspected cases of choledocholithiasis or cholangitis. It is not as sensitive as US for cholecystitis. Intraoperative cholangiogram in combination with cholecystectomy is an option for diagnostic evaluation after fetal organogenesis is complete in the second trimester and does not appear to increase the risk for preterm delivery or adverse fetal outcomes. If MRCP documents stone disease in the biliary tree, ERCP is considered a viable therapeutic option after the first trimester. The risks to the fetus with cholangiogram and ERCP can be reduced with shielding.

CT scan of the abdomen, which is the preferred imaging modality for appendicitis in the non-pregnant patient, confers radiation levels of 5 to 10 rads which approach the maximum permissible radiation dose for fetal exposure during pregnancy. Fetal exposure to ionizing radiation increases risks of microcephaly, microphthalmia, mental retardation, growth restriction, and cataracts. The concern of ionizing radiation is greatest during organogenesis which falls between 3–20 weeks of gestation. The above patient is at 28 weeks and therefore the risk of serious complications with ionizing radiation is limited. CT generally remains behind US and MR on the imaging algorithm for both appendicitis and cholecystitis even in the patient with a fetus of advanced gestational age due to the disputed twofold increased risk of carcinogenesis (1:1000) in the fetus. CT imaging should, however, not be abandoned as a diagnostic modality, as the risk of delay in diagnosis far outweighs the risk of radiation. The consulting radiologist can design CT protocols to minimize the associated risks and counseling can minimize the associated anxiety of the patient.

4. B. Initial non-surgical management can be considered in hemodynamically normal pregnant patients experiencing cholelithiasis. The management plan generally involves bowel rest, intravenous hydration, and NSAID therapy. A short course (< 48 to 72 h) of indomethacin treatment can provide effective analgesia but is generally avoided in late pregnancy due to the potential adverse fetal effects. Use in the third trimester increases the risk of premature closure of the patent ductus arteriosus and oligohydramnios. Intravenous antibiotics to include ampicillin-sulbactam, piperacillin-tazobactam, and ticarcillin-clavulanate are not contraindicated in pregnant patients who need antibiotics for acute cholecystitis or choledocolithiasis.

Early surgery has been advocated for all types of biliary disease in pregnancy. If not treated, cholecystitis can lead to life threatening complications, the most common of which is gangrenous cholecystitis followed by abscess formation, perforation, fistula, ileus, or emphysematous cholecystitis. For symptomatic cholelithiasis with no evidence of cholecystitis, surgery can be delayed. However the literature reports that surgical management of symptomatic cholelithiasis in pregnancy is safe, decreases hospital days, reduces emergency room visits, and the rate of preterm deliveries. The second trimester (from 13 to 27 weeks gestation) is considered the best timeframe for cholecystectomy as the uterus is not obstructing the view of the surgical field, and the risk of miscarriage or preterm birth is lowest. In this patient, with clear evidence of cholecystitis, surgical intervention is warranted to reduce risk of serious complications. If complications such as cholangitis or gallstone pancreatitis develop in a pregnant patient, maternal mortality may approach 15% and fetal loss up to 60%.

Surgical management of biliary disease has been revolutionized with the advent of laparoscopy. Laparoscopic technique can be utilized safely in pregnancy across all trimesters depending on the comfort level of the surgeon. Although data is limited, laparoscopy does not confer an increased risk of adverse pregnancy outcomes to include preterm delivery as compared to laparotomy. Proper positioning in left lateral tilt is important to reduce venal caval compression and maintain adequate placental blood flow, and open entry technique is recommended to prevent injury to the enlarged gravid uterus. Intraabdominal pressure with pneumoperitoneum should be limited to 10 to 12 mm Hg to reduce the theoretical concern of fetal acidosis associated with the effect of CO₂. There is no indication for intraoperative fetal monitoring.

Early surgery for appendicitis is also recommended in pregnant patients, as the consequences for both the mother and fetus can be catastrophic. Abbasi et al., in the largest case series to date involving 7000 patients, documents a markedly increased risk of
severe complications with conservative management to include miscarriage and maternal sepsis. As with cholecystitis, non-operative management of appendicitis is contraindicated in pregnancy.

5. B. Following cholecystectomy, this patient presents with findings consistent with cholecdocholithiasis, with associated gallstone pancreatitis and possible cholangitis. The best option in this case is ERCP with the option of sphincterotomy to decompress the biliary tract. This approach appears safe in pregnant patients with early onset cholangitis with lower morbidity than conservative management. In this patient, repeat surgery with intraoperative cholangiography or bile duct exploration would be a back-up option, if the stones cannot be removed via ERCP. Percutaneous biliary tract decompression would be another option in a high risk patient. MRCP is an excellent and safe diagnostic test in pregnancy and is a viable option in patients where the diagnosis is uncertain.

In a case with a high suspicion of cholangitis, this step could delay therapy which could have severe consequences for both fetus and mother. More aggressive therapy for cholangitis is therefore indicated in pregnancy. Although conservative treatment with continued intravenous antibiotics and observation may be appropriate in the non-gravid patient, the risks of this non-surgical approach are higher in the gravid patient and predispose her to grave complications. Premature delivery of the fetus is not indicated for the treatment of biliary disease.

BIBLIOGRAPHY


A 60-year-old male presents with 2 months history of rectal bleeding associated with anorexia and a 10 lbs weight loss. He underwent a diagnostic colonoscopy revealing an ulcerated and circumferential right cecal mass; biopsy returns as invasive adenocarcinoma. Staging CT scan of chest/abdomen/pelvis shows bilobar and peripheral liver masses ranging from 2 to 3 cm in diameter with a total of 3 masses, no regional or paraaortic adenopathy, and no other distant sites of disease. Percutaneous biopsy of a right lobar liver mass reveals metastatic adenocarcinoma, consistent with the colon as the primary site of malignancy. The patient has hypertension and hypercholesterolemia. He has no family history of colorectal cancer. His functional status is good.

1. The best initial management in this patient is:
   A. Neoadjuvant chemotherapy
   B. Concomitant right hemicolectomy and liver resection
   C. Right colectomy then chemotherapy
   D. Radiofrequency ablation of liver tumors
   E. Hepatic Intraarterial chemotherapy

2. Regarding neoadjuvant chemotherapy that is used for metastatic colorectal cancer, which of the following statements is true?
   A. XELOX (capecitabine and oxaliplatin) is less effective than 5-FU and leucovorin.
   B. FOLFOXIRI (leucovorin, 5-FU, oxaliplatin, irinotecan) is recommended over FOLFIRI (5-FU, leucovorin, and irinotecan).
   C. FOLFIRI increases overall survival compared to FOLFOX (5-FU, leucovorin, and oxaliplatin).
   D. Ceftriaxone plus multiagent chemo (FOLFOX or FOLFIRI) is best used for patients with the K-RAS wild type colorectal cancer.
   E. 5-FU and leucovorin are adequate.

3. Contraindications to liver surgery for metastatic tumor resection include:
   A. Resection that would remove 5 hepatic segments
   B. Bilobar liver involvement
   C. Resection that would require removal of 60% of the liver
   D. 4 cm liver lesion
   E. Tumor involving the common hepatic artery

4. After successful resection of both the primary colon cancer and its liver metastases, the guidelines for surveillance include:
   A. Occult fecal blood testing every 6 months
   B. CEA levels annually for the next 5 years
   C. CT scans of thorax/abdomen/pelvis every 3 months for the next 5 years
   D. Surveillance colonoscopy one year after surgery, then every 5 years if no advanced adenomas found.
   E. Annual PET scan

5. For initially unresectable colorectal liver metastases, what percentage of patients will be resectable following neoadjuvant chemotherapy?
   A. About 5%
   B. About 15%
   C. About 30%
   D. About 50%
   E. About 70%
ANSWERS

1. B. Concomitant colon and liver resections would be preferable for this patient. If hepatic metastases are resectable on presentation, surgical resection should be considered rather than preoperative chemotherapy for medically fit patients with 4 or fewer metastases. The definition of resectable disease encompasses both the character of the metastatic lesions and the patient's overall health status. The patient has minimal co-morbidities and a good functional status rendering him a potentially good candidate for major abdominal surgery. The liver lesions in this scenario are considered resectable because of their overall number (4 or less), moderate size (only 2 to 3 cm), and its ideal peripheral liver location. Central or large metastatic liver lesions (> 6 cm) that encroach upon major liver vasculature such as the hilum of the main portal vein would preclude liver resection. Unfortunately no more than 20% of patients with isolated hepatic metastases are amenable to potential curative hepatic resection; but because of clear survival impact, surgical resection is the treatment of choice for resectable colorectal metastases to the liver.

There is an exception to this rule and that is, if the metastatic tumor response to chemotherapy is expected to create a significantly less complex liver resection, then neoadjuvant therapy is recommended. The next recommended management option is an initial right hemicolecction if the patient is already exhibiting GI obstructive symptoms, followed by four to six cycles of chemotherapy (must be cognizant of potential hepatotoxicity if too much chemotherapy is given), and then consideration of liver resection if still indicated. Radiofrequency ablation (RFA) is not considered curative for larger liver metastases. Intra-arterial chemotherapy should be limited to centers with expertise in this modality.

2. D. The use of 5-FU (fluorouracil) and leucovorin has historically been the basis of adjuvant chemo-therapy for Stage III colon cancer. Similarly for Stage II and III rectal cancer, 5-FU and leucovorin along with radiation therapy is recommended. Currently for Stage III colon cancer, FOLFOX is considered the superior regimen over 5FU-Leucovorin, with improved survival but has additional risk of peripheral neuropathy. For Stage IV disease, there seems to be increased response and better survival with the addition of biologic agents like cetuximab, panitumumab, and bevacizumab, or alkylating agents like oxaliplatin, and topoisomerase inhibitors like irinotecan to the 5FU-leucovorin regimen. The table of chemotherapeutic regimens listed below +/- bevacizumab or cetuximab are acceptable for metastatic colorectal cancer treatment in the neoadjuvant setting. 5FU and leucovorin alone is not adequate treatment for patients with metastatic colorectal disease.

FOLFOXIRI when compared to FOLFIRI was equivalent in overall survival, response rates, and median time to disease progression. FOLFOXIRI, however, was associated with more significant side effects. Furthermore, the addition of biologic agents, cetuximab or panitumumab is recommended for patients with colorectal tumors exhibiting the K-RAS wild-type, which may increase the number of patients eligible for liver resection post-chemotherapy (pt reevaluated for conversion to resectable disease every 2 months) to improve their outcomes.

For colorectal metastatic disease, FOLFOX or FOLFIRI are considered to be equally effective with different toxicity profile. Capcitabine is an orally administered tumor-activated 5-FU prodrug.

3. E. Inadequate post-resection liver reserve is considered a contraindication for liver resection of colorectal metastases. That being said, in healthy livers, up to 70% of the liver or up to 6 hepatic segments can be resected safely. The location of the tumor is also important as metastatic tumors invading the

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<th>Chemotherapeutic Regimen</th>
<th>5-FU</th>
<th>Leucovorin</th>
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common hepatic artery, common hepatic duct, main portal vein, or >3 hepatic veins would be considered contraindications. Extrahepatic involvement of the celiac, portal, or paraaortic nodes would also be considered a contraindication. Lesions larger than 6 cm would also be considered a relative contraindication to resection. Bilobar disease or greater than 4 metastatic lesions that do not shrink with neoadjuvant chemotherapy was deemed inappropriate for liver resection based on OncoSurge statistical modeling.

4. D. Surveillance is an important aspect of cancer care in order to determine adequate initial management and to detect early recurrences. A patient would not be considered cured until they have survived at least 5 years after initial therapy. The clinical guidelines of surveillance for colon cancer patients have been put forth by the National Comprehensive Cancer Network, version 1.2016. Their recommendations include clinical assessments every 3 to 6 months for the first 2 years, then every 6 months for the next 3 years. T includes a serum CEA level at each clinic visit. A CT scan of the chest/abdomen/pelvis is recommended every 6 to 12 months for 5 years for patients at high risk of recurrence. Regarding colonoscopy, one is recommended 1 year after surgery. If no lesions or a simple adenoma is found (not advanced such as villous polypl, polypl >1 cm, or high grade dysplasia), a colonoscopy should be repeated in 3 years, and then repeated every 5 years for the remainder of their lives. If an advanced or large adenoma is found (and subsequently removed completely via colonoscopy), then repeat colonoscopy is recommended in 1 year. A PET scan is reserved for instances were the CEA is rising or lesions are seen on follow up CT scanning. Fecal occult blood testing is not required for surveillance.

5. A. About 5% of patients will benefit from neoadjuvant chemotherapy in terms of ability to resect liver metastases. Two randomized studies, the CRYSTAL and OPUS trials, showed modest improvement of liver resection rates from 3.7% to 7% and 2.4% to 4.7%, respectively with the use of the biologic agent ceclupimab to FOLFOX or FOLFIRI versus FOLFOX or FOLFIRI alone. When the analysis was limited only to (liver) metastatic pts with wild-type KRAS, resectability was increased from 4% to 10%.

BIBLIOGRAPHY


A 55-year-old man with a known history of cirrhosis secondary to alcohol (ETOH) abuse presents with a several month history of an increasing umbilical bulge. On exam he had a reducible umbilical hernia with a 3 cm fascial defect and shifting dullness and a fluid wave complete with moderate ascites. He denies any symptoms other than mild discomfort at the hernia. He denies any previous episodes of GI bleed. History, physical exam, and serum laboratory evaluation of the above patient shows a Child-Turcotte-Pugh classification of 9 points or class B and a MELD score of 10. His platelets are 160,000, HGB is 12 g/dL, sodium level is 135 MeQ/L, and albumin is 3.0 ng/dL.

1. Regarding evaluation and management of this patient’s ascites, which of the following is true?
   A. Variceal bleeding is the most common complication of cirrhosis.
   B. Paracentesis is the first step in the evaluation of this patient.
   C. Cessation of ETOH once ascites develops will have little impact on controlling ascites.
   D. Ascites is refractory in less than 5% of patients with ascites secondary to cirrhosis.
   E. Use of non-steroidal anti-inflammatory drugs (NSAID), angiotensin converting enzyme (ACE) inhibitors, and angiotensin receptor blocking (ARB) drugs can prevent the progression to renal failure.

2. Regarding umbilical hernia repair in patients with cirrhosis, which of the following is true?
   A. Incidence of umbilical hernia is 20% in patients with cirrhosis and ascites.
   B. Large volume paracentesis (LVP) decreases the risk of incarceration for umbilical hernias in the setting of refractory ascites.
   C. Non-operative management of patients with umbilical hernia and ascites is the preferred management because of the morbidity and mortality associated with surgery.
   D. Use of synthetic mesh is contraindicated in repair of umbilical hernias in patients with cirrhosis and ascites.
   E. Complication rates are significantly higher in elective repair of umbilical hernia in cirrhotics when compared to non-cirrhotics.

3. Regarding morbidity and mortality in non-hepatic surgery in patients with liver cirrhosis, which statement is true?
   A. Open surgery is preferred to laparoscopic surgery because of the concern for increased bleeding following laparoscopic procedures in cirrhotics.
   B. Elective pancreatic surgery in CTP class A and B has acceptable morbidity and mortality.
   C. Elective inguinal hernia repair is indicated for symptomatic inguinal hernias even in advanced liver disease with decompensated cirrhosis.
   D. Morbidity and mortality are higher for all surgical procedures in patients with liver cirrhosis when compared to patients without cirrhosis.

4. The above patient presents to the emergency room several days after your evaluation with fever, abdominal pain, and ileus. His vitals are a
temperature of 101°F, heart rate of 90, and a systolic blood pressure of 100. On exam he is diffusely tender, without exam evidence of peritonitis, and has increased ascites. Plain films of the chest and abdomen show an ileus pattern, without obstruction and no free intraperitoneal air. Your working diagnosis is spontaneous bacterial peritonitis (SBP). Which of the following is true?

A. Administration of broad spectrum antibiotics as the first step is necessary to avoid circulatory collapse and hepatorenal syndrome.

B. SBP is associated with the finding of multiple organisms on paracentesis culture.

C. Ascitic fluid analysis would expect to show neutrophils > 250/mm³ with lactate dehydrogenase greater than the upper limit of normal for serum, glucose less than 50 mg/dL and ascitic protein > 1 g/dL.

D. Administration of 1.5 g/kg of albumin on admission and 1 g/kg on day 3 has been shown to decrease mortality.

E. A positive peritoneal culture is necessary for diagnosis.

5. The above patient undergoes elective umbilical hernia repair. On the day 3 after the operation, he develops hematemesis and hypotension. Based on the most likely etiology of his upper gastrointestinal hemorrhage, which of the following is true?

A. Propranolol plays an important role in the acute management of this problem by decreasing splanchnic blood flow.

B. Transfusion to a HGB of 10 is the goal of resuscitation.

C. Antibiotic therapy is an important component.

D. Trans-jugular intra-hepatic shunt (TIPS) procedures have no role in the acute setting.

E. Pharmacologic therapy should not be started until varices are confirmed by esophagogastroduodenoscopy (EGD).

ANSWERS

1. B. The cessation of alcohol usually leads to improvement in liver function with alcohol associated cirrhosis. One study found improvement of the Child–Pugh score was observed within 3 months in 66% of the abstinent patients. Ascites is the most common complication of cirrhosis with 50% of compensated cirrhotics developing ascites over the course of 10 years. Paracentesis with appropriate ascitic fluid analysis is the first step in the evaluation of clinically apparent ascites. The serum-ascites albumin gradient (SAAG) with a value ≥ 1.1 g/dL is indicative of portal hypertension. Medical management with salt restriction and diuretics is highly effective in most patients with ascites. Refractory ascites occurs in less than 20% of patients. The use of ACE inhibitors and ARB drugs can induce renal failure and hypotension increasing mortality in patients with ascites. NSAIDs impair glomerular filtration rate due to a reduced renal perfusion secondary to inhibition of renal prostaglandin synthesis leading to renal failure.

2. A. Umbilical hernia is present in 20% of patients with cirrhosis and this is 10 times higher than the incidence in the overall population. The increased incidence is related to ascites, abdominal wall attenuation, and malnutrition. A sudden decrease in the amount of ascites, as with transjugular intrahepatic portosystemic shunt (TIPS) or LVP, can lead to strangulation of an incarcerated umbilical hernia. Non-operative management is associated with higher mortality when compared to elective repair. The higher mortality is related to the development of bowel incarceration or spontaneous rupture from necrosis of overlying skin and subsequent peritonitis developing during “watchful waiting.” These complications force prompt elective repair in patients who are at very high risk for death with emergency surgery. A randomized study comparing umbilical hernia repair with or without prosthetic material in cirrhotic patients with symptomatic, or complicated hernia found a decreased recurrence rate favoring prosthetic repair. The same study showed a non-significant increase in infections in the prosthetic group but no mesh had to be removed in any of the cases. Morbidity in elective repair of umbilical hernia is similar between cirrhotics and non-cirrhotics.

3. C. Patients with advanced decompensated cirrhosis frequently have severe symptoms because of ascites entering the hernia sac both in the standing position and when recumbent making it difficult to relieve symptoms. Patients with decompensated cirrhosis have been shown to benefit the most in terms of improved quality of life and the procedures can be done with minimal morbidity. Laparoscopic cholecystectomy has been shown to be safe in patients with Childs-Turcotte class A and B cirrhosis and is
associated with less blood loss and shorter hospital stay when compared to open cholecystectomy. Similar benefits are seen favoring laparoscopic appendectomy over open appendectomy. The data is limited for patients with Child's C classification. Pancreatic surgery is associated with an increased risk of post-operative complications in patients with liver cirrhosis. The mortality in Child's A patients is similar to non-cirrhotics but the mortality for Child's B patients is prohibitive. Although morbidity is higher for cirrhotics when compared to non-cirrhotics for most procedures, some procedures such as inguinal hernia repair have similar morbidity even for advanced liver disease. Mortality in Child's A patients is often fairly similar to non-cirrhotics for a variety of procedures ranging from pancreatic surgery to cardiac surgery.

4. D. The use of IV albumin in cirrhotics with SBP in addition to antibiotics has been shown to decrease in-hospital mortality. The effect is more pronounced for patients with a creatinine greater than 1 mg/dL or a bilirubin greater than 4 mg/dL. Ascitic fluid testing should be done prior to the initiation of antibiotics because 86% of cultures will be negative even after a single dose of antibiotics. The finding of multiple organisms from a diagnostic paracentesis should prompt consideration of a secondary peritonitis not SBP. The findings of neutrophils > 250/mm$^3$ with lactate dehydrogenase greater than the upper limit of normal for serum, glucose less than 50 mg/dL and ascitic protein > 1 g/dL are associated with secondary peritonitis. A cirrhotic patient with signs and symptoms of SBP should be treated empirically regardless of culture results. The cultures are important for narrowing of antibiotic coverage given the increasing emergence of resistant organisms.

5. C. Variceal bleeding accounts for 70% of all upper gastrointestinal bleeding in patients with cirrhosis. Antibiotic prophylaxis in cirrhotic patients with gastrointestinal bleeding has been shown to decrease the risk of bacterial infections, re-bleeding and overall mortality. Nonselective beta-blockers (propranolol) do reduce portal blood flow by decreasing cardiac output (B-1 effect) and, more importantly, by producing splanchic vasoconstriction (B-2 effect) and play a role in prevention of variceal bleeding. However, they should not be used in the acute setting as they will decrease blood pressure and will blunt a physiologic response to bleeding. The goal for transfusion is to a hemoglobin of approximately 7–8 g/dL. This is based on studies showing aggressive restoration of blood volume leads to increases in portal pressure and subsequent rebleeding and mortality. TIPS procedures are very effective in controlling bleeding in the 10% to 20% of patients who fail pharmacologic and endoscopic therapy. Early placement of TIPS within 24 to 48 hours after admission has been shown to improve survival in patients at the highest risk of re-bleeding (Child's C and patients with a hepatic venous pressure gradient (HVPG) over 20 mm Hg). Vasoconstrictor therapy (vasopressin ± nitroglycerin, terlipressin, somatostatin, or octreotide) is considered first-line therapy and should be started at the time of admission in any patient with suspected variceal hemorrhage even prior to EGD.

BIBLIOGRAPHY


Pancreatitis and Pancreatic Cysts

Kiran Lagisettty

A 56-year-old male presents to the emergency department complaining of acute onset of intense boring epigastric pain radiating to his back. He is unable to find a comfortable position in which to lie in bed. His laboratory analysis is significant for a serum lipase of 1300, serum glucose of 260 mg/dL, LDH of 375 IU/L, AST of 350 IU/L, and WBC of 18k.

1. In order to diagnose acute pancreatitis 2 out of 3 which of the following criteria are required?
   A. Epigastric pain, radiologic evidence of pancreatitis, serum lipase at least 2 times normal.
   B. Epigastric pain, radiologic evidence of pancreatitis, serum amylase at least 3 times normal.
   C. Cholelithiasis, radiologic evidence of pancreatitis, serum lipase at least 3 times normal.
   D. Epigastric pain, cholelithiasis, serum lipase at least 2 times normal.

2. Which of the following enzymes has been implicated in the etiology of pancreatitis?
   A. Pepsin
   B. Trypsin
   C. Gastrin
   D. Lipase

3. Which of the following conditions is most likely the etiology of our patient’s condition?
   A. Serum triglyceride level of > 1000 mg/dL
   B. Cholelithiasis
   C. HIV infection
   D. Pancreatic head mass
   E. Seat belt sign following MVA

4. Which of the following conditions associated with acute pancreatitis increases the mortality rate from 1% to 10–20%?
   A. Necrosis of greater than 1/3 of the pancreas
   B. Distant organ failure
   C. Development of local complications (hemorrhage, abscess, pseudocyst)
   D. All of the above

5. A 7 cm acute peripancreatic fluid collection was identified on CT scan shortly after admission. It was managed expectantly and a repeat CT scan was obtained 6 weeks after admission. Which of the following would be criteria for surgical management of a pseudocyst?
   A. There is no evidence of malignancy on CT and only a simple 5 cm pseudocyst persists.
   B. Decrease in size from 7 cm to only 4 cm or less than half its original size.
   C. Decrease in size from 7 cm to 4 cm with persistence of abdominal pain.
   D. Cholelithiasis
   E. No communication between the pseudocyst and a pancreatic duct such that the pseudocyst cannot drain.

ANSWERS

1. B. At least two of the following criteria are required to diagnose acute pancreatitis: Characteristic abdominal pain, radiologic evidence of pancreatitis, and/or serum amylase or lipase level at least 3 times normal.
2. **B.** Trypsin

3. **B.** Each of the above conditions is known to cause pancreatitis. The most common etiologies are gallstone and alcohol related. Hypertriglyceridemia > 1000 mg/dL is the third most common. Other known causes of acute pancreatitis include HIV infection, certain medications, carcinoma, parasites, and trauma.

4. **D.** Mild acute pancreatitis is associated with a mortality rate of about 1%. Acute pancreatitis in conjunction with any of the listed complications is considered severe acute pancreatitis and increases the mortality rate to 10% to 20%; necrosis of greater than one third of the pancreas, organ failure to include a systolic blood pressure ≤ 90 mm Hg, serum creatinine > 2.9 mg/dL, gastrointestinal blood loss > 500 mL within a 24 hr period of time, or PaO₂ < or = 60 mm Hg. The development of an abscess or pseudocyst also represents severe acute pancreatitis and thus, also increases the mortality rate.

5. **C.** Approximately 50% of pancreatic pseudocysts will resolve spontaneously after about 4 to 6 weeks and should therefore be managed expectantly. Repeat CT scan after 6 weeks should be obtained to ensure the pseudocyst is resolving. Indications for intervention are clinical symptoms, cyst enlargement or persistence over 6 cm, ductal communication, and suspected malignancy. An interval of 6 weeks is generally recommended to give time for the pseudocyst wall to “mature” into a thick, fibrous rind. The presence of cholelithiasis is not an indication for operative intervention of a pancreatic pseudocyst.

**BIBLIOGRAPHY**

A 60-year-old male with no significant medical history except a long history of smoking presents with painless jaundice of 1 week duration. He denies any symptoms of obstruction, weight loss, or fatigue. Initial labs show mild elevation in transaminases to less than 1.5 times normal values and a bilirubin of 8 mg/dL. A right upper quadrant (RUQ) ultrasound was obtained that shows dilated intra and extra-hepatic bile ducts and a dilated gallbladder without stones. The pancreas is not well visualized secondary to overlying bowel gas.

1. What would be the next best step in the evaluation of this patient?
   A. Magnetic Resonance Cholangiopancreatigram (MRCP).
   B. Thin slice CT scan with arterial and venous phases.
   C. Whole body Positron Emission Tomography (PET) scan.
   D. Endoscopic Retrograde Cholangiopancreatography (ERCP).
   E. CA19-9 laboratory specimen.

2. The above patient is found to have a 2 cm mass in the head of the pancreas with no evidence of vascular invasion, adenopathy or metastatic disease on CT scan. His CA19-9 level is mildly elevated to 1.5 times the normal level. What is the next most appropriate step?
   A. PET scan to evaluate for occult disease.
   B. ERCP and stenting of the bile duct.
   C. EUS and FNA biopsy of the mass.
   D. Pancreaticoduodenectomy within the next 2 weeks.
   E. Diagnostic laparoscopy to evaluate for occult metastases.

3. The above patient is instead noted to have a 3 cm mass in the head of the pancreas that abuts greater than 180 degrees of the superior mesenteric vein (SMV) with occlusion of a short segment. There is no evidence of metastatic disease. Endoscopic ultrasound (EUS)-guided fine needle aspiration (FNA) biopsy was obtained showing adenocarcinoma. What is the most appropriate management for this patient?
   A. Initiation of neo-adjuvant chemoradiation followed by reassessment for resection following neo-adjuvant therapy.
   B. Pancreaticoduodenectomy with resection and reconstruction of the involved SMV followed by adjuvant chemoradiation.
   C. Initiation of palliative chemotherapy for unresectable pancreatic cancer.
   D. Performance of prophylactic surgical biliary and gastric bypasses prior to initiating palliative chemotherapy.

4. Which of the following is not true of patients undergoing neo-adjuvant therapy for adenocarcinoma of the pancreas when compared to patients undergoing upfront resection?
   A. Significantly fewer patients undergoing neo-adjuvant ultimately undergo surgery.
   B. Significantly lower rate of lymph node positivity in patients undergoing resection following neo-adjuvant therapy.
   C. Significantly increased overall survival following resection after neo-adjuvant therapy.
D. Significantly increased rate of R0 resections in patients undergoing neo-adjuvant therapy.
E. Significantly decreased local recurrence rate in patients undergoing neo-adjuvant therapy.

5. Which statement is true regarding operative management in patients undergoing pancreatocoduodenectomy?

A. Pancreaticogastrostomy has been shown consistently to have a lower incidence of pancreatic leak than pancreaticojejunostomy.
B. External drainage of pancreaticojejunostomy has been shown to decrease pancreatic leak rate.
C. Octreotide has been shown consistently to decrease the incidence of clinically significant pancreatic leak rate.
D. Internal drainage of pancreaticojejunostomy has been shown to decrease pancreatic fistula rate.
E. Extended lymphadenectomy has been shown to increase overall survival.

ANSWERS

1. B. Given the lack of stones, painless presentation and age of the patient the most likely etiology is a peri-ampullary neoplasm. Abdominal CT scan with arterial and venous phases and 1 mm slices is the modality of choice for identifying pancreatic tumors, hepatic metastases and determining resectability. Magnetic resonance cholangiopancreatography (MRCP) is most useful in evaluating ductal anatomy such as in cases of intra-ductal papillary mucinous neoplasm (IPMN) or if choleodocholithiasis is suspected. MRCP is not as accurate as thin cut CT scan in determining resectability. A PET scan is not standard preoperative evaluation for a resectable lesion and unless combined with a thin slice dual phase CT scan, is not as good as thin cut CT scan in determining resectability. ERCP sensitivity for diagnosis of a pancreas mass is no better than imaging and it has largely been replaced by EUS and FNA biopsy when tissue is needed because of low sensitivity for brushings in pancreatic cancer. CA19-9 level is correlated to the size of a pancreatic adenocarcinoma and can miss small tumors and is elevated in benign causes. It is correlated with extent of disease and can be used to guide diagnostic laparoscopy and thus would be appropriate to draw once a pancreatic mass is identified.

2. D. Patients who are suitable operative candidates with a resectable solid mass in the head of the pancreas and no evidence of metastatic disease on thin slice CT scan can proceed with resection without additional work up. PET scan is not currently recommended as standard preoperative evaluation in resectable pancreatic cancer. Preoperative biliary stent drainage is associated with stent related complications and post-operative infectious complications and is not routinely recommended. Biliary drainage should be considered when there will be a significant delay in surgery such as in malnourished patients or in patients undergoing neo-adjuvant therapy. When a stent is placed, covered metal stents have shown better patency than plastic stents and are removable at time of surgery. Routine biopsy of a pancreatic mass should be avoided because of a significant false negative rate, potential complications, and a small but not insignificant false positive rate. No prospective trial has shown benefit in laparoscopic staging over thin slice CT scanning and it exposes patient to two procedures under general anesthesia. However, a selective approach for staging laparoscopy may be undertaken in patients known to be at higher risk for metastases. These patients include tumors greater than 3 cm, tumors of body/tail and very high CA19-9 levels.

3. A. The above example is a borderline resectable pancreatic cancer and technically resectable with resection of a segment of the SMV. However this is likely to result in a positive resection margin and would potentially benefit from neo-adjuvant therapy to improve the R0 resection chances. Resectability is determined by the degree of involvement of the surrounding vessels by the tumor. There are three categories: resectable, borderline resectable, and locally advanced. The borderline resectable group is usually the hardest to define but in general represents a lesion that is resectable but runs a high risk of having a margin positive resection. Two major pancreatic surgery groups, the MD Anderson Cancer Center (MDACC) and a consortium of the American Hepatopancreaticobiliary Association (AHPBA)/Society of Surgical Oncology (SSO)/National Comprehensive Cancer Network (NCCN), have attempted to define what constitutes each category. However, the two groups are not in agreement in what is resectable and what is borderline resectable. In general, the MDACC categories require greater vessel involvement to meet
borderline resectable criteria. The involvement of greater than 180 degrees involvement of the SMV in this case would be considered borderline resectable under both definitions. Two meta-analyses of retrospective data show similar survival of patients undergoing portal/SMV resections to patients undergoing Whipple without vein resection.

However, if the tumor infiltration involves 50% or more of the vascular circumference the survival is decreased when compared to patients not requiring venous resection. The extent of disease in this patient is not unresectable and an acceptable operative candidate should not be relegated to only palliative therapy. The use of endoscopic biliary drainage has largely replaced surgical bypass procedures for biliary obstruction. Multiple studies have shown that endoscopic biliary drainage has identical success and short term efficacy as surgical bypass with decreased morbidity, costs, and hospital stay. In addition, metal stents have increased long term patency when compared to plastic stents. In contrast to obstruction of the biliary system which occurs in 80% of patients, duodenal obstruction occurs in only 20% of patients with peri-ampullary tumors. In fact, when duodenal palliation is necessary endoscopic therapy has been shown to have shorter operative time, shorter hospitalization with more rapid resumption of oral intake, with no difference in morbidity or mortality when compared to surgical bypass.

4. C. There are no randomized trials showing a superiority of neo-adjuvant therapy over adjuvant therapy regarding median or overall survival. When neo-adjuvant therapy is used, significantly fewer patients will ultimately undergo surgery when compared to similar patients with borderline resectable disease who do not undergo neo-adjuvant therapy because of disease progression. The use of neo-adjuvant therapy by sparing patients from major surgery that was not going to be successful because of aggressive disease. Neo-adjuvant therapy has shown to significantly reduce the finding of node positive disease at resection when compared to patients taken directly to surgery. Neo-adjuvant therapy has also consistently shown an improved R0 resection rate when compared to patients taken directly to surgery and is the rationale for applying neo-adjuvant therapy to patients with borderline resectable disease. As expected with an improved R0 resection rate and decreased nodal positivity, the local recurrence rate is significantly decreased. Unfortunately none of these improvements in local control has translated to improved survival.

5 B. Pancreatic fistula is the most frequent complication after pancreatic surgery. External drainage of the main pancreatic duct placed intra-operatively during pancreaticoduodenectomy has been shown in several randomized trials to decrease the rate of pancreatic fistula and hospital stay. There is in contrast to a prospective randomized trial that found no benefit to placement of an internal stent in the main pancreatic duct following pancreaticoduodenectomy. The majority of randomized studies, systematic reviews, and meta-analyses have shown no difference in outcome with respect to the occurrence of postoperative pancreatic fistula based on pancreaticojugunostomy versus pancreaticogastrostomy. A single multi-center trial did show a decrease in the pancreatic fistula rate with pancreaticogastrostomy, but no difference in overall complication rate, length of stay or mortality. The use of octreotide to reduce the rate of pancreatic fistula has been extensively studied including prospective randomized trials and meta-analyses with conflicting results. A recent Cochrane review (Cochrane Database Syst Rev. 2013; 4; CD008370) did find an overall decrease in pancreatic leak rate and complications for the use of octreotide but no difference in length of stay or mortality. The use of octreotide has largely replaced surgical bypass procedures for pancreaticoduodenectomy, with no decrease with the use of octreotide.

BIBLIOGRAPHY


http://surgerybook.net/


A 53-year-old female with a 3-week history of melena presents to her primary care provider and is found to have scattered ecchymoses, heme-positive stool, and a platelet count of 45,000. Colonoscopy screening was performed 1 year ago and was negative. She does not take any medications. Other than a mild anemia, laboratory work-up is otherwise unremarkable. Peripheral smear and bone marrow biopsy are negative which do not demonstrate an underlying malignancy. She is diagnosed with idiopathic thrombocytopenic purpura (ITP).

Despite 8 weeks of prednisone therapy and the addition of intravenous immunoglobulin (IVIG), the patient continues to have platelet counts ranging from 20,000 to 40,000 and ongoing mucosal bleeding. She has been sent for a surgical consultation to discuss the possibility of splenectomy in the setting of her steroid-refractory ITP.

1. Which of the following statements characterizes ITP?
   A. Endothelial damage triggers deposition of platelets and fibrin in small arterioles and capillaries, leading to microvascular thrombotic events.
   B. IgG autoantibodies directed against platelet fibrinogen receptors cause increased platelet destruction via removal by macrophages.
   C. Abnormal myeloid precursor cells are hyperplastic resulting in splenic sequestration of platelets and associated thrombocytopenia.
   D. Peripheral blood smears in patients with ITP show schistocytes, nucleated red blood cells, and basophilic stippling.
   E. Renal failure and neurologic complications are both seen in late stages of ITP.

2. Which of the following statements about steroid-refractory ITP is correct?
   A. Rituximab therapy can be used as an alternative to splenectomy and has an equivalent response rate.
   B. Approximately 98% of patients who undergo splenectomy are found to have a permanent response with no need for further therapy.
   C. Significant splenomegaly is seen in ITP patients who do not respond to medical therapy.
   D. Plasmapheresis is a first-line therapy for steroid-refractory ITP and should be initiated before considering splenectomy.
   E. Although initial response rate to splenectomy is in the range of 85% to 90%, the relapse rate over the next 5 years can be as high as 25%.

3. Regarding the preoperative and intraoperative management of patients undergoing splenectomy for ITP, which of the following statements is correct?
   A. Platelet transfusion should be initiated once anesthesia is induced and continued into postoperative day 1 until the platelet count rises above 50,000.
   B. Patients should be vaccinated against encapsulated organisms (Haemophilus influenzae B, polyvalent Pneumococcus, and Meningococcus) in the holding area just prior to surgery.
   C. The splenic hilar vessels are often divided simultaneously with suture ligatures or a vascular load on a linear stapler device.
   D. Accessory spleens can be present in 10% to 30% of patients and are most commonly found at the splenic hilum, the tail of the pancreas, within the
splenocolic and gastrosplenic ligaments, in the omentum, or in the paraduodenal area.

E. Laparoscopic splenectomy is less effective than open splenectomy in identifying and removing accessory spleens.

4. Which of the following statements is true regarding postoperative complications after splenectomy for ITP?

A. Overwhelming post-splenectomy infection (OPSI) is seen in approximately 5% of children and 15% of adults, regardless of vaccination status.

B. Splenectomy is associated with an increased risk of abdominal venous thromboembolism within the first 90 days after surgery.

C. Patients with ITP who are treated with medical therapy alone are at an equivalent risk for venous thromboembolism when compared to those who undergo splenectomy.

D. It is standard of care for patients of all ages to take daily prophylactic antibiotics for at least a 5-year period following splenectomy.

E. Rates of bleeding and infectious complications are similar in ITP cases that show a response to splenectomy and in those that do not.

5. Which of the following statements best characterizes the current role of thrombopoietin (TPO) receptor agonists in the treatment of ITP?

A. These agents are indicated in cases of symptomatic thrombocytopenia despite multiple first- and second-line therapies, and commonly induce remission of ITP.

B. TPO receptor agonists are effective at increasing platelet counts via stimulation of megakaryocyte production in the bone marrow and can be used preoperatively to boost platelet counts in preparation for splenectomy.

C. TPO receptor agonists are commonly used in conjunction with steroids as first-line therapy for ITP.

D. TPO receptor agonists are given in the postoperative period in order to stimulate platelet production and increase the chances of a therapeutic response to splenectomy.

E. Both romiplostim and eltrombopag are commonly used TPO receptor agonists that require weekly intravenous infusions.

ANSWERS

1. B. ITP is an acquired, immune-mediated disorder that involves the splenic production of IgG autoantibodies.
3. D. Accessory spleens can be present in 10% to 30% of patients and are most commonly found at the splenic hilum, the tail of the pancreas, within the splenocolic and gastroplenic ligaments, in the omentum, or in the paraduodenal area. Both laparoscopic and open approaches can be effective in identifying accessory spleens.

Platelet transfusion should be initiated after the splenic artery is ligated in order to prevent platelet consumption. The splenic vessels should ideally be ligated separately, in order to prevent arteriovenous fistula formation. Vaccination against encapsulated organisms should be performed in the 2- to 4-week period prior to surgery or 14 days after surgery or at the time of discharge from the hospital. If patients were previously on rituximab therapy, vaccinations may need to be delayed for up to 3 months to allow for B-cell recovery.

4. B. In a retrospective review of 9,976 patients with ITP, 1,762 who underwent splenectomy, the incidence of thrombotic events was evaluated. An increased risk of portal vein or mesenteric vein thrombosis was seen in the first 90 days after splenectomy, but not after 90 days when compared to patients who underwent medical therapy alone. There was an increased risk of venous thromboembolism in both the early and late periods in the splenectomy group.

No consensus has been reached in terms of the benefit or duration of antibiotic prophylaxis. Studies have shown that asplenic patients carry a lifelong risk of OPSI and this risk is highest in the first 2 years after surgery. Children are at a higher risk than adults (5% vs. 0.9%) and OPSI is reported to have a 50% mortality rate. A retrospective analysis of 233 patients with ITP who underwent splenectomy showed that, in a 10-year follow-up period, a stable response to splenectomy was associated with a lower rate of infectious and bleeding complications.

5. B. TPO agonists are used for persistent thrombocytopenia despite first- and second-line medical and surgical therapy, and they do not induce remission. They stimulate production of megakaryocytes and subsequently platelets in the bone marrow by activating the TPO receptor. Upon cessation of the medication, platelet counts begin to fall again. These medications are considered maintenance therapy and require ongoing use in refractory cases of ITP. Romiplostim is administered as a once-weekly subcutaneous injection and eltrombopag is given as a once-daily pill.

TPO agonists can be used in the preoperative setting in order to boost platelet counts in preparation for splenectomy. They have also been used in patients who are not good candidates for rituximab therapy secondary to infectious risks. Patients who do not want to have surgery or are not good candidates can also use TPO agonists as chronic maintenance therapy. It is not standard to use these agents in the postoperative period unless a relapse occurs and they do not increase the chances of responding to a splenectomy.

BIBLIOGRAPHY


You are called to the emergency room to see a 66-year-old male with a chief complaint of abdominal pain with nausea and vomiting. Reviewing his ER record reveals he has a heart rate of 115, blood pressure of 145/90, and a normal temperature at 98.6°F. On exam the patient appears to be in mild distress with a distended abdomen. The patient states that the pain started 48 hours before, is intermittent and crampy, and is now getting worse. He states that he has been vomiting now for about the last 24 hours and is unable to keep any fluids down. He also states that he cannot remember the last time he passed flatus or had a bowel movement. The patient has been in the ER for about half an hour, his labs are still pending, and no imaging studies have been done. His past medical history is significant for hypertension, hyperlipidemia, chronic kidney disease, diet controlled type 2 diabetes, and gout. His past surgical history is significant for an open appendectomy 50 years earlier and a laparoscopic converted to open sigmoidectomy secondary to diverticulosis 5 years prior. The patient denies ever having symptoms like this before.

1. Following fluid resuscitation with two liters of crystalloid, the heart rate downtrends to 90 and the blood pressure remains normal. Which of the following is the next best step in management of this patient?
   A. To the OR immediately for a diagnostic laparoscopy with possible exploratory laparotomy.
   B. Admission to the surgical floor, continue IV fluids and perform abdominal exams every 4 hours.
   C. Placement of a nasogastric tube and an acute abdominal series.
   D. Immediate CT scan of the abdomen and pelvis with PO and IV contrast.
   E. Discharge to home from the ER with close clinic follow up within 48 hours.

2. Which of the following is the most common cause of bowel obstruction?
   A. Small bowel ileus
   B. Mechanical small bowel obstruction
   C. Mechanical colonic obstruction
   D. Acute colonic pseudo-obstruction
   E. Gastric outlet obstruction

3. Which of the following is the most common cause of mechanical small bowel obstruction?
   A. Adhesions
   B. Strictures
   C. Hernias
   D. Gallstones
   E. Tumors

4. Twenty-four hours has now passed since the above patient was admitted and had a nasogastric tube (NG) and foley catheter placed. Since that time his NG tube has put out 1.6 liters of bilious fluid and his urinary output has been around 1.1 cc/kg/hr. The patient’s pain and physical exam only worsen intermittently. The man’s heart rate is in the 90s and his blood pressure is holding steady. Which of the following is true?
   A. The presence of “small-bowel fecalization” on CT scan of the abdomen and pelvis with IV/oral contrast predicts the need for an operation.
B. If this patient had his sigmoidectomy 4 weeks ago, he would still be a candidate for non-operative management.

C. An exploratory laparotomy is indicated.

D. If a laparoscopical approach is chosen within the first 48 hours of admission, it is more likely to be completed without conversion.

E. One can continue observation in this patient for up to 3 days without increasing morbidity.

5. A decision is made to proceed to surgery 24 hours later because the patient developed a fever and a leukocytosis. Which of the following is true regarding surgical management?

A. The laparoscopic approach is associated with longer operating times.

B. The laparoscopic approach may be associated with decreased mortality.

C. The rate of major complications is similar for both the laparoscopic and open approaches.

D. The optical view approach is recommended for this patient.

E. The laparoscopic approach has no effect on post-operative length of stay.

ANSWERS

1. C. This patient is presenting with symptoms most consistent with some type of bowel obstruction. This patient has received 2 liters of crystalloid with an appropriate response in his heart rate but he still requires an NGT tube. Given his lack of peritonitis, imaging studies are appropriate and an acute abdominal series is adequate, especially given this patient's history of chronic kidney disease and an as yet unknown creatinine level.

   Answer A is not appropriate given that he does not have peritonitis and his work up is not yet complete. Given that he is responding to resuscitation this patient should be given the chance to see if his symptoms resolve with non-operative management.

   Answer B is not appropriate in that this patient still has a work up to be done with labs and imaging as the diagnosis is still unclear at this time.

   Answer D is not appropriate in that while CT has a high specificity and sensitivity for bowel obstructions and can locate points of blockage his creatinine is unknown and with his history of kidney disease and likely kidney injury from dehydration a contrast load would not be advisable. An acute abdominal series is fast and with careful interpretation the diagnosis of a small bowel obstruction can still be made. A non-contrast CT scan, however, would be a reasonable option as it would not risk an insult to the kidneys and it may determine an internal hernia, which would be an indication for surgical intervention. Answer E is not appropriate as this patient still requires work up.

2. A. Small bowel ileus is, by far, the most common form of intestinal dilation as it is seen after many surgical procedures whether they are performed in the abdomen or not. The exact etiology of the ileus is unclear but is probably multifactorial taking into account anesthesia and narcotic usage. Viral ileus can also be seen in cases of gastroenteritis. Ileus is most times self-limited and resolves with or without NG tube decompression and keeping the patient NPO.

   Answer B, mechanical small bowel obstruction, is the second most common cause of bowel obstruction and, 90% of the time, is due to adhesions, hernias, or cancer; though gallstones, bezoars, and parasitic worms have also been reported. Mechanical colonic obstruction, while usually more severe in its presentation, only accounts for around 10% of all mechanical obstructions. T he usual causes of this are cancer, volvulus, or diverticulitis resulting in a stricture.

   Answer D, Acute colonic pseudo-obstruction is much less common and is usually seen in older, debilitated or institutionalized patients who are on numerous medications and answer E, gastric outlet obstruction is a less common form of obstruction and is usually seen with gastric/duodenal/pancreatic malignancies or gastric ulcers. T ese would not, however, result in intestinal dilatation.

3. A. Up until the early to mid-1900s the leading cause of mechanical small bowel obstruction was due to hernias but over the past century that has now switched to postoperative adhesions accounting for over 75% of all mechanical small bowel obstructions.

   Hernias are the second most common cause of mechanical small bowel obstructions and in the absence of a surgical history the presence of an incarcerated inguinal, umbilical or incisional hernia needs to be ruled out. T e remaining answer choices have all been shown to cause mechanical bowel obstructions though their incidence is low.

4. E. This patient's physical exam and clinical status is largely unchanged. As such he is a candidate for
non-operative management for up to 72 hours. Patients who have had abdominal surgery within six weeks before the episode of small bowel obstruction, patients with signs of strangulation (fever, tachycardia, leukocytosis, metabolic acidosis, continuous pain), and patients with irreducible hernias are NOT candidates for non-operative management. On CT scan, the lack of small bowel fecalization, free intraperitoneal fluid, and mesenteric edema predict the need for urgent laparotomy. As he is not exhibiting signs of peritonitis, ischemia, or strangulation he is most appropriately a candidate for continued observation. If after 72 hours, if there is no improvement in his status, an operation is indicated. Until then there is no increase in morbidity or mortality with observation. There is no data suggesting that earlier intervention with a laparoscopic approach will reduce morbidity, mortality, or conversion rates.

5. B. In a study published in 2014 on over 9600 patients using the National Surgical Quality Improvement Database, laparoscopic intervention for small bowel obstructions was shown to have decreased operative time (77.2 vs. 94.2 min) and decreased length of stay (4.7 vs. 9.9 days). Additionally, the laparoscopic approach was less likely to develop major complications, with an odds ratio of 0.7. Additionally the laparoscopic approach showed a lower 30-day mortality rate (1.3% vs. 4.7%). As such if the surgeon feels comfortable, the laparoscopic approach may be a safer alternative for the surgical management of small bowel obstructions. When accessing the abdomen in a patient with previous abdominal incisions, the recommended technique for gaining the pneumoperitoneum and placing the initial trocar is via the Hasson or open technique.

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A 26-year-old male with no significant past medical history presents to the emergency room in distress, complaining of chest discomfort and severe epigastric pain of sudden onset three hours prior to presentation. Thorough history reveals cocaine abuse prior to onset of symptoms. The patient is tachycardic and tachypneic, physical exam reveals a diffusely tender abdomen with rigidity.

1. Which of the following is true regarding complications of stimulant drug abuse?
   A. Perforated gastroduodenal ulcer is unlikely to occur without known history of ulcer disease.
   B. Acute abdominal processes are the most common complications of stimulant drug abuse.
   C. An ileus is the most well-documented acute abdominal complication of cocaine abuse.
   D. Systemic vasoconstriction may cause multiple gastrointestinal complications.

2. Which radiographic study would most readily provide the diagnostic finding for the diagnosis in the patient presentation above?
   A. CT scan
   B. Abdominal ultrasound
   C. Upright chest radiograph
   D. Angiography

3. After making the diagnosis above, which of the following would be the most appropriate intervention?
   A. Fluid resuscitation, gastric decompression via nasogastric tube, and antibiotic therapy for H. pylori infection.
   B. Abdominal washout, debridement of ulcerated tissue, and omental patch closure.
   C. Truncal vagotomy with pyloroplasty.
   D. Truncal vagotomy with antrectomy and Billroth I or II reconstruction.

4. In addition to the surgical management of the perforated ulcer, what, if any, adjunctive management should be included in the patient's care?
   A. Nothing, the pathophysiology is directly related to the stimulant drug and management is directed at repair of the acute perforation.
   B. Empiric triple or quadruple therapy for H. pylori.
   C. Ulcer biopsy for H. pylori infection, and triple or quadruple therapy only with presence of bacteria.
   D. Pharmacologic vasodilation to reverse effects of stimulant physiology.

5. If a patient presents with mesenteric ischemia secondary to stimulant drug abuse along with peritonitis or an acidosis. After resuscitation, which of the following represents appropriate management?
   A. Exploratory laparotomy with resection of necrotic bowel and vasodilation.
   B. Endovascular thrombolysis and arterial stenting.
   C. Operative SMA embolectomy.
   D. Aortomesenteric arterial bypass.
ANSWERS

1. D. Illicit drugs such as cocaine and methamphetamine are highly addictive central nervous system stimulants which produce a rapid euphoria secondary to elevated levels of the monoamine transmitters dopamine, serotonin, and norepinephrine. Immediate effects of stimulant use include wakefulness, increased physical activity, decreased appetite, tachypnea, tachycardia, hypertension, and hyperthermia. The most common and well-known serious side effects of stimulant drug abuse include cardiac and neurologic complications such as myocardial infarction, arrhythmias, and cerebral vascular accidents, additionally pulmonary and psychiatric complications are common. Though less common, acute abdominal complications related to both cocaine and methamphetamine are well documented in the medical and surgical literature. The two most commonly documented gastrointestinal complications are perforated peptic ulcer and mesenteric ischemia, both thought to be secondary to splanchnic vasoconstriction via activated alpha-1 receptors following rapid elevation in norepinephrine. Gastroduodenal perforation after stimulant drug abuse may be the initial presentation of ulcer disease, and the clinician should have a high index of suspicion for such when a patient presents with acute abdomen and a history of stimulant abuse, despite the lack of ulcer disease in the patient's history. Less commonly, methamphetamines can cause paralytic ileus.

2. C. The diagnosis of perforated gastroduodenal ulcer, in conjunction with an appropriate history, is confirmed by the finding of pneumoperitoneum, most quickly visualized on the upright chest x-ray under the hemidiaphragm(s) or on the left lateral decubitus abdominal X-ray. In some cases of perforated ulcer of the anterior duodenal wall, free air and the fish-eye sign may be demonstrated via ultrasound. In approximately 25% of perforated peptic ulcer presentations, free air will not be visualized. A CT scan will demonstrate inflammatory changes surrounding the perforated ulcer, and is highly sensitive for evidence of micro-perforation (free air or fluid). However, in diagnosing a perforated peptic ulcer for which plain film did not already reveal pneumoperitoneum, CT scan did not demonstrate additional diagnostic utility within the first 6 hours. Had the patient's acute abdomen also presented with hematochezia in the setting of stimulant drug abuse, mesenteric ischemia would be higher on the differential, diagnosed by angiogram. In the setting of stimulant drug abuse and an acute abdomen, it is important for the provider to obtain imaging to evaluate for the presence of pneumoperitoneum, indicating possible perforated peptic ulcer.

3. B. In the absence of free air or shock, a trial of nonoperative management may lead to spontaneous closure of approximately 50% of perforations. Non-operative management of a perforated peptic ulcer presenting with free air and a surgical abdomen would not be appropriate; surgical intervention is indicated. With the success of medical therapy directed toward H. pylori and gastric acid suppression, surgical goals for perforated ulcers have been increasingly narrowed from the traditional options for acid-reducing operations to management of the acute complication with omental patch closure of the perforation, with or without primary closure. Gastroduodenal ulcerations presenting in conjunction with stimulant drug abuse in particular often occur at a younger age and without known history of ulcer disease. Though the prevalence of H. pylori is still high in stimulant-associated perforated ulcers, the path to perforation is promoted by vasoconstriction and focal ischemia. Given this pathophysiology, the indication for acid-reducing surgery remains limited to perforations in patients who have failed medical therapy prior to perforation.

4. C. The traditional approach to perforated gastroduodenal ulcer, outside of stimulant drug use, presumes that the vast majority of perforated ulcers involve H. pylori infection. As such, standard treatment includes surgical management of the acute complication as well as empiric treatment for H. pylori with triple or quadruple therapy. Standard triple therapy for H. pylori infection includes a proton pump inhibitor and dual antibiotic coverage with clarithromycin plus amoxicillin or metronidazole; quadruple therapy includes a proton pump inhibitor, dual antibiotic coverage with tetracycline plus metronidazole, and bismuth subsalicylate. Perforated gastroduodenal ulcers following stimulant drug abuse may occur with or without previous symptoms of peptic ulcer disease. Despite lack of previous symptoms, there
is evidence to show that up to 80% of these ulcers are positive for H. pylori per intraoperative biopsy. However, despite the potential presence of H. pylori, a key component in the acute perforation is vasoconstriction leading to focal ischemia, ultimately causing ulcer perforation in patterns different from standard ulcer behavior, notably at younger ages. Given the potential multifactorial ulcer etiology in the setting of perforation following stimulant drug use, the result of H. pylori testing on intraoperative ulcer biopsy can direct the inclusion of triple or quadruple therapy following surgical intervention. Despite the vasoconstrictive physiology in stimulant drug related perforations, treatment recommendations are directed at repair of the perforation rather than vasodilation.

5. A. Acute mesenteric ischemia (AMI) may result from arterial occlusion via embolus or thrombus (65%), venous occlusion (10%) or non-occlusive etiologies (25%). Prompt diagnosis of AMI is strongly correlated to outcomes, as a delay in intervention results in morbidity up to 50%. Selective mesenteric catheter angiography is the traditional diagnostic gold standard, however abdominal CT angiography with intravenous contrast can provide a faster diagnosis with decreased procedural risk to the patient. Endovascular thrombolysis and arterial stenting can be effective at restoring splanchnic perfusion in acute arterial thrombosis; however, acute embolic arterial occlusions typically do not respond to thrombolytic therapy (which may also result in secondary distal embolization from fragmented portions of the embolus), and require laparotomy with SMA embolectomy. Splanchnic vasoconstriction secondary to catecholamine release in stimulant drug use is a rare cause of acute non-occlusive mesenteric ischemia (ANOMI), and impacts the major arterial sources of bowel perfusion, the SMA and IMA, as well as smaller collaterals. Thrombolysis, embolectomy, and bypass have no role in the management of these cases. Intra-arterial vasodilator therapy can be effective at restoring bowel perfusion. Regardless of the AMI etiology, with evidence or suspicion of peritonitis or bowel ischemia or infarction, urgent exploratory laparotomy and resection of necrotic bowel is imperative, typically conducted according to damage control principles with subsequent exploration for reassessment of tenuous bowel. Additionally, major abdominal vessels and mesenteric perfusion can be assessed by direct vessel palpation.

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A 50-year-old otherwise healthy male presents to the emergency room with nausea, vomiting, and abdominal pain. He has had a one month history of chronic intermittent abdominal pain. He has no prior history of abdominal surgeries and had a normal colonoscopy earlier this year. His vital signs are within normal limits. On exam, his abdomen is soft, non-distended, with mild diffuse abdominal tenderness. There are no hernias present. His laboratory exam is unremarkable. He undergoes an abdominal CT scan which demonstrates an area of intussusception in the distal small bowel with thickening and calcification of the adjacent mesentery (seen below).

1. What is the best next step in diagnosis?
   A. Small bowel follow through
   B. Abdominal MRI
   C. Capsule Endoscopy
   D. Barium Enema
   E. Diagnostic Laparoscopy

2. What is the most likely malignant pathologic diagnosis?
   A. Adenocarcinoma
   B. Carcinoid tumor
   C. Lymphoma
D. Small bowel sarcoma
E. Small bowel gastrointestinal stromal tumor (GIST)

3. After you complete your diagnostic workup, you take the patient to the operating room for a diagnostic laparoscopy. You identify a 4 cm solid mass in the mid-jejunum. The adjacent mesentery appears thickened and fore-shortened. There is no evidence of metastatic disease. You perform a resection with primary anastomosis. In the recovery room, the patient has profound flushing, altered mental status, and hypotension refractory to fluid resuscitation. What is the next best step in management?
   A. Initiation of vasopressors
   B. Broad spectrum antibiotics
   C. IV octreotide
   D. Stress dose corticosteroids
   E. Transfusion of packed red blood cells (PRBCs)

4. The patient ultimately recovers well and is discharged. What labs should be ordered for surveillance of recurrence and metastatic disease?
   A. Chromogranin A and Urine 5-HIAA
   B. CEA and CA 19-9
   C. Plasma VMA and metanephrines
   D. FSH and LH
   E. AFP and HCG

5. Three years later on surveillance CT scan, the patient is noted to have multiple new liver masses. Biopsy is consistent with metastatic disease. What is the best treatment option?
   A. Systemic chemotherapy
   B. Metastatectomy
   C. Hepatic artery embolization
   D. External beam radiation
   E. Observation

ANSWERS

1. E. Intussusception in an adult is typically due to a pathologic lead point. Only 8% to 20% of intussusceptions are idiopathic. Malignancy accounts for up to 30% of cases of adult intussusception. Benign causes for intussusception include Meckel's diverticulum, postoperative adhesions, lipomas, adenomatous polyps, and intestinal tubes (i.e., jejunostomy). Although advanced imaging techniques may provide additional information, surgery remains the definitive modality for diagnosis and treatment of adult intussusceptions.

   T is differs from intussusception in a child which is typically idiopathic or associated with a viral infection. Non-operative enema reduction is the treatment of choice of uncomplicated intussusception in children and has a success rate of 90%. Surgery is reserved for children with evidence of shock, peritonitis, or failed enema reduction.

2. B. The most common small bowel malignancy is carcinoid tumor (37.4%), followed by adenocarcinoma (36.9%), lymphoma (17.3%), and stromal tumor (8.4%). The most frequent location of carcinoid tumors are the ileum, followed by the duodenum, and least frequently in the jejunum.

3. C. This patient has developed carcinoid crisis. Carcinoid crisis is a phenomenon that occurs after manipulation of tumor masses, during induction of anesthesia, and after administration of chemotherapy, but can also occur in up to 11% of patients with metastatic disease. Significant amounts of serotonin, histamine, and other mediators cause the characteristics of profound flushing, extreme changes in blood pressure, bronchoconstriction, arrhythmias, and mental status changes. If the condition is associated with hypotension, it is usually refractory to fluid resuscitation but can be treated with the infusion of plasma and the use of octreotide.

   If the diagnosis of carcinoid is made preoperatively, steps can be taken to reduce the risk of carcinoid crisis, including administration of antihistamines and octreotide. Octreotide is a long-acting somatostatin analogue. In addition to reducing the release of GI hormones, it reduces the amount of serotonin released from tumor cells. Regardless, intraoperative carcinoid events are difficult to predict and there is no standard octreotide administration regimen available.

4. A. Chromogranin A is a protein associated with neuroendocrine cells and tumors. It is useful for monitoring disease response and progression in patients with carcinoid tumors. Plasma Chromogranin A levels are an independent predictor of survival. 5-HIAA is the primary urinary metabolite of serotonin. Measuring these levels are useful for diagnosis, monitoring, and prognosis of patients with carcinoid
tumors. There is also reduced survival among patients with elevated Urine 5-HIAA levels and the degree of elevation is correlated with the degree of carcinoid symptoms.

CEA is a marker for colon and pancreatic cancer. CA 19-9 is a marker for pancreatic cancer. Plasma VMA and metanephrines are useful in the diagnosis of pheochromocytoma. FSH and LH are hormones released by the pituitary gland that are not particularly useful in tumor surveillance. AFP and b-HCG can be used to identify testicular cancer.

5. B. Many different chemotherapy regimens for carcinoid tumors have been investigated with response rates ranging only from 0% to 33%. Chemotherapy has not been shown to improve survival but is typically used for control of symptoms caused by metastases.

Surgery for metastatic carcinoid disease has been shown to relieve symptoms related to intestinal obstruction and ischemia. Multiple studies have shown that surgery provides an improved control of carcinoid syndrome symptoms. In addition, cytoreductive surgery to include liver metastases has shown to improve survival when compared to observation, systemic chemotherapy, and hepatic artery embolization.

In 2006, Osborne et al. demonstrated that patients who underwent cytoreductive resection for metastatic carcinoid tumor had better complete symptom relief (69% vs. 59%) and a significantly longer mean survival (43 vs. 24 months) when compared to those patients undergoing embolization.

BIBLIOGRAPHY


A 67-year-old male with a history of hypertension, atrial fibrillation, and obesity presents to the emergency department with acute onset abdominal pain, nausea, vomiting, and hematochezia. Previous operations include a laparoscopic appendectomy. On physical exam the patient appears to be in significant distress due to pain; however, his abdomen is soft, non-tender, and non-distended. Laboratory analysis is remarkable for a white blood cell count of $21 \times 10^9$/mL and a lactate of 3.5 mmol/L. Abdominal radiography is unremarkable. CT angiography is significant for absence of flow distal to the origin of the superior mesenteric artery (SMA).

1. **What is the likely etiology for this SMA occlusion?**
   A. Splanchnic vasoconstriction
   B. Embolic occlusion of the mesenteric circulation
   C. Acute thrombosis of the mesenteric circulation
   D. Hypercoagulable state
   E. Mesenteric venous thrombosis (MVT)

2. **Associated risk factors with acute mesenteric ischemia include which of the following?**
   A. Hypertension
   B. Malignancy
   C. Recent cardiac events
   D. Hypovolemia
   E. All of the above

3. **What is the optimal management approach for this patient?**
   A. Therapeutic anticoagulation
   B. Intra-arterial thrombolytics
   C. Supportive care with avoidance of vasopressors and optimization of fluid status
   D. Mesenteric bypass
   E. Surgical embolectomy

4. **During surgical exploration, the bowel is assessed for viability and 50 cm of small bowel is resected. What is the most reliable means of determining bowel viability after revascularization?**
   A. Second-look laparotomy
   B. Acid-base status
   C. Intraoperative Doppler ultrasound
   D. Transcutaneous oxygen measurement
   E. Resection of all necrotic and marginal appearing bowel during initial exploration

5. **Regarding outcomes, which of the following is true?**
   A. Delays in diagnosis contribute to the high morbidity and mortality in mesenteric ischemia.
   B. Mesenteric ischemia-reperfusion is an uncommon cause for postoperative morbidity.
   C. MVT has a worse prognosis than other forms of mesenteric ischemia.
   D. Endovascular intervention is the mainstay of treatment for all forms of mesenteric ischemia today.
   E. Percutaneous transluminal angioplasty (PTA) for chronic mesenteric ischemia is associated with a low restenosis rate.
ANSWERS

1. B. There are four distinct pathophysiology for mesenteric ischemia: arterial thromboembolism, hypoperfusion syndrome, acute arterial thrombosis on chronic ischemia, and venous thrombosis. Arterial types are classified as acute or chronic. Acute mesenteric ischemia (AMI) is due to either thromboembolism or hypoperfusion syndromes, also known as non-occlusive mesenteric ischemia (NOMI). Acute on chronic mesenteric ischemia is due to thrombotic occlusion in the setting of atherosclerotic disease. Finally, there is one classification for venous mesenteric ischemia and that is due to MVT.

The most common type is arterial embolism comprising approximately 50% of cases. The classic presentation is acute onset periumbilical abdominal pain out of proportion to physical exam findings. A retrospective study of patients with AMI who underwent surgery found the most frequent presenting symptom was abdominal pain (95%), with nausea (44%), vomiting (35%), and diarrhea (35%) to follow. Patients with thrombotic occlusion, acute-on-chronic mesenteric ischemia, typically have a history of chronic postprandial abdominal pain and weight loss due to “food fear.” It is common in the elderly population with diffuse atherosclerosis leading to relative ischemia after meals.

Patients with mesenteric hypoperfusion, or NOMI, are usually critically ill patients who present with a slower onset of diffuse abdominal pain related to splanchnic vasoconstriction in a low-flow state. Use of MVT may have various, nonspecific abdominal complaints insidious in onset which progressively worsen over time. It is also worth mentioning median arcuate ligament syndrome (MALS), which is a compressive syndrome of the celiac artery on expiration. The presenting symptoms are similar to other forms of mesenteric ischemia and MALS is often associated with recent weight loss. MALS is a diagnosis of exclusion and management is outside the scope of this chapter.

Further diagnosis of mesenteric ischemia relies on associated risk factors, which will be discussed below, as well as laboratory analysis and imaging. One study found the mean white blood cell (WBC) count to be elevated in 98% of patients, and greater than 20 × 10^9/mL in over half of the patients. Lactate was also elevated in greater than 90% of patients and greater than 3 mmol/L in over 60% of patients. Imaging may include abdominal X-rays, duplex ultrasonography, computed tomographic angiography (CTA), magnetic resonance angiography (MRA), and contrast angiography. Contrast angiography is considered the gold standard providing both diagnostic and therapeutic options; however, CTA and MRA are commonly used as well.

Abdominal X-rays may show fluid-filled loops of bowel with bowel wall edema. Endoscopy may be useful for acute on chronic ischemia where the duodenum and right colon may have evidence of ischemia. Classic angiographic patterns exist that assist in the diagnosis of mesenteric ischemia. Firstly, the SMA is the most common site of embolism due to its high basal flow rate and anatomic angle of takeoff from the aorta. Secondly, the emboli typically lodge distal to the middle colic branch and the jejunal branches. It appears as an oval-shaped clot surrounded by contrast in a non-calcified segment. On the other hand, the thrombus in acute on chronic mesenteric ischemia typically forms at the atherosclerotic plaque, most commonly at the origin of the mesenteric vessel causing complete absence of flow. It will appear as a clot superimposed on a heavily calcified occlusive lesion at the ostium. NOMI is caused by hypoperfusion or a low-flow state, thus angiographic findings include the absence of large vessel occlusion with evidence of sequential focal vasospasm. Finally, MVT findings include bowel wall thickening, delayed passage of contrast into the portal system, and a lack of opacification of the portal vein. It is actually better diagnosed with CTA with portal phase enhancement.

2. E. Associated risk factors for acute mesenteric ischemia (AMI) are essential to the diagnosis. General risk factors for AMI include hypertension, tobacco use, peripheral vascular disease, and coronary artery disease. Arterial embolic occlusion is most commonly associated with a cardiac source such as atrial fibrillation leading to atrial appendage thrombus. Other causes include valvular disease and left ventricular mural thrombus due to previous myocardial infarction (MI) and subsequent hypokinesis. Arterial thrombosis involves a slow progression of atherosclerosis until a critical stenosis and subsequent thrombosis develops, thus patients will have other manifestations of atherosclerotic disease. Low flow states can result in acute on chronic ischemia and has been associated with MI, recent cardiac surgery, and acute viral illness. NOMI is also related to
low flow states, but without focal occlusion. Patients
in cardiogenic or septic shock, those with vasopres-
sor infusions, or patients with toxic pharmacologic
infection have all been implicated as inciting events
for NOMI. Dialysis patients with excessive fluid
removal are also at risk. In contrast, MVT is often
due to systemic disease related to hypercoagulable
states such as malignancy, trauma, medications, and
hypercoagulable syndromes.

3. E. Treatment goals in AMI include restoration of
normal pulsatile flow and resection of nonviable
bowel. Open surgery and endovascular interven-
tion can both restore flow; however, open laparot-
omy may be required to assess bowel viability and
is mandatory with peritonitis unless palliative
management is planned. The progression of endo-
vascular technology and skill over the last decade
has made an endovascular or hybrid approach
more common and more accepted. Multiple non-
randomized studies have been published but with
conflicting reports. One retrospective study of
over 4,000 patients compared outcomes for endo-
vascular vs. open surgery in the treatment of AMI
(Beaulieu RJ, et al.) Endovascular intervention had
a decreased mortality and shorter length of hos-
pital stay when compared to open surgery. Other
studies report decreased morbidity and mortality
for endovascular intervention in acute thrombotic
occlusions while others still report no difference in
mortality between the groups. However, no random-
ized clinical trials exist. More importantly, endo-
vascular or a hybrid approach requires a vascular
center with appropriate facilities and support in
place to be successful.

Surgical embolectomy is the standard treatment
for arterial embolic occlusion. The occlusion is not
likely amenable to thrombolytic therapy as it is a
relatively organized cardiac thrombus. Furthermore,
thrombolytics risk distal embolization and bowel
infarction. The standard surgical approach is a trans-
verse arteriotomy with thromboembolectomy using a
3- or 4-Fr Fogarty catheter. In patients without perito-
nitis, endovascular aspiration embolectomy is a treat-
ment option. Further, catheter directed thrombolysis
is an alternative option in cases of incomplete aspira-
tion embolectomy or distal embolization. Thrombotic
arterial occlusion can be managed endovascularly
with stenting and/or thrombolytic therapy as this is
a fresh thrombus. However, the patient may require
exploratory laparotomy if bowel ischemia is a concern.
Revascularization usually precedes bowel resection
and treatment of the underlying stenosis or occlusive
lesion is typically done during the same procedure.

Open surgical management involves surgical
bypass of the occlusion, and may be necessary in
unsuccessful embolectomy as well. Retrograde
bypass from the infrarenal aorta or iliac artery is
preferred due to easier exposure and less hemody-
namic changes as it avoids supraceliac cross-clamp.
However, retrograde bypass may produce inferior
results. Antegrade bypass from the suprarenal aorta
is less susceptible to kinking, however may be more
difficult due to post-surgical adhesive disease and
calcific atherosclerotic disease. A hybrid approach
with SMA thrombectomy followed by retrograde
stenting of the lesion is also an option.

NOMI is preferably managed non-operatively
with optimization of fluid status and cardiac out-
put, and limitation of vasoconstrictors. Interest-
ingly, one study found that 40% of patients with
NOMI had a potentially treatable SMA stenotic
lesion, thus angiography should be performed if at
all possible. Other potential causes of NOMI that
should be addressed include aortic dissection or
abdominal compartment syndrome (ACS) which
is commonly seen after ruptured abdominal aor-
tic aneurysm (AAA) repair. The mainstay of MVT
treatment is therapeutic systemic anticoagulation
and further workup to identify the underlying
cause. For the few patients that fail medical man-
agement, endovascular options do exist but there
are no studies with comparative data. In all cases,
clinical deterioration with peritonitis or any con-
cern for bowel ischemia requires surgical explora-
tion to assess bowel viability.

4. A. Regardless of surgical approach or methods
to assess bowel perfusion at initial exploration, a second-
look laparotomy is essential in the management of
AMI. Published criteria for a second-look lapa-
rotomy include low flow state, bowel resection, and
mesenteric thromboembolectomy. The key is to
plan the return to the operating room 24–48 hours
after initial exploration no matter what the patient’s
condition. After resuscitation and correction of
acid-base imbalances, patients’ conditions may
improve drastically; however, there is still the risk for
necrotic bowel requiring resection. Clearly necrotic
bowel must be resected at the initial operation,
however marginally perfused bowel needs further evaluation to limit the risk of excessive bowel resection and potentially short gut syndrome. Pulse exam, intraoperative Doppler ultrasound, fluorescein, and transcutaneous oxygen measurements are all intraoperative diagnostic options to assess bowel viability after revascularization, but second-look laparotomy is the most reliable means of determining the viability of marginally perfused bowel after revascularization.

5. A. As previously discussed, endovascular therapies are an option but not currently considered standard of care due to the lack of randomized controlled trials and evidence-based outcomes indicating the superiority of endovascular intervention. PTA with or without stent placement is a therapeutic option for chronic mesenteric ischemia, however the long-term risk for restenosis remains relatively high. There are no large, randomized, controlled trials comparing PTA with or without stenting and open surgical revascularization. Thus, close surveillance for recurrence of stenosis is mandatory.

Mesenteric ischemia has a poor prognosis with mortality rates reported at 30% for embolic and thrombotic ischemia, and 80% for NOMI. Diagnostic delays may be the most important prognostic factor, but comorbidities may place patients at further cardiac risk and postoperative complications. A significant proportion of morbidity and mortality is due to the subsequent development of multiorgan dysfunction syndrome (MODS) in relation to mesenteric ischemia and reperfusion. Intestinal reperfusion injury leads to synthesis and release of inflammatory mediators, the formation of reactive oxygen species, and cell membrane instability which ultimately causes remote organ injury. Overall MVT does have a better prognosis than other forms of mesenteric ischemia; however, long-term prognosis for MVT is based on the underlying pathology. Thus, malignancy is associated with shorter survival.

BIBLIOGRAPHY


You are called to the emergency department to evaluate a 25-year-old woman complaining of abdominal pain starting 12 hours prior to presentation. She initially characterized the pain as a periumbilical discomfort, but now it is sharp and localizes to her right lower quadrant. Review of systems is positive for a temperature elevation (measured at 38°C at home), anorexia, and nausea without emesis, and the patient denies diarrhea, melena, and hematochezia. Her past medical history, past surgical history, social history, and family history are all unremarkable. The patient’s last menstrual period was three weeks ago. She does not take any scheduled medications and has no known allergies. Measurement of her vital signs demonstrate a temperature of 37.8°C, heart rate of 88 beats per minute, blood pressure of 118/74 mm Hg, respiratory rate of 18 breaths per minute, and oxygen saturation of 98% on room air. Physical examination is normal except for focal tenderness to palpation most prominent at McBurney’s point.

1. What is the most important laboratory test to order for this patient?
   A. Complete blood count
   B. Type and screen
   C. Prothrombin time (PT) and partial thromboplastin time (PTT)
   D. Human chorionic gonadotropin
   E. Complete metabolic panel

2. Regarding the clinical manifestations of this diagnosis, which of the following is correct?
   A. The location of the appendiceal tip has little to do with determining the presenting symptoms.
   B. Only 25% of adult patients with acute appendicitis will present with a “classic” history.
   C. A clinical diagnosis of acute appendicitis is more accurate in men than women.
   D. The appendiceal obstruction is not the hypothesized pathogenesis of acute appendicitis.
   E. Delay in diagnosis and/or surgical intervention is the most common cause of complicated (gangrenous or perforated) appendicitis rather than patient delay in seeking medical attention.

3. Regarding the use of imaging in acute appendicitis, which of the following is correct?
   A. Ultrasound is the most specific imaging study available.
   B. Selective imaging has been used to lower the accepted negative appendectomy rate to less than 20%.
   C. Confirmatory imaging is not required to make the diagnosis of acute appendicitis in all cases prior to definitive management.
   D. The most accurate ultrasound finding in acute appendicitis is the presence of mesenteric lymphadenopathy.
   E. For pregnant women, magnetic resonance imaging (MRI) is not recommended when ultrasound is non-diagnostic.

4. Regarding non-operative management of acute appendicitis, which of the following is correct?
   A. Non-operative management has been definitively shown to be cost effective.
B. Surgical management is the standard of care for acute appendicitis in the United States.
C. No trials have demonstrated a potential benefit to medical management.
D. Non-operative management has consistently been shown to reduce length of stay.
E. The presence of a fecalith on imaging does not predispose a patient to fail non-operative management.

5. A decision is made to take the patient to the operating room for a laparoscopic appendectomy. Regarding possibilities that may occur during the operation, which of the following is correct?
A. If the appendix appears normal, a diagnostic laparoscopy should be performed to look for other potential causes of the patient’s right lower quadrant pain. The appendix should NOT be removed in such cases.
B. If a sub-centimeter mass is identified at the appendiceal tip, one should perform an ileocectomy.
C. If an enterotomy occurs during trocar placement, one should perform a bowel resection and not attempt primary repair.
D. If a free rupture of the appendix with fecal contamination of the peritoneal cavity has occurred, one should do a washout only at this operation and manage the patient post-operatively with antibiotics.
E. If one encounters a perforated appendix, leaving a drain has not been shown to reduce the rate of abscess formation.

ANSWERS

Introduction to Acute Appendicitis.

Acute inflammation of the vermiform appendix, first described by Fitz in 1886, is one of the most common causes of the acute abdomen encountered by the general surgeon. Anatomically, this structure is a true diverticulum of the cecum as it contains all layers of the colonic wall. It receives its arterial supply from the appendiceal artery (a terminal branch of the ileocolic artery). It is invariably found at the base of the cecum at the convergence of the taenia coli. It is structure is histologically distinct from the cecum in that it contains lymphoid tissue in the mucosa and submucosa. Epidemiologically, acute appendicitis presents most commonly in the second generation of life, is 1.4 times more common in men, is 1.5 times more common in whites, and is 11.3% more common in the summer months. The estimated lifetime risk of acute appendicitis is 8.6% for males and 6.7% for females. The hypothesized pathogenesis of acute appendicitis is that of appendiceal obstruction. It may be caused by a fecalith, true calculi, lymphoid hyperplasia, masses (both benign and malignant), or infectious processes. When the appendix becomes obstructed, increased intraluminal pressure causes localized ischemia leading eventually to perforation and localized abscess formation or generalized peritonitis.

1. D. All women of childbearing age must have a pregnancy test for two reasons. First, it narrows the differential diagnosis. The differential diagnosis for acute right lower quadrant pain is extensive, especially in a female of childbearing age. It includes such entities as inflammatory bowel disease (Crohn’s Disease, Ulcerative Colitis), ileitis, epiploic appendagitis, cecal diverticulitis, Meckel’s diverticulitis, and renal colic. Specific to women, obstetrical diagnoses (pregnancy, ectopic pregnancy) and gynecologic diagnoses (ruptured ovarian cyst, endometriosis, pelvic inflammatory disease, tubo-ovarian abscess, Mittelschmerz, ovarian torsion) are in play. A rectal examination along with pelvic examination in women or genitourinary examination in men should be considered. Second, the result of this test will most directly impact the diagnostic workup and management of the patient. If the patient is found to be pregnant and is still suspected to have acute appendicitis, the diagnostic study of choice will change (ultrasound vs. MRI over computerized tomography (CT)), teratogenic medications should be avoided, and fetal heart tones will be documented both before and after anesthesia.

2. C. Clinical diagnosis of acute appendicitis is more accurate in men than it is in women. While the overall accuracy of a clinical diagnosis of acute appendicitis is given as approximately 80%, this value is significantly higher in men than women because acute obstetric and gynecologic pathology may confound the diagnosis. The anatomic location of the appendix along with the time of the presentation determines the clinical manifestations of acute appendicitis. Further, the “classic” presentation of appendicitis (vague peri-umbilical discomfort followed by nausea and anorexia followed by migration
of the pain to the right lower quadrant) only occurs in 50% to 60% of presentations. Interestingly, patient delay in seeking medical attention is cited as the most common cause for the intra-operative findings of gangrenous or perforated appendicitis. The other factor that heavily influences delay in diagnosis is the patient's age. Appendicitis often presents atypically in children (particularly those younger than three years of age) and the elderly (defined as those patients over sixty). Adult patients who are obese, diabetic, or immunologically compromised may also present in an atypical manner. A high index of suspicion is required to make the diagnosis in these patient populations.

3. C. Confirmatory imaging is not required to diagnose acute appendicitis, and there is evidence to suggest that waiting for imaging only serves to delay definitive management in cases where there is little doubt of the history, physical exam, and laboratory evaluation. While historically the negative appendectomy rate was accepted as 10% for men and 20% for women, this value has been reduced to less than 10% with the selective use of pre-operative imaging (primarily CT) in cases where the diagnosis is not clinically apparent. Computerized tomography is the most specific imaging modality available, with an estimated specificity of above 95%. Regarding ultrasound, an appendiceal diameter of 6 mm or greater has been set as the threshold for making the diagnosis of acute appendicitis in an individual with coexistent right lower quadrant pain. MRI is recommended for pregnant women when the transabdominal ultrasound is non-diagnostic for acute appendicitis.

4. B. Surgical management remains the standard of care for acute appendicitis in the United States. Appendectomy, increasingly done using a laparoscopic approach, has become an extremely safe procedure with a reported intra-operative complication rate of 0.7% and general post-operative complication rate of 1.5%. In the adult literature, there has recently been some promising research including several randomized, prospective trials that collectively have documented an aggregate treatment failure rate and recurrence rate (adjudged as crossing over to operative management) ranging from 14% to 32% at 2 years. For those who are successfully managed nonoperatively, reviews have demonstrated decreased morbidity, decreased pain, and a reduced amount of sick leave and disability. Unfortunately, there has also been evidence that those who fail conservative management more often present with abscess or perforation (around 30%). Non-operative management has also not been shown to be cost effective because of an associated longer length of stay along with the cost of re-admission and cross-over to the operative arm. The presence of a fecalith is considered a contraindication to non-operative management because this finding has an association with treatment failure, recurrence, and complicated appendicitis.

5. E. There is no evidence that drains reduce complications (e.g., abscess formation, wound infection) following appendectomy for any stage of appendicitis. In the event that a normal appearing appendix is encountered intra-operatively, care should be taken to perform a thorough evaluation of the peritoneal cavity. Most authors recommend incidental appendectomy to remove appendicitis from the differential going forward. It should be noted that even if the appendix appears normal, final pathology will not infrequently demonstrate inflammation consistent with a diagnosis of acute appendicitis. Appendiceal tumors are rare and are only found in 1% of appendectomy specimens. Of these, carcinoid tumors are the most common (> 50%) and 90% are located at the appendiceal tip. If the tumor is less than 2 cm, an appendectomy is adequate. If the tumor is greater than 2 cm in size or there is a question of incomplete resection (positive margins, grossly positive lymph nodes), the National Comprehensive Cancer Network (NCCN) recommendation is initial appendectomy followed by re-exploration and right partial colectomy if the staging evaluation is negative for metastatic disease.

An enterotomy may be repaired primarily if it is identified at the time of the original operation. While operative management of appendiceal phlegmon or abscess at the time of presentation is controversial, thorough washout and appendectomy (either laparoscopically or via laparotomy) without drain placement is indicated for cases of fecal peritonitis caused by free rupture of the appendix.

**BIBLIOGRAPHY**


A 48-year-old male is referred to your office for painless hematochezia, which has been present for 1 year. He notes some mild fatigue but is otherwise asymptomatic and has no other past medical or surgical history. He is adopted so his family history is unknown. On physical exam, he has a BMI of 32 kg/m². His rectal and anoscopic exam show no lesions. His fecal occult blood test is positive. The rest of his exam is normal.

1. The patient is in the process of finding his biological family and is inquiring about risk factors for colon cancer. Which of the following is true?
   A. All newly diagnosed colorectal cancers under age 70 should be evaluated for the mismatch repair deficiency of Lynch syndrome.
   B. In families with suspected familial adenomatous polyposis (FAP) syndrome, screening should start in the third decade of life and done every 5 years.
   C. In patients at risk for attenuated FAP (AFAP), the average age of onset of colon cancer is the same as with FAP.
   D. In patients with Peutz-Jeghers syndrome, COX-2 inhibitors have been shown to slow the progression to cancer.
   E. In serrated polyposis syndrome, the polyps are typically hyperplastic in nature and thus, this syndrome is not associated with an increase risk of malignancy development.

2. For this patient, the next step in management should be
   A. Computed tomography (CT) virtual colonography
   B. Fecal immunochemical test
   C. Colonoscopy
   D. Stool DNA
   E. Capsule endoscopy

3. The entire colon was able to be evaluated and a 4 cm sessile polyp is noted in the distal descending colon on the above study. A subsequent biopsy is done which shows a moderately differentiated adenocarcinoma with extension past the lamina propria. There are no other lesions in the colon. Which of the following is the next best step in management?
   A. Left colectomy
   B. Repeat colonoscopy to determine if the lesion is amenable to endoscopic resection.
   C. Rigid proctoscopy
   D. CT scan
   E. CT/PET scan

4. The patient is prepared for surgery. He is interested in a laparoscopic resection so he can return to work faster. Which of the following is true regarding laparoscopic approaches?
   A. The robotic assisted laparoscopic approach has the least amount of blood loss.
   B. A single-incision laparoscopic approach has less pain than other laparoscopic approaches.
   C. The laparoscopic approach has higher rates of port site/wound recurrences versus an open approach.
D. The laparoscopic approach has less deep surgical site infections than does an open approach.
E. A single-incision laparoscopic approach has a shorter length of hospital stay.

5. A review of your hospital’s National Surgical Quality Improvement Program (NSQIP) data shows that the average length of stay for colon resections is 9 days. The Chief of Surgery is considering implementing an Enhanced Recovery After Surgery (ERAS) protocol for colon surgery. Which of the following is true?
   A. Epidural anesthesia is a requirement.
   B. Use of preoperative carbohydrate drink hastens the return of bowel function.
   C. ERAS has been shown to decrease non-surgical complications.
   D. ERAS has been shown to decrease length of stay but has a higher readmission rate.
   E. There is no need to start a ERAS protocol because the national standard for length of stay is 10 days.

ANSWERS

1. A. Hereditary syndromes of the gastrointestinal tract account for 5% to 10% of GI malignancies including colon cancer. There are several known such syndromes: Lynch syndrome (formerly Hereditary non-polyposis colorectal cancer), adenomatous polyposis syndromes including FAP-familial polyposis syndrome, AFAP-attenuated familial polyposis syndrome and MAP-MUHY-associated polyposis, Peutz-Jegher syndrome, Juvenile Polyposis syndrome, Cowden syndrome, Serrated/Hyperplastic Polyposis syndrome, and the conditions of Hereditary Pancreatic Cancer, and Gastric Cancer. All of these syndromes increase the risk of colorectal cancer development and in the case of the FAPs, all of these patients will progress to malignancy.

Lynch syndrome (LS): This is the most common hereditary syndrome and these patients have a mismatch repair gene mutation. The average age of colorectal cancer diagnosis is 44 to 61 years (sporadic cancer is 69 years). LS is also hallmarked by right-sided colon predominance and rapid progression from adenomatous polyp to cancer (35 months). All newly diagnosed colorectal cancer patients should be genetically screened for LS mutations. For those family members at risk, screening with colonoscopy should begin at 20 to 25 years and continued at least every 2 years.

Adenomatous Polyposis syndromes: There are three variants: milial adenomatous polyposis (FAP), attenuated FAP (AFAP), and molecular adenomatous polyposis (MAP). 100% of FAP patients will go on to develop colon cancer with an average onset of 39 to 41 years of age. The condition is hallmarked by > 100 synchronous polyps. Colon cancer screening should begin at age 10 to 12 via colonoscopy and should continue annually; and fortunately, screening with subsequent surgery can eliminate the mortality from this disease. In AFAP, the amount of colonic polyps is reduced to about 50% and correspondingly the average age of malignant onset is higher at 58 years and occurs in about 69% of patients with AFAP. Screening is recommended to begin in the third decade of life and continued every 1 to 2 years. In MAP patients, cancer develops in 41% to 100% of patients with average age of onset of 58 years. These are typically 20 to 99 synchronous polyps. Here the MUTYH is a base excision repair gene and its mutation causes the oncogenesis. In addition to other malignancies, APSs are associated with desmoids tumors.

Prophylactic colectomy, meaning total colectomy with ileo-rectal anastomosis or total proctocolectomy with ileal pouch-anal anastomosis, should be considered in the late teens and early 20s and if there is evidence of high-grade dysplasia, polyps > 10 mm in diameter, marked increases in polyp number from one exam to the next, and if symptoms are present.

Peutz-Jegher syndrome (PJS): PJS is hallmarked by hamartomatous polyps of the GI tract and mucocutaneous pigmentation. Colon cancer develops in 39% of patients with an age of onset of 42 to 44. More commonly patients will present with abdominal pain due to one of the hamartomatous polyps causing an intussusception. This typically occurs in younger patients. Those with a suspected diagnosis or at risk should have screening colonoscopy and esophagogastroduodenoscopy (EGD, for duodenal and gastric cancer risk) at age 8. If polyps are found and can be controlled endoscopically, then surveillance is recommended for every 3 years. If no polyps are found and the patient is asymptomatic, the next screening by endoscopy can be delayed until 18 years of age and then every 3 years. While COX-2 inhibitors are theoretically believed to eliminate the polyps, there is no conclusive evidence that they are helpful in doing so.
Juvenile Polyposis syndrome (JPS): JPS is defined by the presence of 5 or more juvenile polyps in the GI tract, which can present in the first decade of life. The average age of diagnosis for JPS is 18 years of age with the mean age of colon cancer onset being 34 years of age. By this age, 17% to 22% of carriers will have developed colon cancer. Endoscopic screening with both EGD and colonoscopy should begin at age 12 with surveillance every 1 to 3 years.

Cowden syndrome (CS): 95% of CS patients have colonic polyps, typically hamartomatous in nature, and they can be numerous, even over 100. CS is also associated with ganglioneuromas and it carries a 9% to 16% increased risk for colon cancer. Screening should begin at age 15 and continued every 1 to 2 years.

Serrated Polyposis syndrome (SRS): SRS was previously known as hyperplastic polyposis syndrome when it was felt that the only types of polyps present were serrated hyperplastic ones; but in fact, the polyps can be adenomatous also. All of the polyps are serrated however. The diagnosis can be confirmed clinically in patients who have > 5 serrated polyps proximal to the sigmoid colon with at least 2 of them being > 10 mm, or any number of serrated polyps proximal to the sigmoid colon and a first degree relative with the diagnosis, or > 20 serrated polyps distributed throughout the colon. While SRS is felt to increase the risk of colorectal cancer, the exact risk is unknown. The screening age is unknown but once it is diagnosed, colonoscopy is recommended every 1 to 3 years.

2. C. The initial work up for a patient who presents with painless hematochezia should be a colonoscopy. Alternatively a flexible sigmoidoscopy and an air-contrast barium enema (ACBE) together could be used to evaluate the hematochezia as most lesions, including malignancies, will be in the rectum and sigmoid colon. If a lesion is found in the proximal colon on ACBE, then a colonoscopy will need to be done in order to biopsy the lesion. An ACBE alone would likely miss a lesion in the sigmoid colon because the redundancy and mobility of the sigmoid colon prevents adequate visualization of this area. Rigid proctoscopy, in such a patient, is generally reserved for accurately measuring the distance the lesion is from the anal verge. It would, therefore, not be used for diagnostic purposes to evaluate the entire colon.

Fecal Immunochemical Testing (FIT) and Stool DNA testing are other screening tests used to detect the presence of cancer or advanced adenomas. Both are considered to be specific and sensitive in the detection and absence of CRC but their exact role has yet to be defined. Likely they would be used as screening tools in average risk patients. Positive FIT or stool DNA tests would prompt the performance of a colonoscopy.

As this patient has fatigue, albeit mild, the right colon still needs to be evaluated. CT virtual colonoscopy would not be the first diagnostic method in this patient as it is generally used as a screening tool only for asymptomatic patients or for patients who would not tolerate sedation well. Additionally CT colonography has not proven to be as accurate as conventional colonoscopy for lesions < 10 mm in diameter. Similarly capsule endoscopy is accurate in diagnosing the presence of a polyp but the accuracy decreases with polyps smaller than 10 mm. Moreover, the number of studies and the number of patients in these studies is small compared to the other modalities. At this time conventional colonoscopy remains the best diagnostic tool to rule out malignancy for patients with symptomatic colorectal disease.

3. D. An extent of disease work up is recommended prior to proceeding to surgery in cases of colon cancer. The NCCN guidelines recommend a CT scan of the chest, abdomen, and pelvis. Routine preoperative imaging has been shown to change the treatment plan or operative plan in up to 14% of patients. In addition to identifying metastatic disease, preoperative imaging can be helpful with T stage, nodal status, and location of the lesion. Rigid proctoscopy is only needed for rectal cancer to better determine the distance of the lesion from the anal verge to help determine if a low anterior resection can be done. One need not repeat the colonoscopy because the lesion has already advanced into the submucosa and definitive removal via endoscopy is not possible. Additionally, the entire colon was examined with the use of conventional colonoscopy in the last sentence of question 2.

PET scan is more routinely used after resection of colon cancers to determine recurrence but this is not mandatory. PET scan/CT colonography are recommended if the proximal colon cannot be examined due to an obstructing lesion or if metastatectomy is anticipated.
4. E. Laparoscopic colonic resection continues to be more popular and it has proven advantages of decreased hospital length of stay, less post-operative pain, decreased superficial surgical site infection, and decreased non-surgical complications. While robot assisted laparoscopic surgery is touted that it will decrease blood loss because of superior vision and articulation of instruments, there is no proof that any surgical outcomes, including operative time, associated injury, post-operative pain, need for reoperation, and leak, are superior with use of a robot. Additionally, use of the robot is theoretically felt to decrease discomfort and injury to the surgeon, but this has yet to be proven. Indeed there is no proven advantage with use of a robot in laparoscopic surgery.

Single incision laparoscopic surgery (SILS), also known as Single Port Access surgery or Laparoscopic Single Site surgery, was touted to reduce post-operative pain, decrease recovery time, and improve cosmetic outcomes, as all of the laparoscopic instruments would be placed through a single < 4 cm incision. SILS is technically more demanding than traditional laparoscopic techniques. When compared to standard multi-port laparoscopy, the SILS approach is associated with a shorter length of stay.

Initially the use of laparoscopic surgery for colon cancer resection was felt to increase the rate of port site metastases, but this has not proven to be true. There is no increase in metastatic disease with the use of laparoscopy. Furthermore, the laparoscopic approach is equivalent to the open one in terms of oncologic outcomes.

5. C. The Enhanced Recovery After Surgery (ERAS) protocols are designed to standardize the post-operative course for commonly performed surgeries so that surgeons, nursing staff, other providers, and the patients themselves know what the process is for the patient’s post-operative care. ERAS protocols have been shown to decrease the length of stay after colon surgery, as well as many other procedures. In the case of colon surgery, ERAS is only used for elective procedures. ERAS protocols for colon surgery generally start prior to the surgical procedure. The basic tenants of the protocol include the patient drinking a high-carbohydrate drink 2 hours prior to their surgery, decreased intra-operative intravenous fluid use, non-narcotic pain control, ambulation on the day of surgery, early removal of a urinary catheter, and starting a clear liquid diet on the evening after surgery. There are many different protocols amongst hospitals, however, and none of the tenants mentioned have individually proven beneficial to decrease length of stay, hasten return of bowel function...
function, or decrease complications with the exception that early urinary catheter removal decreases post-operative urinary tract infections. Thus, while an epidural may reduce the need for narcotic pain medications, it is not a requirement for ERAS protocols.

ERAS protocols have been shown to reduce post-operative length of stay to about 5 to 7 days and they have shown a reduction in non-surgical complications like pneumonia and myocardial infarction. However, they have not shown a reduction in surgical complications like bleeding, superficial surgical site infections, deep surgical site infections, leaks, and so on. The readmission rate after using ERAS protocol is similar to non-protocol post-operative outcomes in that 10% to 13% of patients are readmitted.

The NSQIP data is used to track 30-day outcomes for all surgeries performed at hospitals that participate. A length of stay of 8 days has been determined as the national standard and those outside of 8 days represent the bottom tenth percentile of hospitals and are thus considered outliers. Length of stay, however, does not necessarily mean there are poorer outcomes for patients.

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A 28-year-old woman with a history of Crohn’s disease presents to the emergency room with worsening diarrhea, >20 bowel movements a day, and a 10% loss in body weight over the past 6 weeks. She has previously been managed on 5-aminosalicylic acid and Infliximab. Her vital signs on evaluation are significant for a heart rate of 105 beats per minute and a temperature of 100.6°F. Her abdomen is soft with mild left lower quadrant tenderness, and her rectal exam is normal. Her white blood cell count is $15 \times 10^3/\mu L$. She undergoes a computed tomographic (CT) enterography that shows an ileosigmoid fistula with a surrounding three-centimeter rim enhancing fluid collection that abuts the abdominal wall, and a more proximal ileoileal fistula. There is no free air or free fluid.

1. **A surgical intervention should be offered for which of the following presentations of Crohn’s disease?**
   A. Enterocentric fistulas with mild symptoms.
   B. Medically managed disease but on two medications.
   C. New inflammatory changes of the terminal ileum on radiographic findings.
   D. Ileosigmoid fistula and associated diarrhea and malnutrition.
   E. Intra-abdominal abscess amenable to CT-guided percutaneous drainage.

2. **In the absence of symptoms, malnutrition and diarrhea, which of the following is the best option for the above patient?**
   A. Ileoceccectomy
   B. Enterectomy with primary hand sewn anastomosis
   C. Enterectomy with stapled anastomosis
   D. Non-operative management
   E. Proximal diversion

3. **Surgical management of the ileosigmoid fistula in the above patient is best approached with which of the following techniques?**
   A. En bloc resection of all inflamed tissue with proximal diversion.
   B. Debridement and primary closure of fistula site on sigmoid colon if there are no secondary signs of inflammation.
   C. Enterectomy, debridement of fistula tract, and segmental colectomy.
   D. Small bowel resection with primary anastomosis alone.
   E. No surgical indications.

4. **Which of the following is true regarding the medical management of enterocentric fistulas?**
   A. Infliximab has demonstrated some benefit in the closure of intra-abdominal fistulas.
   B. Infliximab has a higher rate of closure for intra-abdominal fistulas compared to perianal fistulas.
   C. There is no role for anti-Tumor Necrosis Factor agents in the setting of Crohn’s disease.
   D. There is no risk in postoperative anastomotic complications with pre-operative use of an anti-Tumor Necrosis Factor agent.

5. **Which of the following is true regarding the development of cancer in Crohn’s disease?**
A. There is a higher rate of a Crohn’s associated malignancy in a fistula tract compared to a stricture.

B. The risk of colon cancer in Crohn’s disease is no greater than the general population.

C. Surveillance colonoscopy is not indicated in a patient with an ileosigmoid fistula.

D. Colon cancer in the setting of Crohn’s disease should be managed similar to the general population.

E. Subtotal colectomy with ileorectal anastomosis has better outcomes in Crohn’s disease than a segmental colectomy.

ANSWERS

1. D. Crohn’s disease was first described in 1932. It involves inflammation of the entire gastrointestinal tract from mouth to anus, and 50% of patients present with ileocolic disease. The Vienna system, published in 2000, is most commonly used for the classification of Crohn’s disease. It includes: 1. Penetrating or fistulizing; 2. Strictures; and 3. Non-penetrating, non-fistulizing Crohn’s disease. Surgical management of this disease is reserved for patients who fail medical treatment or who present with complications that include: hemorrhage, perforation, abscess, fistula, strictures, malignancy, and growth retardation in children. Percutaneous drainage of an intraabdominal abscess in an otherwise stable patient should be considered prior to an operative intervention.

2. D. Patients with Crohn’s disease often undergo multiple abdominal operations with 40% to 55% requiring an operation 10 years following their diagnosis, and 75% requiring surgery in their lifetime. Surgery is not recommended for asymptomatic enteroenteric fistulas. However, exacerbation of diarrhea with associated malnutrition is an indication for resection.

3. B. A systematic approach to the surgical management of Crohn’s disease is critical to the preservation of bowel length. Nutrition should beoptimized as tolerated and preoperative studies to include esophagastroduodenoscopy, colonoscopy, and CT enterography should be considered. It is critical to determine the site of inflammation, as often times the colon only needs to be debrided with primary closure of the fistula site. Only the diseased portion of colon or small bowel should be removed. However, healthy bowel should be excised if the fistula is compromising the mesentery. Resection should only be performed back to grossly normal appearing bowel.

4. A. Infliximab is a human chimeric antibody directed against the pro-inflammatory cytokine tumor necrosis factor (TNF). It is therapy was one of the original monoclonal antibodies to show improvement of symptoms, complete endoscopic remission and a decreased need for surgery in Crohn’s disease. Infliximab has been used in the treatment of fistulizing Crohn’s disease. In a review of 26 patients with fistulizing Crohn’s disease, infliximab alone was able to result in a complete closure; however, only one was intra-abdominal.

The ACCENT II study published in 2004 evaluated the maintenance dosing of infliximab in patients with fistulizing Crohn’s who responded to induction therapy. The majority of patients had perianal fistulas. The study showed complete fistula closure in 36% of patients at 54 weeks. When evaluated by location, approximately 97% of perianal fistulas had complete closure, demonstrating the superior outcomes compared to intra-abdominal fistulas.

Anti-TNF agents will impede the immune response following surgery. El-Hussuna and colleagues performed a systemic review of post-operative complications following the use of anti-TNF alpha agents within three months prior to an operation. Fourteen studies were reviewed, and overall there was no difference in anastomotic complications (7.6% vs. 8.2% in the control groups). In a subgroup analysis, studies determined to have a lower chance of bias identified a greater risk of adverse events with the administration of anti-TNF agents.

5. D. The risk of colorectal cancer in Crohn’s disease is a controversial topic, with some reports of up to a 20-fold increase in risk compared to the general population. Lovasz and colleagues in 2013 demonstrated the rate of colorectal cancer to be 5.5% after 5 years, and 7.5% after 10 years of disease duration, with a greater prevalence in stricture disease. Furthermore, it was recommended to employ closer endoscopic surveillance compared to the general population following diagnosis.

Surveillance colonoscopy for Crohn’s disease is recommended at similar time intervals as ulcerative colitis; beginning 8 to 10 years after disease onset for pancolitis, 15 years for left-sided disease, and then annually after 30 years following diagnosis. Surgical management of a Crohn’s associated malignancy
should be treated like the general population with
segmental resection and associated lymphadenectomy.
There have been reports that recommend subtotal
colecotomy in the setting of a Crohn's associated
colorectal cancer due to the risk of synchronous and
metachronous lesions.

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Warren S, Sommers S. Cicatrizing enteritis as a pathologic
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501.
A 47-year-old obese man presents to the emergency room with a two day history of sharp, constant, left lower quadrant pain that is worse with straining and is associated with subjective fevers. This is the patient's first episode of pain. His vital signs are normal and he is in no distress. You are able to elicit moderate tenderness in the left lower quadrant on exam, and a complete blood count shows a mild leukocytosis of 13,000/µL.

1. Regarding the patient described above, what is the single best study to obtain in order to confirm your suspected diagnosis?
   A. Plain abdominal X-rays
   B. Magnetic resonance imaging (MRI) of the abdomen
   C. Computed tomographic (CT) scan of the abdomen and pelvis with IV and oral contrast
   D. CT scan of the abdomen and pelvis with rectal contrast
   E. Abdominal ultrasound

2. Regarding the treatment of acute, uncomplicated, sigmoid diverticulitis in a reliable patient, what is the most appropriate treatment plan?
   A. Discharge with pain medication.
   B. Discharge with oral (PO) antibiotics and close follow up.
   C. Admission, IV antibiotics, and bowel rest.
   D. Urgent exploratory laparotomy and resection of the involved colon.
   E. Discharge with PO antibiotics and planned laparoscopic resection in 6 to 8 weeks.

3. Regarding the indications for elective colon resection after an episode of uncomplicated diverticulitis, which of the following is the strongest indication?
   A. A patient with continued chronic symptoms that fail to resolve with antibiotics.
   B. If the first episode occurs in a patient younger than the age of 50.
   C. After the second episode of uncomplicated diverticulitis.
   D. After the first episode in order to prevent future perforation and abdominal sepsis.
   E. After three documented cases of uncomplicated diverticulitis.

4. Regarding a similar patient who presents without signs of sepsis but on imaging has evidence of complicated diverticulitis with a 6 cm pelvic abscess, what is the best treatment plan?
   A. Discharge with PO antibiotics and close follow up.
   B. Admission, IV antibiotics, and percutaneous drainage.
   C. Admission, IV antibiotics, and Laparoscopic washout with drain placement.
   D. Admission, IV antibiotics, laparoscopic washout with drain placement, and planned laparoscopic resection in 6–8 weeks.
   E. Admission, IV antibiotics, and resection of the diseased segment with end colostomy.

5. Regarding a patient who presents with similar symptoms and early signs of sepsis and an abdominal
exam consistent with diffuse peritonitis, what is the best course of action?
A. Admission, IV antibiotics, and percutaneous drainage.
B. Admission, IV antibiotics, and Laparoscopic washout with drain placement.
C. Admission, IV antibiotics, laparoscopic washout with drain placement, and planned laparoscopic resection in 6–8 weeks.
D. Admission, IV antibiotics, and proximal diversion without resection.
E. Admission, IV antibiotics, and operative therapy with resection of the diseased segment.

ANSWERS

1. C. Multi-slice CT has become the standard imaging modality to confirm the diagnosis of sigmoid diverticulitis. It has been shown to have a sensitivity and specificity as high as 98% and 99% respectively with intravenous and intra-luminal contrast. A CT scan is useful to confirm the diagnosis of diverticulitis, determine disease severity, and guide treatment. Despite the accuracy of cross-sectional imaging in the detection of diverticulitis, it may provide a diagnostic dilemma, as radiographically a colonic neoplasm can appear similar. Therefore, colonoscopy is recommended after the acute process has subsided.

Plain radiographs of the abdomen are inexpensive, easily available, and expose the patient to minimal radiation. However, they offer limited diagnostic information in the evaluation of diverticulitis. Magnetic resonance imaging (MRI) and ultrasound may be a useful alternative in a patient where a CT scan or intravenous contrast is contraindicated. Ultrasound in some studies has diagnostic accuracy up to 97%; however, it is limited by operator variability, patient discomfort, and inability to accurately make an alternative diagnosis. MRI is not limited by the same issues as ultrasound and has a sensitivity and specificity as high as 94% and 92% in some studies.

2. B. Recent publications have questioned the pathophysiology of uncomplicated diverticulitis and have disputed the need for antibiotics in these cases. However, current guidelines recommend that the standard treatment of acute uncomplicated diverticulitis in the United States is outpatient antibiotic therapy. It is supported by the American Society of Colon and Rectal Surgeons (ASCRS) and will continue until there is significant evidence supporting the safety of outpatient management without antibiotics. To be a candidate for outpatient therapy the patient must be stable, non-toxic, reliable, able to maintain an adequate enteral diet, and have uncomplicated disease. Finally, the patient should have close interval follow-up to ensure their symptoms are improving.

3. A. The current indications for elective resection in diverticulitis include chronic symptoms, complicated disease, inability to rule out a malignancy, and patient specific factors. The surgical management of uncomplicated diverticulitis has changed. Previous retrospective studies, performed prior to the use of CT scan, reported recurrence in one third of patients after an uncomplicated episode. Recent data has shown not only a lower recurrence rate, 13% to 23%, but more importantly, a low risk of complicated disease and need for emergent surgery. Due to these findings, ASCRS recommends against routine sigmoid resection for the indications of: two or more uncomplicated episodes, age of $<50$, or to prevent complicated disease in the future. The guidelines recommend that each patient be evaluated individually regarding their overall health, age, access to care, number, severity, and frequency of episodes, as well as the impact of each episode on the patient’s quality of life. These multiple factors should be weighed against the risks associated with elective resection. Thoughtful counseling can be performed with the patient, and an informed decision can be made.

As a subgroup, immune-compromised patients have been found to be at a higher risk of mortality with non-operative treatment; therefore, surgeons should have a lower threshold for resection in this patient population.

4. B. The treatment of complicated diverticulitis with an associated abscess has drastically changed with the advent of image-guided percutaneous drainage. A treatment plan of antibiotics with selective drainage has been shown to allow up to 75% of patients with a diverticular abscesses to avoid urgent surgery. Percutaneous drainage is beneficial as a bridge for stable patients without signs of peritonitis that would have previously needed an urgent operation. Drainage provides patients the opportunity of an elective single stage resection, the avoidance of surgery in the acute inflammatory stage, a lower risk of ostomy
placement, and an overall decrease in morbidity and mortality.

Currently, there is no data to support the outpatient management of acute complicated diverticulitis. Regarding the decision for elective resection after an episode of complicated diverticulitis, ASCRS recommends that resection should be considered in all patients that are appropriate surgery candidates. However, CT scan findings of a phlegmon or extraluminal gas alone does not indicate complicated disease. Finally, there is insufficient data to show that laparoscopic lavage is a safe alternative to resection in patients with purulent or feculent peritonitis. ASCRS does not currently support operative therapy without resection for the treatment of diverticulitis.

5. E. The treatment for patients with complicated diverticulitis with evidence of purulent or feculent peritonitis is an operative approach with resection of the diseased bowel. There is ongoing research in Europe to determine if there is a role for laparoscopic lavage in patients with severe complicated diverticulitis. However, as stated earlier, ASCRS does not currently support non-resectional therapy except in the rare circumstance that the abdomen is too hostile for extirpation of the colon. Previous literature has evaluated diversion without resection, but this technique was shown to have an increased rate of postoperative peritonitis as compared to resection.

In general, the extent of resection should include the entire sigmoid colon with a proximal margin of soft and pliable descending colon. While not all the diverticula need to be removed, it is important to ensure that none are included in the anastomosis if one is performed. The distal aspect of the specimen should include a margin of normal rectum in order to reduce the risk of recurrence.

The decision to perform a primary anastomosis with or without protective ileostomy versus end colostomy in the setting of emergent surgery for diverticulitis is currently being debated. There is nonrandomized and retrospective data that supports primary anastomosis. It was found to be safe and not associated with worse outcomes in the setting of complicated diverticulitis. The inherent selection bias in these studies has prevented the surgical community from making broad recommendations regarding primary anastomosis in the setting of emergent colectomy for diverticulitis.

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A 48-year-old white man presents to your office with a history of seven months of intermittent painless blood per rectum with bowel movements, which was diagnosed as internal hemorrhoids by his primary care provider. He has no other medical problems and has an unknown family history because he was adopted as an infant. On your digital and anoscope evaluations, you find scant bloody mucous, no pathologic hemorrhoids, no other anal diseases, and the visualized area of rectal mucosa is normal.

1. What is the next best step in his evaluation?
   A. Immunohistochemical fecal occult blood test
   B. Guaiac fecal occult blood test
   C. Colonoscopy
   D. Computed tomographic (CT) colonography
   E. Flexible sigmoidoscopy

2. A flexible endoscopic examination demonstrates an endoscopically unresectable mass lesion concerning for cancer is located at approximately 14 cm from the anal verge and a biopsy is performed. The next best step to evaluate the lesion is?
   A. CT scan of the pelvis
   B. Rigid proctoscopy
   C. Serum carcinoembryonic antigen (CEA) level
   D. Hepatic function tests
   E. Fusion positron emission tomography (PET)/CT scan of the chest, abdomen, and pelvis

3. A colonoscopy shows no other lesions. High resolution CT scans of the chest, abdomen, and pelvis do not demonstrate distant disease and recommended blood tests demonstrate only a mild anemia. Pathologic evaluation returns a diagnosis of moderately differentiated adenocarcinoma, about 9 cm from the anal verge. What if any tests remain to complete the pre-treatment staging?
   A. Transabdominal liver ultrasound
   B. KRAS mutation genotype
   C. Fusion PET/CT scan of the chest, abdomen, and pelvis
   D. No further evaluation is necessary.
   E. Magnetic resonance imaging (MRI) of the pelvis

4. Preoperative staging reveals a 4 cm moderately differentiated adenocarcinoma T2N1M0 located at 9 cm from the anal verge. What is the preferred treatment strategy?
   A. Pre-operative chemotherapy followed by chemoradiation therapy followed by full thickness transanal excision of the primary lesion.
   B. Low anterior resection of the rectum followed by chemotherapy or chemoradiation therapy based on pathologic evaluation of the resection specimen.
   C. Pre-operative chemotherapy followed by chemoradiation therapy followed by low anterior resection of the rectum.
   D. Chemoradiation followed by low anterior resection of the rectum.
   E. Pre-operative chemotherapy followed by chemoradiation therapy followed full thickness transanal excision of the primary lesion.

5. Regarding additional testing to evaluate the patient, which is recommended and demonstrated
to be cost effective for all rectal cancer patients under 50?
A. Somatic APC gene sequencing
B. Tumor gene sequencing
C. Circulating tumor cells
D. Hypermethylation analysis of tumor DNA
E. Mismatch repair protein analysis and/or microsatellite instability analysis

ANSWERS

1. C. The diagnostic concern in this patient is primarily cancer, as the most likely other causes of painless rectal bleeding have been ruled out based on office evaluation. Other likely diagnoses to consider would be some form of colitis or bleeding diverticulosis, but these are less likely due to the lack of abdominal symptoms, bleeding only with bowel movements. From the choices listed, the immunohistochemical fecal occult blood test (iFOBT) and Guaiac fecal occult blood test (gFOBT) are designed to detect blood in the GI tract; therefore, they do not advance the patient's work up as he has visible gross blood in his bowel movements. Both flexible sigmoidoscopy and colonoscopy have the ability to diagnose and biopsy cancers, but only colonoscopy can evaluate the entire colon and possibly treat the source of the bleeding. In a comparison of four diagnostic strategies for adult rectal bleeding, colonoscopy was the best overall strategy. CT colonography is controversial in its utility in colorectal cancer screening, but it is not recommended in the evaluation of the symptomatic patient, with sensitivity that is not equivalent to fiberoptic endoscopy.

2. B. The location of the lesion is critical for the next phases of the evaluation and management of this tumor, as there are significant differences in the evaluation and management of certain stages of colon versus rectal cancers, as well as very proximal versus middle and distal rectal cancers. Flexible endoscopy is notoriously unreliable with regards to accurate measurement of a distal lesion, and generally overestimates the distance from the verge. Rigid proctoscopy is mandatory for any lesion in the rectum or recto-sigmoid junction, as it is reliable in its results. It ideally should be performed by the operating surgeon. Tumors with the distal most aspect located above 12 cm from the anal verge are diagnosed as colon cancer and below 12 cm are diagnosed as rectal cancer. However, tumors diagnosed in the rectum from 10.1 cm to 11.9 cm from the anal verge can be treated as colon cancers, as there seems to be no benefit for local control from neoadjuvant or adjuvant chemoradiation therapy. CT is part of the staging of colorectal cancer, but CT of the pelvis alone is incomplete for staging, and both endorectal ultrasound in skilled hands and 3.0 T MRI of the pelvis are better modalities to evaluate for local disease and pelvic regional metastasis. Serum CEA is indicated until a colon or rectal cancer is diagnosed by biopsy, but it is not the next best step. Further, it does not advance the patient's evaluation at this time. Hepatic function tests are unhelpful and not indicated unless there is coexistent liver disease. PET/CT scan does not replace a high resolution CT of the chest, abdomen, and pelvis with oral and IV contrast, and is generally not indicated in the initial evaluation of colon and rectal cancer.

3. E. The lesion is now clearly a rectal adenocarcinoma with no evidence of distant metastasis, giving us a stage of TxNxM0. What we need next is the tests that determine the T and N status in order to generate our treatment plan, thereby making the choice of no further evaluation wrong. The best test listed is the MRI of the pelvis. This test gives the most accurate assessment of tumor depth and presence of nodal metastasis without the user variability of endorectal ultrasound. It is also the best test to assess the possibility of a threatened circumferential radial margin by invasion of or near to the mesorectal fascia. Given the normal CT of the abdomen, there is no indication for the liver ultrasound and again there is generally no indication for the PET/CT in the initial staging of colorectal cancer, especially if a normal high resolution CT scan is normal. KRAS mutation from wild type is useful for predicting whether or not biologic therapy will be useful, but only in patients with metastatic disease, which this patient does not have.

4. D. The patient now can be staged as Stage IIIA and the lower edge of the tumor is below 10 cm from the anal verge. Based on current guidelines, this patient should have neoadjuvant chemoradiation therapy followed by low anterior resection using a total mesorectal approach with a distal margin 4 cm from the tumor. The transanal excision choices are incorrect based on nodal status and tumor size of 4 cm and location of the lower edge above 8 cm from the anal verge.
verge. The choice for low anterior resection (LAR) first then chemoradiation is wrong because in patients who can tolerate the neoadjuvant therapy, there is an absolute decrease in local recurrence of about 7% (6% from 13%) in these patients who get chemoradiation prior to operation compared to after the operation, and is backed by category 1 data. The choice with chemoradiation then chemotherapy then LAR is an option for care, but not preferred in this situation.

5. E. The patient has no knowledge of his family history, nor any timely way to get it, thereby making a preoperative determination of his risk for a hereditary colorectal cancer syndrome by Bethesda or Amsterdam criteria impossible. Approximately 2% to 4% of rectal cancers are known to be due to Hereditary Non-Polyposis Colorectal Cancer (HNPCC) syndrome or Lynch syndrome. T is syndrome is caused by germline mutation in any one of a number of genes involved with the process of DNA Mismatch Repair (MMR). Impairment of MMR results in accumulation of length alterations in simple repeated DNA fragments called microsatellites. T is accumulation leads to a state of genetic instability termed Microsatellite Instability (MSI). T e syndrome is further characterized by an increased incidence of cancers in the female genital system and the urinary system, as well as data supporting an increase in brain, pancreatic and gastric cancers in certain families. T e Evaluation of Genomic Applications in Practice and Prevention (EGAPP) working group of the CDC found it to be cost effective for MMR and/or MSI testing for all colorectal cancers in patients under 50 years of age, and many cancer centers in the United States test all patients under 70 and all patients regardless of age if the Bethesda or Amsterdam criteria are met. Somatic APC gene sequencing is used to diagnose an index mutation in the familial adenomatous polyposis (FAP) syndrome. Tumor gene sequencing may be useful in some settings, but not before performing the more rapid and cheaper testing for Lynch syndrome. T e presence of circulating tumor cells are being studied as a diagnostic tool for cancer and cancer recurrence, but currently is not routinely used. Hypermethylation analysis of tumor DNA is not routinely done and is suggested as the cause of cancer for patients with MMR protein abnormality detected in hMSH1 and a BRAF mutation, rather than a somatic mutation.

BIBLIOGRAPHY


A 40-year-old woman presents with a five day history of worsening gluteal and rectal pain. Her pain is dull and constant and she describes a sensation of rectal fullness. She has fevers and chills. She has had no changes in bowel habits and denies constipation. She denies purulence, hematochezia, melena, or incontinence. She has some discomfort with defecation but no pain. She denies a history of inflammatory bowel disease, hemorrhoids, or rectal prolapse. She denies trauma to the area. She is not sexually active. Her significant past medical and surgical history includes an appendectomy. In the emergency department, she is febrile to 102.3°F, a heart rate of 103, and a blood pressure of 120/83. She has some induration and erythema 4–5 cm laterally and anterior to the anal verge on the right with tenderness, no fluctuance, normal sphincter tone, no masses, and no induration. No fistula openings visible. Laboratory workup is significant only for a white blood cell count of 19.2.

1. **What would be the expected course of a fistula-in-ano (if present)?**
   - A. Radial to the posterior midline
   - B. Curvilinear to the anterior midline
   - C. Radial to the anterior midline
   - D. Curvilinear to the posterior midline

2. **What is the preferred operative management of horseshoe abscesses?**
   - A. Intravenous antibiotics
   - B. Presacral drainage
   - C. Incision and drainage with counter incision
   - D. Single incision and drainage
   - E. Transabdominal drainage

3. **Regarding the outcomes of treatment for anal fistula, which of the following is correct?**
   A. There is no difference in fistula closure rate with fibrin glue versus standard fistulotomy, but those who underwent fibrin glue placement have shorter recovery times.
   B. Fistulas occur in 66% of patients who have perirectal abscesses.
   C. Non-cutting setons have an increased risk of incontinence.
   D. All anterior fistulas in females should be managed with a cutting seton.

4. **Regarding perirectal abscesses, which of the following is correct?**
   A. Horseshoe abscesses can occur in two planes and usually require imaging for diagnosis.
   B. Immunocompromised patients can be managed with bedside incision and drainage and intravenous antibiotics.
   C. Crohn’s disease is responsible for the majority of perirectal abscesses.
   D. Necrotizing soft tissue infection of the perianal and perineal areas has a mortality rate approaching 50%.

5. **Regarding perirectal abscesses, which of the following is correct?**
   A. Supralelevator abscesses can be a complication of diverticulitis.
   B. Perianal abscesses always require a counter incision.
C. Fistulas encountered at the time of incision and drainage of a perirectal abscess should be surgically repaired.
D. External manifestations of intersphincteric abscesses generally include a fistula track.

**ANSWERS**

1. **D.** According to Goodsall’s rule, the transverse anal line generally dictates the course of a fistula track. External orifices of a fistula track posterior to the transverse anal line course in a curvilinear fashion to the posterior midline. External orifices anterior to the transverse anal line generally course in a radial fashion to the anterior midline. However, if a fistula is present greater than 2 to 3 cm from the anal verge, their course does not follow the traditional radial course to the anterior midline. They typically produce curvilinear tracks that may end at the posterior midline or just lateral to the posterior midline. This patient’s area of induration and erythema foci is approximately 4 to 5 cm from the anal verge and thus could be considered a long anterior fistula track; therefore, D is correct.

2. **C.** Horseshoe abscesses encompass almost the entire circumference of the rectum and can occur in the suprapelvis, ischiorectal plane, and the intersphincteric plane. Each area of concern dictates the clinical management. Intravenous antibiotics are not adequate treatment for suppurative perirectal disease and may predispose the patient to worsening perirectal sepsis.

Presacral drainage is not the recommended treatment for horseshoe abscesses and is reserved for rectal injuries in the settings of trauma. Single incision and drainage may be effective in certain abscesses but is generally not recommended in horseshoe abscesses. Drainage may be inadequate or ineffective and counter incisions are preferred which also includes unroofing of the external sphincter complex. The same modality is also preferred in the setting of a horseshoe fistula.

Transabdominal drainage may be warranted in certain clinical scenarios involving suprapelvis abscesses when the origin of the abscess is intra-abdominal in nature. Transabdominal drainage for a cryptoglandular abscess runs the risk of inadequate drainage and transsphincteric fistula formation, along with the risk of systemic sepsis due to inadequate drainage.

3. **A.** Fistula-in-ano represent a common chronic problem after perirectal abscess. Fibrin glue and conventional fistulotomy have similar outcomes for rates of recurrence and closure of fistula tracks, but fibrin glue insertion may have shorter return to work times.

Fistulas occur in up to 25% to 50% of patients who have perirectal abscess. Setons are placed to promote drainage of fistulas and to facilitate fibrosis of the fistula track. Cutting setons are gradually tightened by the surgeon in the outpatient setting, which eliminates the fistula while gradually dividing the sphincter complexes, putting the patient at risk for incontinence.

Non-cutting setons have a significantly reduced risk of incontinence when compared to cutting setons, with some studies suggestive of preservation of continent function, and generally are accepted for treatment of high intersphincteric fistula tracks.

4. **D.** As stated earlier, horseshoe abscesses can occur in the suprapelvis, ischiorectal plane, and the intersphincteric plane. Imaging is not necessary for the diagnosis but does provide a helpful adjunct to clinical correlation.

Immunocompromised patients should generally not be managed in the outpatient setting after incision and drainage of a perirectal abscess. They may or may not manifest systemic or local signs of inflammation and can present with delayed diagnoses of sepsis or necrotizing soft tissue infection. These patients are generally managed with inpatient admission, incision and drainage, and intravenous antibiotic therapy. If the abscess is a superficial perianal one, then incision, drainage, and packing may be performed with close follow-up.

Crohn’s disease manifests in several different ways and can certainly be the inciting factor for perirectal abscesses and complex fistula disease. However, the most common cause of perirectal suppurative is cryptoglandular formation of infection. Other causes include malignancy, trauma, and hidradenitis suppurativa.

Necrotizing soft tissue infection of the perirectal and perineal region is a life threatening process, as is the disease in any soft tissue location. Intersphincteric abscesses can often go unnoticed or misdiagnosed and can result in a delayed diagnosis. In areas without access to healthcare, perirectal disease can progress rapidly as well. Infection can worsen and spread through soft tissue planes, progressing to a
necrotizing soft tissue infection, requiring wide local debridement. In some cases, the debridement is large enough that a diverting colostomy is required for wound healing. Mortality rates with necrotizing soft tissue infection are approximately 40% to 50%.

5. A. Supralevator abscess can occur as a result of intra-abdominal pathology such as diverticular abscesses, malignancy, or trauma. Perianal abscesses usually are superficial, simple abscesses without fistula tracks and are treated with a single cruciate incision with packing, therefore B is incorrect.

Fistulas encountered at the time of a perirectal abscess are common. However, fistulotomy is generally not performed in the acute setting as no improved clinical outcome has been documented with acute management. Intersphincteric abscesses generally have a more insidious clinical course and plague the patient with complaints of vague discomfort without external manifestations. Induration and tenderness can be elicited on a digital rectal examination but other findings are often inconsistent. T is type of abscess requires an exam under anesthesia for adequate treatment modalities.

BIBLIOGRAPHY


Breast Disease

Richard Smith
A 57-year-old, otherwise healthy female presents to your clinic to discuss the results of her recent screening mammogram. She has previously had unremarkable screening mammograms since the age of 40. She has two aunts with breast cancer, and recently heard that her 35-year-old niece was diagnosed with invasive ductal adenocarcinoma. She reports no palpable masses noticed on breast self-exams, no nipple drainage, no breast skin changes, and no other concerning constitutional symptoms.

1. The patient requests counseling on various genetic syndromes, given the young age of her recently diagnosed niece. Which of the following is correctly matched?
   A. BRCA1—chromosome 13q—increased female and male breast cancer risk.
   B. BRCA1—chromosome 17q—increased female breast and ovarian cancer risk.
   C. BRCA2—chromosome 17q—increased female and male breast cancer risk.
   D. Li-Fraumeni syndrome—PTEN mutation—increased breast, nervous system, and GI tract cancers.
   E. Peutz-Jehgers syndrome—KRAF mutation—increased breast and colon cancer, mucocutaneous lesions.

2. The patient’s screening mammogram reveals a 1.1 cm density in the subareolar region of her left breast. She promptly undergoes diagnostic mammogram with ultrasound for further evaluation of the lesion, which the radiologist classifies as BIRADS 4B. She has no palpable lesion on physical exam. The most appropriate next step is:
   A. Repeat mammography in 6 months.
   B. Magnetic resonance imaging (MRI) of the breast.
   C. Genetic screening for inherited mutations.
   D. Stereotactic core needle biopsy.

3. Pathology reveals lobular carcinoma in situ (LCIS). The patient now seeks advice on her overall risk of cancer. Which of the following is true?
   A. LCIS has a 40% lifetime risk of development into lobular carcinoma.
   B. LCIS is not considered a precursor itself, but has an increased risk of malignancy in either breast.
   C. Ductal carcinoma in situ (DCIS) is not considered a precursor to malignancy.
   D. LCIS and DCIS are both precursors to malignancy.
   E. LCIS is the most common type of in-situ breast lesion.

4. The patient opts to proceed with prophylactic bilateral mastectomies. In discussion of operative details, she mentions that her niece, who had Stage I invasive ductal carcinoma with positive estrogen receptor status, underwent a lumpectomy with radiation. Which of the following is true?
   A. All patients benefit from chemotherapy, regardless of nodal status.
   B. Adjuvant therapy with tamoxifen results in significant prolongation of disease-free and overall
survival in patients with HER2/neu gene overexpression.
C. The purpose of radiation is to decrease the risk of distant metastasis.
D. Patients with early stage breast cancer who undergo lumpectomy with sentinel lymph node biopsy followed by radiation have similar survival rates as those who undergo formal axillary lymph node dissection.
E. Aromatase inhibitors may be helpful for adjuvant therapy in pre-menopausal women.

5. At her follow-up visit after her operation, the patient reports feeling a sensation of numbness in her upper inner arm. She has full motor strength of the extremity, and the remainder of her arm has normal sensation. Her incisions appear to be healing well. What is the most likely etiology of this?
A. Injury to cutaneous branches of the brachial plexus.
B. Injury to the thoracodorsal nerve.
C. Injury to the intercostobrachial nerve.
D. Disruption of the lymphatic network.
E. Occult post-operative seroma in the axilla.

ANSWERS

1. B. The BRCA1 gene is located on chromosome 17q, and confers an increased risk of female breast and ovarian cancer.

Breast cancer is the most common cancer in women, and is second to lung cancer as a cause of death in women, with a lifetime risk of 1 in 8. Risk factors for developing breast malignancy include a family history of breast cancer, early menarche, late menopause, personal history of breast or uterine cancer, and nulliparity. The Gail Model is a tool designed to calculate breast cancer risk by assessing risk factors including personal medical history, reproductive history, and history of breast cancer among first-degree relatives, and translating these into a score to estimate risk of developing invasive breast cancer over set periods of time.

Approximately 10% of breast cancers are hereditary in nature. Genes and syndromes implicated in hereditary BCA include, among others, the BRCA1 (chromosome 17q, increased female breast and ovarian cancer risk) and BRCA2 mutations (chromosome 13q, increased ovarian cancer, and female and male breast cancer risk). Li-Fraumeni syndrome (p53 mutation, increased breast cancer, sarcoma, leukemia, brain tumors), Cowden's syndrome (PTEN mutation, increased breast, nervous system, and GI tract cancers), and hereditary non-polyposis colon cancer (HNPCC, mismatch repair defect, increased colon, endometrial, ovarian, and breast cancers).

2. D. For BIRADS 4 or 5 lesions detected on screening studies, stereotactic core biopsy is considered the preferred first step in pathologic diagnosis.

Clinical features concerning for breast cancer include fixed/firm palpable masses, nipple retraction, skin changes, and unilateral nipple discharge. Annual mammography is valuable as a screening tool in women ≤40 years in age, although is limited in women younger than 35 due to increased breast density. Concerning mammographic findings include an architectural distortion, developing asymmetry, mass (with partially or ill-defined margins), or a cluster of microcalcifications with amorphous, linear, branching patterns. Screening mammography in women 50 years and older has decreased breast cancer mortality by 33%. Ultrasound may be used to distinguish solid and cystic masses. Magnetic resonance imaging (MRI) is available as an adjunctive tool, but cannot replace mammography or ultrasound. Fine needle aspiration (FNA) yields simple cytological results but cannot distinguish carcinoma from invasive cancer because it does not include information about architecture. Core biopsy is considered the preferred first step in pathologic diagnosis, particularly for palpable lesions and for lesions detected on screening studies. In general, a two-step approach of initial biopsy followed by definitive operation, if indicated, is the preferred pathway of management.

3. B. LCIS is not considered a pre-cancerous lesion, but is associated with an increased risk of malignancy in either breast. Tamoxifen can decrease this risk, and depending on tumor biology and individual patient risk, management that may be advised includes close observation with serial monitoring, chemoprevention, or surgery.

DCIS is considered a precursor to ductal adenocarcinoma, the most common histologic type of breast cancer, and is associated with a significant increase in risk of ipsilateral cancer. 10% to 20% of patients with newly-discovered DCIS already have associated invasive carcinoma, and when untreated,
40% to 60% of these patients will develop ipsilateral invasive ductal carcinoma. LCIS is not considered a precursor to invasive adenocarcinoma, but is associated with a 20% to 30% risk of ductal adenocarcinoma in either breast. Lobular carcinoma comprises a smaller 10% of all invasive breast cancers. Inflammatory breast cancer is yet rarer and with the worst prognosis of all breast cancer types, comprising 5% of cases, with a characteristic rapid onset of pain, visible breast edema, and skin changes (“peau d’orange”), and a median survival of 36 months. Skin biopsy alone often reveals unique tumor invasion of lymphatic channels.

4. D. Multiple large randomized studies with long-term follow-up including the National Surgical Adjuvant Breast and Bowel Project (NSABP) trials and Milan series showed that disease-free and overall survival rates are similar in Stage I and II patients treated with lumpectomy with axillary dissection followed by radiation, and those treated by modified radical mastectomy. This is led to breast-conserving surgery with radiation to be a safe and less morbid course of treatment for patients with amenable, early-stage breast cancer. This is has been the historical approach to early breast cancer. The Z11 trial showed that patients treated with breast conservation therapy (lumpectomy + SLN biopsy + radiation therapy) and who had a positive sentinel lymph node had the same survival as those who underwent completion axillary lymph node dissection for the positive node. This is further decreased the morbidity of breast cancer surgery. This is makes D the correct answer.

Upon discovering a new diagnosis of breast cancer, the stage must clearly be determined before initiating treatment. Surgery is indicated for Stage I to III disease, while Stage IV (metastatic) disease is generally managed with medical and/or radiation therapies. The purpose of surgery is to obtain local control by either lumpectomy or mastectomy, and to evaluate nodal burden. Lumpectomy may be done with or without pre-operative mammographic needle-localization. Types of mastectomy include simple (removal of all breast tissue), radical (removal of all breast tissue, pectoralis major, pectoralis minor, and an axillary node dissection), and modified radical (removal of all breast tissue, pectoralis fascia only, and an axillary node dissection). If nodes are clinically negative, the preferred method for staging axillary lymph nodes is sentinel node biopsy, which is performed with methylene blue or 99mTc sulfur colloid, a radiopharmaceutical that is taken up by lymphatic capillaries, transported to the sentinel node, and then phagocytosed by macrophages. A formal axillary dissection is generally indicated in the case of clinically positive nodes, or completion axillary dissection in the case of clinically negative nodes with failed sentinel mapping. The currently evolving realm of neoadjuvant chemotherapy, with potential for downstaging both the breast mass and nodal metastases, continues to change the landscape of breast cancer surgery.

Radiation is used to decrease the risk of local recurrence, particularly when used as adjuvant to breast-conserving surgery. Chemotherapy typically consists of anthracycline and taxane agents, and may be helpful for patients with positive nodal status and high risk of relapse, but may generally be excluded in patients with small tumors and negative lymph nodes. Hormonal therapy has been known to decrease risk of recurrence and mortality in patients with estrogen receptor-positive (ER+) tumors. Tamoxifen, a selective ER modulator, reduces recurrence and contralateral disease (side effects include increased risk of endometrial cancer, thromboembolism, and stroke). Adjuvant therapy with tamoxifen has been shown to lead to significant prolongation of disease-free and overall survival in ER+ disease, regardless of nodal status. Anastrozole is an aromatase inhibitor that may be used in patients with contraindications to tamoxifen, and only in post-menopausal women, as they do not produce sufficient estrogen opposition in pre-menopausal women. Trastuzumab is a monoclonal HER2 antibody that may be used as adjuvant therapy in both pre- and post-menopausal women who have overexpression of the HER2/neu gene.

Stage is the best indicator of prognosis. When limited to the breast only, there is a 99% cure rate, however, 5-year survival decreases to 66%–87% based on Surveillance, Epidemiology, and End Results (SEER) data with axillary spread. The purpose of treatment is to decrease the risk of local recurrence, particularly when used as adjuvant to breast-conserving surgery. Chemotherapy typically consists of anthracycline and taxane agents, and may be helpful for patients with positive nodal status and high risk of relapse, but may generally be excluded in patients with small tumors and negative lymph nodes. Hormonal therapy has been known to decrease risk of recurrence and mortality in patients with estrogen receptor-positive (ER+) tumors. Tamoxifen, a selective ER modulator, reduces recurrence and contralateral disease (side effects include increased risk of endometrial cancer, thromboembolism, and stroke). Adjuvant therapy with tamoxifen has been shown to lead to significant prolongation of disease-free and overall survival in ER+ disease, regardless of nodal status. Anastrozole is an aromatase inhibitor that may be used in patients with contraindications to tamoxifen, and only in post-menopausal women, as they do not produce sufficient estrogen opposition in pre-menopausal women. Trastuzumab is a monoclonal HER2 antibody that may be used as adjuvant therapy in both pre- and post-menopausal women who have overexpression of the HER2/neu gene.

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N0 implies negative lymph nodes, N1 means positive mobile ipsilateral axillary lymph nodes, N2 is fixed or matted ipsilateral axillary nodes, and N3 is ipsilateral infraclavicular, supraclavicular, or internal mammary nodes. There is also pathologic N-staging, based upon number of histologically positive lymph nodes.

M0 disease implies no metastatic disease, and M1 means metastatic disease is present. The most common locations for breast cancer metastasis are bone, lung, and brain.

5. C. Injury to the intercostobrachial nerve, the lateral cutaneous branch of the second intercostal nerve, results in numbness of the medial upper arm.

The anatomic borders of the breast are the second rib superiorly, sixth to seventh rib inferiorly, sternal border medially, and midaxillary line laterally. The parenchyma of the breast is comprised of glandular lobes in a radial pattern, each with a ductal system ending at the nipple, and a surrounding connective tissue framework made by the suspensory ligaments of Cooper. The most common distribution of cancer is the upper outer quadrant (45%), followed by subareolar (25%), upper inner (15%), lower outer (10%), and lower inner (5%).

The blood supply of the breast includes perforator branches from the internal mammary artery, branches from the posterior intercostal arteries, and axillary artery branches including the lateral thoracic and pectoral branches of the thoracoacromial artery. Venous drainage parallels the arterial supply. The axillary lymph nodes drain 75% to 85% of lymph from the breast, with the remainder draining to parasternal/ internal mammary lymph nodes. There are three levels of lymph nodes: level I (lateral to pectoralis minor), level II (deep to pectoralis minor), and level III (medial to pectoralis minor). Nerves present in the axillary fat pad, and to be mindful of during dissection, include the long thoracic nerve (innervating the serratus anterior, with injury resulting in a “winged scapula”), the thoracodorsal nerve (innervating the latissimus dorsi, with injury resulting in weak adduction and internal rotation), the intercostobrachial nerve (providing sensation to the upper inner arm, with injury resulting in parasthesias or numbness), and the medial and lateral anterior thoracic nerves (innervating the pectoralis muscles, with injury resulting in weakness).

BIBLIOGRAPHY


A 42-year-old woman presents with extensive new calcifications on screening mammography. She undergoes stereotactic core biopsy that reveals ductal carcinoma in situ (DCIS), intermediate grade, with comedonecrosis. Estrogen receptor status is positive (ER+). She has no significant past medical history and there is no family history of cancer.

1. Which of the following is a risk factor for this patient actually having occult invasion instead of DCIS?
   A. + ER receptor status
   B. Palpable mass on clinical exam
   C. DCIS that spans a diameter larger than 3 cm
   D. intermediate grade histology
   E. Contralateral disease

2. Which of the following statements is true?
   A. For patients undergoing breast conservation therapy (BCT) for DCIS, the optimal margin width is 10 mm.
   B. Adjuvant radiation does not decrease the risk of recurrence after lumpectomy for DCIS.
   C. Adjuvant radiation increases survival in patients undergoing BCT for DCIS.
   D. Risk of death after any treatment for DCIS is less than 2% after ten years, and is usually secondary to recurrence as invasive disease.
   E. Approximately 10% of ipsilateral breast recurrences after lumpectomy alone or in conjunction with radiation are invasive disease.

3. Regarding the role of sentinel lymph node biopsy (SLNB) in DCIS, which of the following statements is true?
   A. SLNB does not need to be performed if this patient undergoes a mastectomy for her DCIS.
   B. By definition, DCIS is noninvasive disease, therefore SLNB should never be performed.
   C. SLNB has an almost negligible risk of lymphedema.
   D. SLNB should be considered at the time of lumpectomy for DCIS located in the axillary tail of the breast.
   E. SLNB should only be considered if a patient has DCIS in the setting of a mass.

4. Regarding imaging in DCIS, which of the following is true?
   A. Approximately 50% of all mammography detected breast cancers are DCIS.
   B. MRI estimates of the size and extent of DCIS often correlate with pathologic evaluation.
   C. DCIS often extends beyond the area of calcification seen on mammography.
   D. Magnetic resonance imaging (MRI) is better than mammography for distinguishing DCIS from benign, atypical proliferative lesions or microinvasion.
   E. MRI is not helpful in identifying multicentric disease and synchronous disease in the contralateral breast.

5. With regard to adjuvant tamoxifen for DCIS, which of the following statements is true?
   A. Tamoxifen (TMX) improves both local recurrence and survival rates in DCIS.
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B. Tamoxifen has no significant effect on survival in invasive breast cancer.
C. Side effects of Tamoxifen include an increased risk of ovarian cancer.
D. Tamoxifen is equally effective in ER+ lesions as in ER- lesions.
E. In women undergoing breast conservation therapy for DCIS, Tamoxifen decreases invasive and non-invasive breast cancer events for both the ipsilateral and contralateral breast.

ANSWERS

1. B. Because of sampling error, after surgical excision of a lesion diagnosed on core biopsy, DCIS is upgraded to invasive cancer in approximately 10% to 20%. Risk factors for occult invasive disease include presence of a mass, extent of DCIS greater than 5 cm, comedonecrosis, or high-grade histology.

DCIS represents a heterogeneous spectrum of disease involving the abnormal proliferation of epithelial cells confined to the breast ducts. Unlike invasive cancer, DCIS is bounded by the basement membranes and does not invade beyond its ductal origin or into the neighboring tissues. Although studies of the natural progression of DCIS are lacking, the general consensus is that in situ disease represents an intermediary between normal breast tissue and invasive disease. However, its behavior is highly variable, ranging from indolent low-grade lesions that may never progress to invasion, to high-grade lesions that may harbor foci of invasive cancer. This non-obligate progression and variation in biologic behavior has raised dilemmas in clinical management with some patients being over treated for the disease.

2. D. The mortality for patients with DCIS after excision is low (less than 2% in 10 years based on population studies) but is generally secondary to recurrence as invasive disease. Almost half the recurrences after treatment for DCIS occur in the form of invasive disease. Therefore, the fundamental goals of management are to prevent recurrence and to minimize treatment-related morbidity. DCIS can be treated by either mastectomy or breast conservation therapy (BCT). Mastectomy should be considered in patients with extensive or multcentric disease, in patients in whom the breast volume to tumor volume ratio is low and lumpectomy with reasonable cosmesis cannot be achieved, or in patients in whom lumpectomy fails to achieve negative margins. Most patients, however, can and should be considered for BCT.

Optimal margins for lumpectomy remain controversial. Studies suggest a decrease in recurrence rates after lumpectomy alone with increased margin width up to 10 mm with no additional benefit to margins wider than 10 mm. However, this benefit is eradiated when radiation is added to lumpectomy and the general consensus is that margin width greater than or equal to 2 mm is adequate with some advocating absence of cancer at the inked margin as the definition of a negative margin.

Given the variable behavior of DCIS, there have been extensive efforts to identify a subgroup of patients with indolent disease for whom radiation can be safely eliminated after lumpectomy. Such efforts have thus far resulted in conflicting data. Therefore, radiotherapy remains standard of care for patient with DCIS who undergo BCT. The prospective National Surgical Adjuvant Breast and Bowel project (NSABP) B-06 trial demonstrated significant decreases in recurrence rate with adjuvant radiation in BCT for invasive disease. There were some women in this study who were initially thought to have invasive disease. However, upon review of their biopsy specimens, they were determined to have DCIS instead.

These women were found to have a significant reduction in recurrence rates, including recurrence as invasive disease. The NSABP B-17 study was subsequently designed to evaluate radiotherapy specifically in patients with DCIS. It is study found a significant reduction in recurrence rates with adjuvant radiation for noninvasive disease. In neither invasive nor in situ disease was there a demonstrated survival benefit to adjuvant radiotherapy. The European Organisation for Research and Treatment of Cancer (EORTC) 10753 trial was a large European study that corroborated similar findings.

3. D. Although by definition DCIS is non-invasive disease, given the significant chance of upgrading to invasive disease after surgical excision, sentinel lymph node biopsy to evaluate for possible nodal metastases has been advocated in certain scenarios. Although it is reasonable to consider SLNB in
patients who have risk factors for occult invasive disease to avoid a second operation should they be upgraded to invasive disease after excision, many patients would undergo unnecessary axillary sampling. SLNB is not entirely benign and there is about a 6% risk of lymphedema. Since SLNB can be performed subsequent to a lumpectomy, SLNB is not advocated at the time of initial excision for most patients. The general consensus, however, is to perform a SLNB if a patient is to undergo mastectomy for DCIS. In this situation, removal of the breast precludes subsequent SLNB should the final pathology reveal invasive disease. These patients would then require axillary lymph node dissection. For the same reason, patients whose DCIS is located in the axillary tail of the breast should be considered for SLNB at the time of initial excision as lymphatic drainage to the axilla may be disrupted during excision and may decrease the likelihood of successful localization of a SLN subsequently. Most patients, however, can and should undergo SLNB subsequent to a final pathological determination of invasive disease.

4. C. Most cases of DCIS are discovered upon screening mammography and DCIS now accounts for approximately 20% of all screening detected breast cancers. DCIS most often presents mammographically as microcalcifications, sometimes with branching corresponding to intraductal disease.

Mammography is limited in that DCIS often extends beyond the area of microcalcifications seen on imaging. Thus, up to (15% to 20%) of women undergoing lumpectomy for DCIS may be subjected to re-excision to obtain negative margins. In addition, up to 40% of DCIS lesions grow discontinuously which can make complete excision difficult. This is a postulated reason as to why adjuvant breast irradiation is effective in decreasing recurrence rates after excision.

Given the limitations of mammography, MRI has been studied as an alternate imaging modality. MRI tends to have high sensitivity but low specificity in breast cancer imaging. Given its high sensitivity, it may be helpful in identifying multicentric or synchronous disease in the contralateral breast. However, it appears to be no better than mammography for distinguishing DCIS from benign proliferative lesions and MRI estimates of lesion size and extent correlate only moderately well with pathological findings, both over and underestimating the size of the DCIS.

5. E. Given the role of estrogen in the pathogenesis of breast cancer, strategies targeting the estrogen pathway have been investigated as possible adjuncts to breast cancer therapy. Tamoxifen is a selective estrogen receptor modulator (SERM). While it is an estrogen receptor agonist at some sites such as the bone and endometrium, it has potent antagonist effects in breast tissue. Studies had demonstrated the benefit of tamoxifen as adjuvant therapy in invasive disease, including decreased local recurrence and breast cancer mortality rates. The NSABP B-24 study was designed to investigate tamoxifen in the setting of DCIS. In this study, patients undergoing lumpectomy and radiation for DCIS were subsequently randomized to receive tamoxifen or placebo. Tamoxifen was administered in the treatment group at 10 mg twice a day for 5 years. The median follow-up was 74 months and patients in the tamoxifen arm had 37% fewer breast cancer events overall and there was both an ipsilateral and contralateral breast benefit. There was no benefit in terms of overall survival. Adverse effects of tamoxifen include an increased incidence of thromboembolic events and endometrial cancer. A subsequent subset analysis demonstrated that the benefit of tamoxifen was limited to those with ER-positive disease.

DCIS represents a very heterogenous group of lesions that have a variable clinical course lending challenges to the management of this disease. Almost all patients with DCIS will be cured of the disease and adjuvant radiation and endocrine therapy have further improved recurrence rates. With further understanding of the biology of the subtypes of DCIS, we will be able to better tailor therapy to individual patients.
<table>
<thead>
<tr>
<th>DCIS</th>
<th>LCIS</th>
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<tbody>
<tr>
<td>Non-obligate precursor to invasive cancer.</td>
<td>Risk factor for invasive cancer, both lobular and ductal. Risk is elevated for both the ipsilateral and contralateral breast. Consider hormone modulators to decrease risk.</td>
</tr>
<tr>
<td>Often diagnosed with mammography as microcalcifications.</td>
<td>Often mammographically occult and found incidentally on biopsy for other reasons. Consider MRI.</td>
</tr>
<tr>
<td>Usually unilateral but multifocality is common.</td>
<td>Often bilateral and multifocal.</td>
</tr>
<tr>
<td>Surgical treatment is with lumpectomy or mastectomy.</td>
<td>Surgical excision is indicated if found on core needle biopsy secondary to risk of sampling error (DCIS or invasive cancer nearby is frequently found). If found on surgical excision, no further excision necessary since it is not treated as a precursor lesion.</td>
</tr>
<tr>
<td>Adjuvant radiotherapy is indicated if treated with lumpectomy.</td>
<td>No adjuvant radiotherapy.</td>
</tr>
</tbody>
</table>

### BIBLIOGRAPHY


A 42-year-old female presents to your office with an erythematous and edematous left breast that she reports as occurring acutely over the past 2 weeks. She is not breast-feeding. She denies any recent trauma or source of infection. She presented to her primary care physician last week who administered a trial of antibiotics for presumed cellulitis, without any improvement in symptoms. Upon your physical exam, you note an erythematous, edematous, left breast with clinical findings of peau d’orange and a mass underlying the area of clinical change. The left breast appears larger than the right breast. You are able to appreciate fullness in the left axilla. You order dedicated breast imaging. She has a diagnostic mammogram performed that shows skin thickening and trabecular distortion in the left breast, with increased tissue density in the retroareolar region.

An ultrasound of the left breast showed a 6 cm vague irregular mass in the retroareolar region, with two enlarged left axillary lymph nodes. A skin punch biopsy is performed in your office and it demonstrates cancer cells infiltrating the dermal lymphatics. A core needle biopsy of the mass reveals invasive ductal carcinoma. A fine needle aspiration of an enlarged left axillary lymph node shows metastases. Based on the clinical presentation, imaging findings, and histopathologic results, a diagnosis of inflammatory breast cancer (IBC) is made. A staging work-up is negative for any distant sites of disease. You discuss the treatment modalities of surgery, chemotherapy, and radiation therapy as part of her treatment plan.

1. What surgical procedure will this patient have?
   A. Mastectomy
   B. Mastectomy with sentinel lymph node biopsy
   C. Modified radical mastectomy
   D. Radical mastectomy

2. What impact has the addition of neoadjuvant chemotherapy had on the outcome of patients with inflammatory breast cancer?
   A. It decreases the risk of developing a contralateral breast cancer in the future.
   B. It decreases the risk of developing a concurrent ovarian cancer.
   C. It increases effectiveness of endocrine therapy.
   D. It improves survival.

3. What is the role of radiation therapy in this clinical scenario?
   A. Decreased incidence of local recurrence.
   B. It improves response to endocrine therapy.
   C. It improves response to chemotherapy.
   D. It prevents distant metastases.

4. What is the usual order of treatments delivered?
   A. Surgery, radiation therapy, chemotherapy
   B. Radiation therapy, surgery, chemotherapy
   C. Chemotherapy, surgery, radiation therapy
   D. Radiation therapy, chemotherapy, surgery

5. What is the underlying pathophysiology in inflammatory breast cancer contributing to the skin changes that are noted on clinical exam?
   A. Infection (mastitis/abscess)
   B. Tumor emboli obstructing the dermal lymphatic vessels
   C. Localized dermatitis

Ranjna Sharma
D. Congestive heart failure causing skin edema  
E. Concurrent non-Hodgkin Lymphoma

ANSWERS

1. C. T is patient will have a modified radical mastectomy (MRM), which is comprised of a simple mastectomy and axillary lymph node dissection. T e borders of the mastectomy portion of the procedure are superiorly to the clavicle and deltopectoral groove, laterally to the latissimus muscle, inferiorly to the upper edge of rectus sheath, and medially to the sternal border. T e posterior border is the fascia overlying the pectoralis major muscle. T e mastectomy should resect any residual gross disease and obtain negative surgical margins. T e surgical plan must remove all skin changes. T e mastectomy skin flaps must be closed without tension. T e borders of an axillary lymph node dissection are the axillary vein superiorly, the serratus anterior muscle medially, and the latissimus dorsi muscle laterally. Within these anatomic boundaries, dissection will occur which will excise the Level 1 and Level 2 axillary lymph nodes.

Inferiorly, the dissection should be carried out to the 4th or 5th rib. T e Level 1 nodes are located lateral to the pectoralis minor muscle and the Level 2 nodes are located posterior to this muscle. A modified radical mastectomy for a patient with IBC with metastases to the axillary lymph nodes will remove the affected skin, generalized disease process in the breast, and involved lymph nodes. T is will contribute to improved local control of the disease process. A sentinel lymph node biopsy is not indicated since there is already known disease in the axillary nodes. Consequently, to control regional disease, a complete axillary lymph node dissection must be done.

2. D. T e introduction of neoadjuvant chemotherapy has significantly improved clinical outcomes in patients with IBC. It is used to downstage the tumor to allow surgical resection to be more successful by decreasing the likelihood of leaving residual disease behind. Anthracycline-based regimens show a survival benefit. A regimen containing cyclophosphamide, 5-fluorouracil, and either doxorubicin or epirubicin is generally used. Taxanes are also administered. T e combination of anthracycline and taxane regimens increases the rate of clinical response to chemotherapy and shows improvement in survival and prognosis. If Her2/neu is overexpressed, then trastuzumab is given for 1 year, which contributes to increased pathologic complete response (pCR). T e skin changes of erythema and edema in IBC will generally improve when a patient is responding to neoadjuvant chemotherapy. If a pCR can be achieved, survival is increased. T e improvement in survival is seen in both disease-free survival and overall survival.

3. A. Radiation therapy is administered after MRM, thus it is post-mastectomy radiation therapy (PMRT). PMRT is given to improve local control of the disease process and decrease the risk of local recurrence seen in patients with IBC due to high local disease burden at the time of diagnosis. Administration of PMRT is known to decrease the risk of recurrence on the chest wall, mastectomy scar, and regional lymph node basins. It is delivered to the chest wall and regional lymph node basins in the axilla, infraclavicular, supraclavicular, and internal mammary regions in standard fractionation, with a boost to the chest wall scar. Any area with pretreatment skin involvement should receive radiation to decrease the risk of local recurrence.

4. C. IBC is treated with a multidisciplinary/multimodality approach, combining local and systemic treatments. Local treatment modalities are surgery and radiation therapy, whereas chemotherapy and endocrine therapy are utilized as systemic therapies. However, in regards to endocrine therapy, most IBC’s are ER/PR negative, so there would be no role for endocrine therapy in those patients. T is is combination and order of neoadjuvant chemotherapy, MRM, and PMRT will improve local disease control, thus decreasing risk of local recurrence. MRM is most effective if a patient has a good clinical response (decrease in skin erythema and edema) to neoadjuvant chemotherapy, and particularly so in patients who have a pathologic complete response (pCR) to neoadjuvant chemotherapy. T is multimodality treatment plan has improved survival, particularly disease-free survival.

5. B. In IBC, tumor emboli invade the dermal lymphatic vessels, causing an obstruction, which leads to the edema, induration, and peau d’orange appearance. T e emboli invade vessels in the papillary and reticular dermis.
BIBLIOGRAPHY


A 42-year-old otherwise healthy female recently underwent core-needle biopsy of a palpable 4 cm left breast mass in the upper outer quadrant that revealed invasive ductal carcinoma. On physical exam she had no further palpable lesions and no palpable lymph nodes. Metastatic work-up was negative. She would like to discuss mastectomy and reconstruction options prior to her surgery.

1. Regarding breast reconstruction options, which of the following is correct?
   A. Autologous tissue reconstruction is preferred whenever possible over implant reconstruction.
   B. If implant reconstruction is desired, tissue expanders will be placed at the time of mastectomy and final implants will be placed 4 to 6 weeks later.
   C. Reconstruction does not significantly interfere with the detection of recurrent disease.
   D. Smoking is an absolute contraindication for autologous tissue reconstruction.
   E. Autologous and implant reconstruction can significantly delay subsequent adjuvant therapy.

2. Which of the following is an advantage of autologous tissue reconstruction?
   A. Better symmetry with the contralateral breast
   B. Shorter operating time
   C. Shorter inpatient hospitalization
   D. Lower potential for the need of blood transfusion when compared with implant reconstruction
   E. No revisions needed

3. The patient inquires about a nipple-sparing mastectomy. Which of the following is a contraindication to this procedure?
   A. 3 cm tumor
   B. Paget's disease
   C. A large tumor-to-areola distance
   D. Positive axillary lymph nodes
   E. Multifocal disease

4. The patient undergoes skin-sparing mastectomy and sentinel lymph node biopsy with tissue expander placement at the time of surgery. Which of the following pathologic criteria would preclude her from completing implant reconstruction?
   A. A negative sentinel lymph node biopsy
   B. ≥ 3 cm primary tumor
   C. 10 mm margins
   D. Stage IIA
   E. Stage IB

5. Intraoperatively, the patient's sentinel lymph node biopsy is positive for invasive ductal carcinoma, she undergoes axillary dissection and her final pathology returns pT2 pN1 MO, Stage IIB invasive ductal carcinoma. She undergoes adjuvant chemotherapy and radiation therapy to the chest wall, infraclavicular, supraclavicular, and inframammary areas. She may not be an appropriate candidate for which of the following autologous tissue reconstructions?
Deep Inferior Epigastric Perforator flap

Before

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Free TRAM Flap Surgery

Before

© Alila Medical Media - www.AlilaMedicalMedia.com

Latissimus Dorsi Flap

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**ANSWERS**

1. C. Autologous or synthetic breast reconstruction has not been shown to decrease the ability to detect local or locoregional breast cancer recurrence. Multiple studies have shown that reconstruction after mastectomy with a variety of methods does not adversely affect the incidence or time to detection of recurrent breast cancer. There is debate about whether breast reconstruction delays time to adjuvant therapy, primarily surrounding autologous reconstruction due to increase in post-operative wound complications, however, this does not appear to be significant enough to affect cancer-specific survival.

   Additionally, immediate breast reconstruction of any variety is associated with decreased breast cancer-specific mortality, particularly among younger women. Patient preference, and lifestyle, the availability of autologous tissue, and plans for adjuvant cancer therapies are variables that can influence the timing and choice of operative technique. While heavy smoking is not an absolute contraindication for autologous tissue reconstruction, it does influence/limit the type of autologous tissue options that are available.

A. Pedicled transverse rectus abdominis myocutaneous (TRAM) flap
B. Free transverse rectus abdominis myocutaneous (TRAM) flap
C. Latissimus dorsi flap
D. Deep inferior epigastric perforator (DIEP) flap
E. Superficial inferior epigastric artery (SIEA) flap
2. A. Autologous tissue reconstruction involves the transfer of vascularized muscle, skin, and subcutaneous tissue to the mastectomy defect. Tissue can be transferred on a vascular pedicle or as a free flap requiring a microsurgical anastomosis. This method typically allows for a more natural appearing breast contour, with a softer texture than implant reconstruction and oftentimes eliminates the need for contralateral symmetry procedures. Autologous reconstruction is also associated with fewer revision surgeries. Disadvantages include longer operative times, prolonged inpatient recovery time, higher need for blood transfusion, morbidity associated with the donor site and in the case of free flaps*, the increased potential for total flap loss. (*Note: total flap loss may occur with any autologous reconstruction—pedicled or free.)

3. B. The literature suggests that the nipple-sparing mastectomy is oncologically safe with a clearly defined set of pathologic parameters. Contraindications to nipple-sparing mastectomy include tumors 4.5 cm or greater, tumors located less than 2.5 cm from the areolar edge or less than 4 cm from the nipple center, gross involvement of the nipple-areola complex including bloody nipple discharge or Paget disease. Tumors that are multicentric, multifocal, or contain extensive ductal carcinoma in situ (DCIS) remain eligible for nipple-sparing mastectomy. Additionally, women who have undergone neoadjuvant therapy and subsequently meet the criteria for tumor size and location can also be considered, but inflammatory breast cancer is absolutely excluded. The presence of clinically positive axillary lymph nodes is not a contraindication.

4. E. In general, women who have or will undergo radiation therapy are not ideal candidates for prosthetic reconstruction because of decreased local vascularity, the increased incidence of capsular contraction, and the increased risk of surgical site infection. The indications for radiation therapy in breast cancer according to the 2014 NCCN guidelines on invasive breast cancer include those patients undergoing breast conservation therapy, tumors > 5 cm, those with positive axillary lymph nodes, or positive (<1 mm) surgical margins. According to the AJCC TNM classification, a tumor > 5 cm is considered a T3 lesion while any lymph node involvement is at least N1. Stage IIA (T2 N0 M0) disease does not indicate the need for radiation therapy. Stage IB includes T0-1, N1 M0 lesions and therefore may require radiation therapy.

5. C. Because the patient underwent axillary dissection and locoregional radiation therapy to the chest wall and axilla, vessels in the area may have been damaged during treatment. The latissimus dorsi myocutaneous flap receives its primary blood supply from the thoracodorsal vessels, which may be compromised during an axillary dissection or locoregional radiation. The primary blood supply to the TRAM flap are the superior epigastric vessels, while the primary blood supply to the DIEP flap is from deep inferior epigastric perforators, and the superficial inferior epigastric artery provides the primary blood supply to the SIEA flap.

BIBLIOGRAPHY


A 35-year-old female presents with a 3 cm mass in the left adrenal gland that was incidentally found on a computed tomography (CT) scan done for diffuse abdominal pain. The patient reports intermittent increases in blood pressure but she does not take any anti-hypertensive medications. She has no other complaints. She has no significant past medical history and her only past surgery is a laparoscopic appendectomy 15 years ago. She does have a sister who had a total thyroidectomy for medullary carcinoma of the thyroid gland. She is referred to the general surgery clinic by her primary care physician for evaluation of this left adrenal gland.

1. Regarding the workup of this adrenal mass, which of the following is correct?
   A. Diagnosis of Cushing’s syndrome is suggested by suppression of plasma cortisol levels after an overnight low-dose dexamethasone test.
   B. Patients with primary cortisol producing adenomas have elevated cortisol levels and low plasma adrenocorticotropic hormone (ACTH).
   C. The risk of adrenal carcinoma is increased due to the size of this adrenal mass.
   D. Percutaneous biopsy of this mass is critical in making the diagnosis.

2. Due to the history of intermittent hypertension, the patient is evaluated for a pheochromocytoma. Which of the following is correct?
   A. Plasma-free metanephrine levels but not normetanephrine levels are sensitive markers for pheochromocytoma.
   B. Monoamine oxidase inhibitors (MAOIs) can falsely elevate plasma free metanephrine and normetanephrine levels.
   C. Pheochromocytoma on a CT scan is represented by venous phase enhancement exclusively.
   D. Pheochromocytomas represent the majority of incidentalomas found on CT scan.

3. In relation to perioperative considerations in patients with adrenal tumors, which of the following is true?
   A. In patients with pheochromocytoma, beta blockade should be initiated prior to alpha-adrenergic blockade.
   B. Tumor manipulation may stimulate sudden catecholamine release during the surgery.
   C. Patients with an aldosterone secreting adrenal tumor will most likely have hyperkalemia.
   D. Patients with cortisol producing tumor should not receive heparin due to their hypocoagulability.

4. Which of the following is correct regarding the natural history/treatment of the adrenal mass in this patient?
   A. Due to the size of the mass (3 cm), the patient should be taken for an adrenalectomy even if the mass is non-functional.
   B. Since the patient has a family history of medullary carcinoma of the thyroid, she should be taken for an adrenalectomy.
   C. Metastatic cancer presenting as a true adrenal incidentaloma is common.
D. The patient can be followed with serial CT scans since malignancy at 3 cm is uncommon.

5. Which of the following statements on operative treatment/technique is correct?
A. The right adrenal vein is identified as it enters directly into the vena cava.
B. Laparoscopic adrenalectomy should not be performed if the patient has adrenal carcinoma.
C. For benign disease, laparoscopic adrenalectomy is clearly superior over the open adrenalectomy.
D. Posterior retroperitoneal approach has a higher risk of injury to the liver and spleen compared to the transabdominal approach.

ANSWERS

1. B. The diagnosis of Cushing's syndrome can be accomplished by a dexamethasone suppression test. Patients with Cushing's syndrome fail to suppress plasma cortisol levels after an overnight low-dose dexamethasone suppression test. In addition, these patients have an elevated 24-hr urine free cortisol level. Once diagnosis of Cushing's syndrome is confirmed, further tests can be performed to identify the cause.

Patients with primary cortisol producing adenomas have elevated cortisol levels and a low ACTH level. In addition, these patients should have a CT scan or MRI finding of an adrenal mass. Approximately 20% of patients with Cushing's syndrome are due to a cortisol producing adenoma. The signs and symptoms of Cushing's syndrome include weight gain, hypertension, diabetes mellitus, and centripetal obesity. Other causes of Cushing's syndrome are aldosteronomas and adrenocortical carcinomas, although these are rare.

The patient's adrenal mass is 3 cm in size. Adrenal cortical carcinoma should be suspected with adrenal masses greater than 6 cm. The risk of a 3 cm adrenal mass being a carcinoma is very low.

Percutaneous biopsy of an adrenal mass is not commonly performed. One indication for a percutaneous biopsy is obtaining tissue diagnosis prior to initiating treatment on a patient who has adrenal metastasis on imaging. Biopsy should not be performed on patients suspected to have pheochromocytoma due to the possibility of precipitating a hypertensive crisis. As a rule, percutaneous biopsy has a minimal role in the diagnosis of an adrenal mass.

2. B. Pheochromocytoma evaluation is necessary in all patients with an adrenal mass, even if they have no signs or symptoms of tachycardia, severe hypertension, cardiac palpitations, arrhythmias, anxiety, and sweating. Plasma-free metanephrine and normetanephrine levels are sensitive markers for pheochromocytoma and are easier to obtain than a 24-hour urine collection. The plasma-free metanephrine and normetanephrine levels should be 3 to 4 times the normal in patients with pheochromocytoma.

Some medications can falsely elevate plasma-free metanephrine and normetanephrine levels. These include MAOIs, tricyclic antidepressants, decongestants, amphetamines, and phenoxybenzamine. If possible, these medications should be discontinued prior to testing for pheochromocytoma.

Pheochromocytomas are hypervascular and they have intense enhancement on the arterial phase of the CT scan. They also have a slow washout on delayed imaging. With non-contrast CT scan, the density of pheochromocytoma is similar to that seen in muscle. They also represent a small percentage of all incidentalomas found on CT scan, comprising 0% to 11%. Non-functioning adrenal adenomas are the most common incidentalomas found on CT scan examinations.

3. B. All patients with a diagnosis of pheochromocytoma should undergo alpha-adrenergic blockade. It is recommended to initiate approximately 1 to 2 weeks before surgery. Alpha blockade should help with blood pressure control and control of intraoperative arrhythmias. After initiation of alpha blockade, beta-blockers can be used in patients with persistent tachycardia or hypertension. Some side effects of alpha blockers are fatigue, loose stools, dizziness, and somnolence.

During the surgery for pheochromocytoma, careful dissection of the adrenal gland must be performed due to the fact that tumor manipulation may cause a sudden release of catecholamines. This may result in a sharp increase in blood pressure and bleeding from the small vessels. Immediate cessation of manipulation of the adrenal gland will help normalize the blood pressure. Good communication with the anesthesiologist throughout the procedure is necessary.

Patients with an aldosterone secreting adrenal tumor have hypokalemia. The aldosterone causes the distal renal tubules to increase sodium and water resorption and thereby increasing the potassium loss, resulting in hypokalemia. Hypokalemia is associated with increased risk of arrhythmias. Therefore, oral
and intravenous supplementation should be given to correct the hypokalemia.

Patients with cortisol producing tumors are hypercoagulable due to the hyperhomocysteinemia, increased clotting factors, impaired fibrinolysis, and abnormalities in von-Willebrand factor. Therefore, these patients should be considered for pre-operative heparin injection to decrease the risk of venous thromboembolic events.

4. D. Adrenocortical carcinoma is not common and the frequency ranges from 1.2% to 12% of all incidentalomas found on CT scan. Carcinoma is rare for an adrenal mass size of less than 4 cm. Malignant transformation should be considered if a mass enlarges by 1 to 2 cm over 1 to 3 years. Since this patient has an adrenal mass of 3 cm, it can be followed by serial CT scans if the mass is non-functional.

With a family history of medullary carcinoma of the thyroid, multiple endocrine neoplasia (MEN) syndrome must be considered. However, if the patient has a non-functioning adrenal adenoma and workup for pheochromocytoma is negative, there is no need to perform an adrenalectomy in a 3 cm adrenal mass.

Metastatic cancer presenting as a true adrenal incidentaloma is extremely rare. In a study by Lee et al. only 0.2% of patients had unknown primary cancer presenting as an adrenal mass. All of these patients had tumor sizes greater than or equal to 6 cm.

5. A. The anatomy of the right adrenal gland is different than the left in that the adrenal vein enters directly into the inferior vena cava (IVC). Therefore, during the operative approach, a plane is developed between the lateral aspect of the IVC and the medial border of the adrenal gland. The vein is double clipped or stapled with an Endo-GIA. On the left side, the adrenal vein drains into the left renal vein.

There is no clear literature on the use of laparoscopic adrenalectomy for adrenal carcinoma. Reviews have been done that show the laparoscopic approach to be equal to an open approach; and in a NSQIP review of over 600 patients, the laparoscopic approach was associated with shorter operations, shorter hospital stays, less transfusions, fewer reoperations, and less 30 day mortality. However, the surgeon has to be aware of the possibility of invasion to other structures. In cases of large adrenal cancers or invasion, an open approach may be advisable. However, small lesions suspicious for carcinoma can be performed by the laparoscopic approach.

As the technique of laparoscopic adrenalectomy has grown in use, it is now considered a standard of care for small benign lesions. However, like laparoscopic cholecystectomy, there have not been randomized controlled trials comparing open to laparoscopic adrenalectomy.

There are two basic approaches to laparoscopic adrenalectomy: the transabdominal and the posterior retroperitoneal. The laparoscopic posterior retroperitoneal adrenalectomy has certain advantages over the standard transabdominal approach. It eliminates the need to retract the liver for the right side and the spleen for the left side. It also reduces the risk of injury to organs such as the liver and spleen. However, patient selection is important and it can be technically more demanding than the transabdominal approach.

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A 30-year-old female is referred to your general surgery practice for evaluation for hypercalcemia by her primary care physician. A chemistry panel performed for her insurance a month ago shows an elevation of her serum calcium levels. Her primary care physician reordered the chemistry panel two days ago, which shows a persistent calcium elevation but her urinalysis and CBC are also normal. He is concerned she may have primary hyperparathyroidism. The patient states she feels fine. Her past medical history is significant for a kidney stone a couple of years ago. Her physical exam is unremarkable.

1. You decide to check the patient’s parathyroid hormone level. If the patient has primary hyperparathyroidism, the parathyroid hormone level would be:
   A. Low
   B. Normal
   C. Elevated
   D. A and B
   E. B and C

2. The patient’s parathyroid hormone level (PTH) and following 24 hour urinary collection for calcium and creatinine excretion confirm your suspicion of primary hyperparathyroidism. You obtain a sestamibi scan for preoperative planning that shows a likely adenoma of the right lower parathyroid gland. Your management of this patient would be:
   A. Repeat observation and follow up.
   B. Bilateral neck exploration with identification of all four parathyroid glands and subtotal resection of 3½ glands.
   C. Bilateral neck exploration with identification of all four parathyroid glands and removal of the abnormal parathyroid adenoma.
   D. Bilateral neck exploration with identification of all four parathyroid glands with total resection of all four glands and reimplantation of ½ a normal gland in the sternocleidomastoid muscle.

3. During your parathyroidectomy for the above patient, you are unable to locate the right lower parathyroid gland despite finding the other three normal appearing glands. The next step would be:
   A. Close up and repeat sestamibi scan.
   B. Right thyroid lobectomy.
   C. Explore the retroesophageal space.
   D. Perform a partial median sternotomy.
   E. Selective venous sampling for parathyroid hormone.

4. After performing a total thyroidectomy in a 55-year-old female, the patient develops Chvostek’s sign and parasthesias on post-operative day one. She is started on calcium and vitamin D replacement therapy and discharged home with those medications as well as teriparatide shots (parathyroid hormone replacement therapy). After
one year postsurgery, the patient still requires calcium and vitamin D replacement as well as teriparatide shots. The likely structure injured during the thyroidectomy was the:

A. Superior thyroid arteries  
B. Middle thyroid veins  
C. Recurrent laryngeal nerves  
D. Inferior thyroid arteries  
E. Superior laryngeal nerves

ANSWERS

1. E. Hypercalcemia or high-normal serum calcium levels with normal or elevated parathyroid hormone levels confirm primary hyperparathyroidism. Elevated calcium levels should normally suppress PTH production. Other associated lab findings of primary hyperparathyroidism may include decreased serum phosphate levels, elevated serum chloride levels, and elevated BUN, Cr, and alkaline phosphatase.

   Primary hyperparathyroidism is usually found by routine lab testing, and most patients are asymptomatic. If symptoms are present, they usually consist of history of renal calculi, bone pain, pathologic fractures, bone shaft tumors, muscle weakness, and depression/lethargy and body aches/pains.

2. C. A single parathyroid adenoma causes primary hyperparathyroidism in 80% to 85% of cases. The rest of the cases are caused by parathyroid gland hyperplasia (10%), double adenomas (4%), and parathyroid carcinoma (1%). Observation and medical management is not cost effective in the management of primary hyperparathyroidism. The resection of the 3½ parathyroid glands would be most applicable to parathyroid gland hyperplasia.

   A more recent alternative to the traditional approach of bilateral neck exploration and four gland identification is the removal of the parathyroid adenoma using preoperative/intraoperative gamma-probe localization with or without the use of intraoperative PTH assay. This approach (minimally invasive radioguided parathyroidectomy or MIRP) relies on the adenoma being seen on the technetium-99m sestamibi (MIBI) scan which it does about 80% to 90% of the time. If the MIBI scan is positive, then the long-term success rate of the MIRP (98%) is equivalent to conventional four gland identification with the benefits of a significantly decreased hospital stay and avoidance of general anesthesia.

3. C. Surgical excision of the parathyroid adenoma is curative of primary hyperparathyroidism in 90% to 97%. A missed parathyroid adenoma accounts for the majority of surgical treatment failures. Methods described to acquire the missing parathyroid gland via the transcervical incision include examining the retroesophageal space, the carotid sheath, the submandibular region, and the thymus gland. The most common location for a missing parathyroid adenoma is the retroesophageal space. Additional adjuncts include intraoperative ultrasound. Partial
or complete thyroid lobectomy, bilateral internal jugular vein sampling of PTH to evaluate for which side of the neck the adenoma is on, and partial or complete median sternotomy are additional options to consider. If the parathyroid gland is still missing, a last approach is to ligate the inferior thyroid artery and its arterial branches on the side of the missing gland.

4. **D.** Most of the time, the inferior and superior parathyroid arteries are derived from branches off of the inferior thyroid artery. Another common variant is the superior parathyroid arteries arising from the anastomosing branches of the superior and inferior thyroid arteries.

**BIBLIOGRAPHY**


A 43-year-old female is referred to your office by her primary care physician for evaluation of a left thyroid lesion. The primary care physician thought the left side of the neck felt fuller than the other and ordered an ultrasound of the neck and lab work. A lesion was seen on the ultrasound and her primary care physician referred her to general surgery for evaluation. The patient states that she feels perfectly well with no loss in weight or hot flashes. She has no family history of cancer or neck irradiation. After performing a thorough physical exam, you feel a fullness in her left neck corresponding with her left thyroid gland but no obvious discrete mass. Her lab work shows a normal chemistry panel and normal thyroid panel. The ultrasound reveals a 0.4 cm circular, smooth, solid, intracapsular lesion.

1. What would be your next step in management for this lesion?
   A. Fine-needle aspiration (FNA)
   B. Repeat lab work
   C. Observation
   D. Subtotal thyroidectomy

2. What would your next step be if the lesion were 1.1 cm on imaging and palpable?
   A. FNA
   B. Repeat lab work
   C. Follow-up with repeat ultrasound in 6 months
   D. Subtotal thyroidectomy

3. What would be your treatment option if the 1.1 cm lesion showed suspicion for a papillary thyroid cancer on FNA and no lymphadenopathy on ultrasound?
   A. Follow-up with repeat ultrasound in 6 months
   B. Left thyroid lobectomy
   C. Left thyroidectomy with isthmusectomy
   D. Total thyroidectomy

4. What is the recommended initial surgical approach if the 1.1 cm lesion was non-diagnostic on initial and repeat FNA, and no lymphadenopathy is seen, and the patient desires a limited surgical procedure?
   A. Repeat FNA again
   B. Left thyroid lobectomy
   C. Near-total thyroidectomy
   D. Total thyroidectomy

5. A 23-year-old Pacific Islander female is referred to you for evaluation for a left neck mass. She rarely receives any medical care. She has noticed the neck mass for the past 6 months. The lump is increasing in size with time. She states that otherwise, she feels normal. On physical exam, she has a palpable lump on her left thyroid gland as well as left neck lymphadenopathy. She is very thin with long limbs and round, firm lumps in her lips. You suspect she has multiple endocrine neoplasia (MEN) 2B syndrome. What potential abnormalities would you suspect and work up?
   A. Papillary thyroid cancer
   B. Pituitary adenoma
   C. Pheochromocytoma
   D. Parathyroid hyperplasia
   E. Hirschsprung's
ANSWERS

1. C. Thyroid nodules are common with approximately 4% of the population having a palpable nodule and more than 50% having a nodule on ultrasound. Per Durante et al., the majority of patients with asymptomatic, sonographically or cytologically benign thyroid nodules will not undergo any significant size increase or display cancer at five years. No FNA or surgery is required for this nodule per the American Thyroid Association (ATA) 2015 guidelines and repeating lab work is not indicated for this patient. The ATA in their 2015 guidelines recommend considering repeat ultrasound at 6–12 months for nodules with highly suspicious ultrasound patterns (hypoechoic, taller than wide) and 12–24 months for nodules with low to intermediate suspicion on ultrasound pattern (iso or hyperechoic, hypoechoic with smooth margins and no microcalcifications).

2. A. The ATA and the AACE recommend biopsy if the nodules are > 1 cm. The ATA recommends biopsy of subcentimeter nodules larger than 5 mm that are suspicious appearing on ultrasound (hypoechoic with microcalcifications) and individuals with a high risk history (e.g., family history of papillary thyroid cancer, history of irradiation as a child or adolescent, prior hemithyroidectomy with discovery of thyroid cancer, and positron emission tomography (PET) positive thyroid nodules). The AACE recommends biopsy of nodules of any size for suspicious history (e.g., history of irradiation in childhood or adolescence, family history of thyroid cancer or MEN syndrome, previous thyroid surgery for cancer, increased calcitonin levels) or suspicious ultrasound findings (e.g., hypochogeticity, irregular borders, microcalcifications, taller than wide, chaotic intranodular vascular images).

3. D. For patients with FNA biopsies showing thyroid cancer, the initial surgical procedure should be near-total or total thyroidectomy for lesions greater than 1 cm. Thyroid lobectomy may be considered for < 1 cm, low risk, unifocal, intrathyroidal papillary carcinomas in patients with no history of prior head and neck irradiation and no evidence of cervical nodal metastases.

4. B. For indeterminate biopsies on FNA such as follicular neoplasms or Hurthle cell neoplasms on pathology, the malignancy risk is approximately 20%. T is risk increases with large tumors (> 4 cm) and pathology findings consistent with cellular pleomorphism or other atypia and suspicion for papillary carcinoma. Other risk factors include family history of thyroid carcinoma and previous radiation exposure. Per the 2015 ATA guidelines, for patients with an isolated indeterminate solitary nodule, thyroid lobectomy is the recommended initial surgical approach. Total thyroidectomy is recommended for indeterminate nodules which are large (> 4 cm), show marked atypia present on biopsy, in patients with a family history of thyroid cancer, in patients with a history of radiation exposure, or for those with FNA biopsy results suspicious for papillary carcinoma.

5. C. The MEN 2B syndrome is characterized by medullary thyroid cancer, pheochromocytomas, and mucosal neuromas as well as marfanoid appearance. MEN 2A syndrome is characterized by medullary thyroid cancer, pheochromocytomas, and parathyroid hyperplasia causing hyperparathyroidism as well as Hirschsprungs and cutaneous lichen amyloidosis. MEN 1 syndrome is characterized primarily by pituitary, pancreatic, and parathyroid tumors.

BIBLIOGRAPHY

1. The patient from the previous question denies any family history of multiple endocrine neoplasia (MEN). In regards to MEN syndromes, which of the following is correct?

A. The most common endocrinopathies in MEN-1 are pituitary adenomas, reaching 100% penetration by age 50.
B. The most common endocrinopathy in MEN-2 is pheochromocytoma.
C. MEN-2B includes medullary thyroid cancer and pheochromocytoma in all patients.
D. Prophylactic thyroidectomy is not recommended in patients with a confirmed RET germ-line mutation and a discernable thyroid mass by ultrasound if the serum calcitonin levels are normal.
E. During work up for a MEN, if a pheochromocytoma is detected it should be resected prior to surgery on the thyroid.

2. A 40-year-old male was found to have recurrent hypoglycemic symptoms with a plasma glucose level of 44 mg/dL and a C-peptide level of ≥200 pmol/L. He has relief of his symptoms with administration of glucose. Further workup includes a positive 72-hour fast. In regards to pancreatic neuroendocrine tumors, which of the following is true?

A. Pancreatic neuroendocrine tumors (PNETs) are common and 75% of cases are found in association with symptoms related to a specific hormone.
B. With PNET lesions located in the body or tail of the pancreas, a distal pancreatectomy can be performed and even if the lesion is thought to be malignant, splenic preservation may still be attempted.
C. Enucleation and formal resection of PNETs generally lead to equivalent outcomes for the management of small PNETs less than 2 cm.
D. Most nonfunctional PNETs are benign, even if they have local invasion and regional lymph node involvement.
E. Formal resection with appropriate lymphadenectomy is recommended for patients with insulinoma/gastrinoma smaller than 2 cm and other functional tumors such as VIPoma, somatostatinoma, and glucagonoma which demonstrate no evidence of metastatic disease.

3. You are evaluating a 50-year-old male with a history of recurrent duodenal ulcers located in the second portion of the duodenum. Further work-up demonstrates that he is H. pylori negative and an upper endoscopy shows markedly hypertrophic gastric folds. Which of the following is true regarding his likely underlying diagnosis?

A. A fasting serum gastrin level of more than 1,000 pg/mL (normal is < 100 pg/mL) is considered diagnostic for gastrinoma.
B. Following intravenous secretin injection, an idiosyncratic rise in serum gastrin of 10 pg/mL is diagnostic.
C. The majority of gastrinomas are generally found within the gastrinoma triangle, which is bound
by the junction of the cystic and common bile duct, the junction of the first and second portion of the duodenum and the junction of the neck and body of the pancreas.

D. Gastrinomas are commonly found in locations such as the gallbladder, renal capsule, splenic hilum, mesentery, omentum, ovary, lymph nodes, and heart.

E. Medical treatment of Zollinger-Ellison Syndrome with proton pump inhibitors is very effective, eliminating any malignant potential, thus preventing the progression of malignant disease.

4. A 59-year-old male patient presents with diabetes, anemia, and a 30 pound weight loss. Recently, he started to develop a rash described as raised erythematous plaques that developed central bullae that sloughed, leaving necrotic centers and serous crusts. Serum glucagon levels are 1100 pg/dL. A CT scan of the abdomen and pelvis demonstrated a 4 cm mass in the tail of the pancreas. Which of the following is true regarding his diagnosis?

A. Localization with CT and staging with somatostatin receptor scintigraphy are generally insufficient for obtaining a diagnosis, despite the large size and somatostatin-rich receptor status of these tumors.

B. Necrolytic migratory erythema occurs in approximately 5% of these patients.

C. Deep venous thrombosis and thromboembolism are quite common and patients should be fully anticoagulated at the time of diagnosis and inferior vena cava filters should be considered preoperatively.

D. Glucagonomas are most commonly located in the head of the pancreas and are usually sensitive to chemotherapy.

E. When performing a distal pancreatectomy and splenectomy for a distal pancreatic glucagonoma, a cholecystectomy should not be routinely performed.

ANSWERS

1. E. MEN-1 is manifested by hyperparathyroidism, pituitary adenomas, and pancreatic neuroendocrine tumors. MEN-2A is manifested by medullary thyroid cancer in nearly all patients but pheochromocytoma develops in only 40% to 50% of patients.

Hyperparathyroidism occurs in approximately 20% of patients. Medullary thyroid cancer (MTC) is typically the first presenting endocrine tumor manifesting between the age of 5 and 25 years. MEN-2B is relatively rare, accounting for less than 10% of the cases of familial medullary thyroid cancers. T is syndrome includes medullary thyroid cancer in all patients and pheochromocytoma in approximately 50%. Affected patients also exhibit a marfanoid body habitus, enlarged lips, and have mucosal neuromas of the eyelids, lips, and tongue.

MEN-2B is an aggressive form of MEN-2 in that MTC tends to present earlier than in MEN-2A or familial medullary thyroid carcinoma (FMTC), often during the first year of life. If a carrier state is identified in a pre-clinical setting, surgery should be done before the age of typical onset of cancer or metastasis. In a prophylactic setting, the procedure of choice is a total thyroidectomy. If the patient has an elevated calcitonin level, then a total thyroidectomy and central neck dissection should be done. Genetic testing dictates stratified management of the thyroid. T e American T yroid Association (ATA) has developed risk groups based on the specific mutation. Carriers with MEN-2B should have a thyroidectomy within the first six months. Patients with MEN-2 should have a thyroidectomy before the age of five and patients with the lowest level of risk should have a thyroidectomy between the ages of 5 and 10 years. Similarly, identification of the specific codon will dictate screening and management for pheochromocytomas and hyperparathyroidism.

2. C. PNETs are uncommon in the general population, accounting for only 3% to 5% of pancreatic malignancies, a majority of which are sporadic and functional. Several important factors must be considered when selecting the operative approach to, including the tumor's functional status, benign or malignant nature, involvement with contiguous structures, presence of metastatic disease, and whether the tumor is sporadic or associated with a genetic syndrome. Clinical symptoms and biochemical evidence of hormone excess determine the tumor's functional status. Preoperative evaluation by cross-sectional and functional (somatostatin) imaging combined with endoscopic ultrasound can help determine the tumor's benign or malignant nature by delineating the degree of local invasion, lymph node involvement, and metastases to the liver and elsewhere.

http://surgerybook.net/
Endoscopic fine needle aspiration biopsy can confirm the presence of neuroendocrine cells and may help determine the proliferative index (Ki67) which in turn can help grade the likelihood of malignancy.

An accurate history and genetic testing can determine whether the tumor is sporadic or associated with a genetic syndrome and must be considered during preoperative decision making and planning for resection. The goal of surgery for primary PNETs is to resect the primary tumor and associated lymph nodes while preserving the maximal amount of pancreatic mass. The indications for surgery in patients with PNETs include systemic symptoms due to hormone overproduction, local compressive symptoms due to mass effect, and prevention of malignant transformation or dissemination. Formal pancreatic resection with appropriate lymphadenectomy is recommended for patients with established known malignancy, including splenectomy when lesions are found within the tail of the pancreas. With insulinomas/gastrinomas larger than 2 cm and other functional tumors such as VIPoma, somatostatinoma, and glucagonoma who have no evidence of metastatic disease a formal resection is the preferred operative management strategy. For those lesions smaller than 2 cm, the survival of simple enucleation is similar to a formal resection.

3. A. Gastrinomas are associated with Zollinger-Ellison syndrome (atypical peptic ulcer disease, gastric hyperacidity and hyper-secretion). Proton-pump inhibitors have no effect on the natural history of the disease. Most patients are male (60%) and the average age at diagnosis is about 60 years. A fasting serum gastrin level of more than 1000 pg/mL (10 times the upper limit of normal) is diagnostic of gastrinomas. Gastrinomas can be distinguished from these other conditions by virtue of its paradoxical effect on serum gastrin levels in response to a secretin infusion (secretin stimulation test). After baseline gastrin measurement, secretin is administered and gastrin levels are rechecked. An increase in gastrin levels of greater than 120 pg/mL over basal levels has 94% sensitivity and 100% specificity for gastrinoma. The majority of gastrinomas are generally found within the gastrinoma triangle, which is bound by the junction of the cystic and common bile duct, the junction of the second and third portion of the duodenum and the junction of the neck and body of the pancreas. Localization of gastrinomas is best performed with endoscopic ultrasonography and somatostatin-receptor scintigraphy. Because of the malignant potential of gastrinomas, medical treatment alone does not prevent progression of malignant disease and with the development of excellent pharmacologic therapy for the control of gastric acid}

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<tr>
<th>Syndrome</th>
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<tr>
<td>MEN 1</td>
<td>Chromosome 11</td>
<td>MENIN</td>
<td>Parathyroid Hyperplasia (4-gland) Pancreatic Islet Cell Tumors (Gastrinoma) Pituitary Tumors (Prolactinoma)</td>
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<td>MEN 2A</td>
<td>Chromosome 10</td>
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<td>Parathyroid Hyperplasia (4-gland) Pheochromocytoma Medullary Thyroid Carcinoma</td>
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<td>MEN 2B</td>
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MEN – Multiple Endocrine Neoplasia, RET – REarranged during Transfection.
hypersecretion, surgery for gastrinomas has shifted toward tumor localization and resection.

4. C. Glucagonomas have been described as causing the 4 “Ds”: dermatitis, diabetes, depression, and deep vein thrombosis. Weight loss and a characteristic skin rash (necrolytic migratory erythema) are the most common presenting features, occurring in about 70% of patients, with other symptoms occurring less frequently at initial presentation. Necrolytic migratory erythema, which is an intensely pruritic rash that usually presents on the lower abdomen, perineum, perioral area, or lower extremities, may present before any other signs or symptoms and is pathognomonic for glucagonoma and is found in up to 70% of patients. Most glucagonoma patients have glucose intolerance and fasting serum glucagon levels between 1000 and 5000 pg/mL.

The initial management of a patient with a glucagonoma should focus on blocking and treating the metabolic effects of glucagon hypersecretion and preventing or treating venous thromboembolism. Octreotide and intravenous fluids should be administered. Additionally, due to their hypercoagulable state and predisposition to thromboembolic events, patients should be fully anticoagulated. Glucagonomas are most commonly located in the tail of the pancreas and surgical resection usually consists of a distal pancreatectomy along with a splenectomy. A cholecystectomy should be performed prophylactically at the time of the initial operation to eliminate the potential for gallstone related complications which are associated with octreotide therapy.

BIBLIOGRAPHY
A 55-year-old Caucasian male is referred to your clinic for a palpable 2 cm mass located 2 to 3 cm anterior to his right tragus. He states that it has been present for about 9 months and has slowly been getting larger. He denies any pain, facial weakness or numbness, fevers, weight loss, fatigue, and dry mouth. He has no medical or surgical history and does not take any medications. On physical exam you find a well-circumscribed, mobile, non-tender 2 cm mass, with no overlying skin changes. There is no lymphadenopathy and the rest of the exam is normal.

1. Regarding the above patient, which of the following is the most likely diagnosis?
   A. Mucoepidermoid carcinoma
   B. Adenoid cystic carcinoma
   C. Pleomorphic adenoma
   D. Papillary cystadenoma lymphomatosum
   E. Sjogren’s syndrome related glandular enlargement

2. Which of the following studies is the next best step in the diagnostic workup?
   A. Core needle biopsy
   B. Incisional biopsy
   C. Positron emission tomography (PET) scan
   D. Fine needle aspiration (FNA)
   E. Ultrasound

3. Tissue and imaging studies reveal a pleomorphic adenoma that appears to be confined to the superficial parotid gland. What is the next best step?
   A. Total parotidectomy
   B. Superficial parotidectomy, sparing the facial nerve
   C. Superficial parotidectomy, sacrificing any facial nerve that may be involved
   D. Enucleation of the mass, sparing nerve and normal glandular tissue
   E. Surveillance of the mass with serial computerized tomography (CT) scans

4. Tissue and diagnostic studies instead reveal a high grade mucoepidermoid carcinoma that is clearly deep to the facial nerve. What is the next best step?
   A. Total parotidectomy with resection of any adjacent facial nerve and immediate interposition nerve graft
   B. Total parotidectomy with sparing of the facial nerve, followed with post-operative radiation
   C. Radiation and chemotherapy with post-treatment surveillance
   D. Radiation alone with post-treatment surveillance
   E. Superficial parotidectomy, sparing the facial nerve, followed with post-operative radiation

5. A month after the operation the patient returns to your clinic complaining of flushing and sweating on the right side of his face when he eats. What is the cause of this?
   A. Cross innervation between para-sympathetic fibers from the superior salvatory nucleus with sympathetic fibers from the superior cervical ganglion to the skin
B. Cross innervation between fibers in the auriculotemporal nerve with sympathetic fibers to the skin
C. Cross innervation between fibers in branches of the facial nerve with sympathetic fibers to the skin and sweat glands
D. Cellulitis
E. Changes in the skin caused by congestion of dermal lymphatics

ANSWERS

1. C. Most salivary gland tumors arise in the parotid gland (70%) with fewer being found in the submandibular gland (20%). The larger the gland, the more likely the tumor will be benign. In the parotid gland 80% of tumors will be benign. Submandibular glands have a ratio of 50:50 and minor salivary glands have a ratio of 25:75 benign to malignant, respectively.

   Signs and symptoms including pain, rapid growth, nerve weakness, paresthesias, cervical lymphadenopathy, and fixation to underlying tissue are all concerning for malignancy. Skin changes, purulent drainage, fevers, chills, and tenderness to palpation are more indicative of an infectious cause or granulomatous disease. Dry mouth or mucus membranes, with bilateral swelling is associated with Sjogrens disease.

   It is important to realize that pleomorphic adenomas, a benign tumor, are the most common tumors in the parotid gland and account for 40% to 70%. The second most common tumor is papillary cystadenoma lymphomatosum, also known as a Warthin’s tumor. T is tumor is also benign with a higher propensity to be bilateral. Mucoepidermoid carcinoma is the most common malignant tumor of the parotid gland. Adenoid cystic carcinomas, which are malignant, are the most common tumors of the submandibular and minor salivary glands.

2. D. T is patient’s signs and symptoms suggest a benign tumor, however malignancy may be present. Therefore, tissue diagnosis is recommended prior to proceeding with surgical intervention. T e next best step for surgical planning and patient counseling would be to obtain tissue preoperatively with a fine needle aspiration. FNA has excellent sensitivity (92%), specificity (100%), and accuracy (98%). FNA with or without ultrasound guidance would be the initial study of choice.

   MRI and CT scans are being used more frequently to help assess for regional lymphadenopathy, extent/depth of tumor and tumor location in relationship to other important structures. Core needle biopsy in the face and neck is usually not recommended due to the proximity of sensitive structures. Ultrasound alone, without an FNA, will yield little additional value than what a CT, MRI, and FNA will provide and may be considered a waste of time and resources. PET is helpful in tumors that are PET avid, such as Warthin’s tumors, or when there is concern for distant disease. PET is not recommended as part of the routine workup.

   Incisional biopsy of the tumor for tissue diagnosis is not recommended due to high recurrence rates, concerns for seeding, and the potential to turn a single lesion into multiple lesions. T e thought is that an incisional biopsy will not entirely remove a single lesion and when the disease recurs it will recur in multiple locations due to the tumor left behind from the initial biopsy.

3. B. Pleomorphic adenomas rarely extend into the deep space and a superficial parotidectomy should be the first surgical intervention for most of these benign tumors. Pleomorphic adenomas do not invade into the nerve and all attempts should be made to identify and spare the facial nerve and its branches during the surgery. For a benign tumor, resecting the least amount of tissue will result in superior cosmetic outcomes and results in less potential for injury to the facial nerve. If the tumor is benign and has no obvious invasion into the deep lobe then all that is required is a superficial parotidectomy.

   Total parotidectomy is not necessary in the patient unless intraoperative findings show involvement of the deep lobe. Enucleation of the tumor is not recommended as there is a high risk for recurrence when this is performed. Surveillance of parotid gland tumors with serial examination and CT is recommended for certain Warthin’s tumors in patients that have contraindications to surgery, but is otherwise not recommended for either malignant or benign tumors of the salivary glands.

4. B. In this patient there is involvement of the deep lobe, which is an indication for total parotidectomy. Since the patient has no neurologic symptoms prior to the operation, if the nerve is not being visibly/directly invaded then you should attempt to dissect
the tumor off of the nerve followed by post-operative radiation. You should still plan for the potential need to do a nerve harvest and graft, should you find that there is nerve invasion during the operation. The sural nerve and greater auricular nerve are commonly used conduits. Some sources suggest that malignant tumor confined to the superficial lobe with no obvious peri-neural involvement can be treated with a superficial parotidectomy, dissection of the tumor off of the facial nerve, followed by post-operative radiation. Non-surgical management, preoperative chemotherapy and radiation only of malignant salivary tumors are not currently recommended methods of treatment.

Malignant salivary tumors are staged according to size and degree of local invasion. They are also classified according to histological grade which separates them into either high or low, based on the number of mucoid cells and epidermoid components. High grade tumors indicate a more aggressive tumor and thus exhibit a worse prognosis. High grade histology is typically an indication for an ipsilateral neck dissection. Indications for post-operative radiation include: high grade, extra-glandular involvement, peri-neural invasion, direct invasion of surrounding structures, dissection of tumor off the facial nerve and distant metastatic disease.

5. B. Frey's syndrome is a rare complication of parotid tumor surgery and is the result of necessary injury to the parotid gland. The auriculotemporal nerve has parasympathetic fibers that trigger secretion of saliva from the parotid gland. When these fibers are injured during parotidectomy and undergo healing, they can sometimes cross innervate with sympathetic nerve fibers that travel to the skin and sweat glands. The result is "gustatory sweating" or triggering of the sweat glands from signals in the auriculotemporal nerve, meant to trigger salivation in a gland that no longer exists or has had part of it removed.

Option A describes a phenomenon that is found when submandibular glands or minor salivary glands are injured and is similar to Frey's syndrome in the sense that it is caused by aberrant nerve regeneration. However, it involves different nerves and would not present as a result of parotid surgery.

Cellulitis is usually accompanied by pain and continuous redness, not sweating, and is usually sooner after the operation. Congestion of dermal lymphatics would create a peau d'orange appearance of the skin and is usually associated more with inflammatory breast cancer not salivary gland tumors.

**BIBLIOGRAPHY**


Pediatric Surgery
Mary J. Edwards
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A 4-year-old girl is brought in to see her primary care provider (PCP) by her parents. They have noticed a small mass on the anterior portion of her neck, but recently started noticing that it was spontaneously draining and has become erythematous. Her PCP has the girl stick out her tongue and notices that the mass moves with tongue protrusion. The physician correctly identifies that this is likely an infected thyroglossal duct cyst. She appropriately places the child on antibiotics, covering for oral flora, and then refers the child to surgery for operative intervention, delayed until the infection clears.

1. What is the most appropriate treatment for a thyroglossal duct cyst?
   A. Surgical resection of the cyst, taking care to only remove the cyst and not disturb any of the critical surrounding neck structures
   B. Resection of the thyroglossal duct and the complete hyoid bone
   C. Removal of the cyst en bloc, excising a core of tissue around the tract to the base of the tongue, and including the central 1/3rd of the hyoid bone
   D. Total thyroidectomy

2. Regarding branchial cleft cysts, which of the following statements is correct?
   A. The first branchial cleft extends to the auditory canal, placing both the facial nerve and the parotid at risk for injury.
   B. Type I cysts are the most common, accounting for 80% to 90% of all lesions.
   C. When a child presents with an infected branchial cleft cyst, unlike a thyroglossal duct cyst, it is imperative to perform resection immediately to control the infection and prevent further complications.
   D. If a cyst is located on the anterior border of the sternocleidomastoid muscle it is a type II branchial cleft cyst.

3. Which of the following statements is true regarding the presentation, diagnosis, and management of a lymphatic malformation?
   A. Lymphatic malformations never present with airway compromise given their position in the posterior neck.
   B. Ninety percent of lymphatic malformations are apparent at birth, with most diagnosed during prenatal ultrasound.
   C. Fine needle aspiration (FNA) is necessary to confirm the diagnosis of a lymphatic malformation prior to resection.
   D. Given that lymphatic malformations are benign, radical resection should never be performed, due to the lesion's close association or proximity to vital structures.
   E. All of the above are true.

4. What is the most common childhood malignancy presenting as a head or neck mass in children over the age of 5?
   A. Thyroid carcinoma
   B. Lymphoma
C. Rhabdomyosarcoma
D. Neuroblastoma
E. Melanoma

5. Which of the following is true regarding treatment for torticollis?
   A. Division of the sternocleidomastoid muscle is only indicated if the infant has plagiocephaly or hemihypoplasia.
   B. Botulinum toxin injection should be the first treatment, ideally preventing the infant from needing to undergo physical therapy.
   C. Physical therapy, with passive range of motion and neck-stretching, is the primary treatment modality.
   D. Ocular imbalance causing torticollis will be fixed by corrective lenses.

**ANSWERS**

1. C. Thyroglossal duct cysts are found in the midline of the neck. These are the second most common congenital pediatric neck masses, though the most common midline anomaly. Though classically described as midline, up to 40% may actually lie just lateral to the midline. These cysts, based on their embryological descent, are found to have a tract extending from the hyoid bone up to the base of the tongue. The normal thyroglossal duct involutes by the eighth fetal week, with remnants leading to cyst formation or ectopic thyroid tissue anywhere along the tract. Approximately 60% of these cysts lie adjacent to the hyoid bone, 24% lie above, and 13% lie below the hyoid bone. Cysts may also present intralingually, with 2% occurring at the base of the tongue, which may place a neonate at risk for airway obstruction. Surgery involves removal of the middle 1/3 of the hyoid bone, called the Sistrunk procedure, with removal of the hyoid necessary to prevent recurrence.

This procedure was first described in 1920, and he described the importance of an en bloc dissection, excising a core of tissue around the tract, necessary given the possible existence of multiple tracts. Recurrence rates are less than 10% and usually related to incomplete excision or intraoperative rupture. There is a possible association between preoperative infection and risk of recurrence, though not confirmed in recent analyses. These congenital lesions have the potential for malignant transformation, with papillary adenocarcinoma found in up to 10% of adults presenting with a thyroglossal duct cyst. Papillary carcinoma can arise in adulthood from the dysgenetic ectopic thyroid tissue and is reason to perform complete excision of the lesion in a child with a thyroglossal duct cyst or sinus. Though these cysts, similarly to branchial cleft cysts, often present with an acute infection during childhood, up to 40% present after the age of 20. Dermoid cysts are often usually found midline on the neck, potentially being confused with a thyroglossal duct cyst. However, they are not associated with the thyroid and will not move when the patient swallows or with protrusion of the tongue, as opposed to a thyroglossal duct cyst. It is recommended that the presence of normal thyroid tissue outside of the thyroglossal duct cyst is confirmed prior to excision. Ectopic thyroid tissue is identified in surgical specimens in approximately 25% to 35% of cases, though it is actually rare that this is the child's only thyroid tissue. However, if thyroid tissue is noted in the resected specimen thyroid scanning is still indicated to identify the child that may require lifelong thyroid hormone replacement.

2. A. The differential diagnosis of a lateral neck mass is extensive and includes branchial cleft remnants, lymphatic malformation, dermoid cyst, hemangioma, lymphadenitis, torticollis, neurofibroma, lipoma, or metastatic malignancy to the cervical lymph nodes. Branchial cleft cysts are the most common congenital neck lesion, accounting for approximately 20% to 30% of all pediatric neck masses. Sinuses, fistulas, and remnants are usually noticed at birth or early in life, opposed to branchial cleft cysts which are more likely to present later in childhood. They are six paired branchial arches, containing ectodermal, mesodermal, and endodermal components.

Understanding the relationships of these arch components is helpful to conceptualize and categorize congenital neck masses. The dorsal portion of the first cleft becomes the external auditory canal. Given this tract's location, it places the facial nerve at risk for injury during resection. Type II is the most common abnormality, with 90% to 95% of cases. They are found along the anterior border of the sternocleidomastoid muscle (SCM) and may be bilateral in 10% of cases. Anomalies of the third cleft are extremely rare, but are also located along the anterior border of the SCM. However, they are usually lower in the neck and pass lateral to the carotid bifurcation rather than through it. Sinus tracts of the
second branchial anomalies pass between the external and internal carotid arteries, entering the lateral wall of the pharynx at the tonsillar fossa. Congenital lesions may present while acutely infected, and prior to operative intervention their close relationships to major nerves and vessels needs to be understood. Injury to the parotid gland and facial nerve may occur from recurrent infection of a Type I branchial cleft cyst, or from a complication of an incision and draining. Infection of the third and fourth branchial cleft cysts are rare and more challenging to diagnose and treat. Suppurative thyroiditis may be due to an infected third or fourth arch sinus. Type III and IV cysts may cause airway edema and difficulty swallowing, which can often be controlled by controlling the acute infection.

It is important that the cysts and their fistula tracts be excised after the acute infection has been cleared in order to prevent recurrence. The initial treatment is antibiotics and not surgery. Surgery is usually 6 weeks later, and the entire tract, to include the skin punctum if present, needs to be removed as recurrent infections are common with incomplete removal. In an infant, surgery may be delayed until age 3 to 6 months. **Figure 63-1** demonstrates the relationships between the first, second, and third branchial cysts and fistulas.

3. **D.** Lymphatic malformations, previously referred to as cystic hygromas or lymphangiomas, are most commonly located in the head and neck, specifically in the posterior triangle of the neck. However, they can occur in other locations, and when they involve the tongue or the mediastinum they may result in airway compromise, or in dysphagia and failure to thrive. These are vascular malformations, occurring in 1 out of every 2000 to 4000 births. They occur due to sequestrations of lymphatic tissue that don’t communicate with the normal lymphatic system. Ninety percent of these lesions appear before the age of two, with 50% to 65% appearing at birth. These lesions are more commonly located on the left side of the neck and if large enough may be noted on prenatal ultrasound.

However, lymphatic malformations can be found anywhere in the soft tissues of the face or oral cavity, with other locations including the axilla, chest, extremities, retroperitoneum, or perineum. The majority of these lesions are asymptomatic, though large lesions can invade the floor of the mouth and cause upper airway obstruction. Fine needle aspiration (FNA) should not be used to diagnose a lymphatic malformation due to the possibility of hemorrhage into the lesion and subsequent rapid expansion, causing airway compromise. The only indication for aspiration of the lymphatic malformation is if there is a need to emergently decompress the cyst to relieve airway obstruction. Spontaneous hemorrhage within the mass may also occur, causing rapid enlargement with swelling and ecchymosis. Hemorrhage predisposes the child for infection and antibiotics should be started. Complete excision may be difficult without involving vital structures, so multiple debulking procedures may be performed. CT with intravenous contrast or magnetic resonance angiography can be used when planning for resection to evaluate the extension from one body space to another and delineate associated vital structures. Radical resection is not indicated. Sclerotherapy has also been studied and is an option particularly in macrocystic lesions. Picinabil (OK-432), bleomycin, doxycycline, acetic acid, alcohol, and hypertonic saline have all been used as sclerosing agents. There is a small possibility of spontaneous regression in low-stage macrocystic lymphatic malformations, so

![Figure 63-1](http://surgerybook.net/)

**Figure 63-1** A child with a cleft cyst and remnants of the first three branchial systems. Note the important relation to the sternocleidomastoid muscle and fistula’s origin. (Reprinted with permission from Welch KJ, Randolph JG, Ravitch MM, et al. editors. Pediatric Surgery. 4th ed. Chicago: Year Book Medical; 1986, p. 543.)
observation and monitoring may also be an option in some of these patients.

4. B. Malignancies of the head and neck account for approximately 12% of pediatric malignancies, with an increasing incidence. Head and neck malignancies are more common in 15 to 18 year olds, followed by age group < 4 years. Females aged 11 to 18 are most likely to have thyroid carcinoma. However, lymphoma is the number one cause of a malignant head or neck mass, with up to 80% of pediatric patients with Hodgkin's disease having cervical lymph node involvement. Though non-Hodgkin's lymphoma is more common in the pediatric population, it is less likely to have cervical lymph node involvement. Rhabdomyosarcoma is the most common pediatric solid tumor in the head or neck and typically causes symptoms through localized compression or infiltration.

In children under the age of 5, neuroblastoma is the most common solid tumor. Neuroblastoma occurs anywhere along the sympathetic chain and may present with Horner syndrome. On imaging, calcifications will be evident. Melanoma should also be on the differential of either a primary tumor in the head and neck, or as a cause for a malignant lymph node. Lastly, teratomas are a rare and usually benign tumor in children, of which only 0.47 to 6% present in the head and neck. Though rare they are important to be aware of, given that the majority present at birth with respiratory distress. Despite being a benign disease, head and neck teratomas carry a 12.5% to 23% risk of intrauterine or neonatal death.

5. C. Torticollis occurs from fibrosis and shortening of the SCM and has an incidence as high as 16% in the newborn population. It is fibrosis and shortening causes a “mass” in the muscle that causes the infant to turn his face toward the contralateral side and tilt the head towards the ipsilateral shoulder. In children who can walk, they may compensate for their torticollis by elevating one shoulder to keep their head and eyes level. Facial and cranial asymmetries can result from the abnormal positioning of the child's head if the torticollis is not treated. When the infant's head is turned towards the contralateral side, the contralateral occiput presses against the bed when they are supine, and flattening of the occiput then leads to secondary flattening of the ipsilateral forehead, referred to as plagiocephaly. As the torticollis resolves the plagiocephaly also typically resolves.

The only indication to operate, by dividing the muscle, is facial hemihypoplasia. Here, the ipsilateral side of the face grows more slowly than the normal side, causing progressive asymmetry. Persistent symptoms after 1 year of conservative treatment may also be a possible indication for surgery. The etiology of torticollis is usually from trauma, though there are other possible etiologies such as ocular imbalance, cervical hemivertebrae, posterior fossa tumors, deep cervical infections, or atlanto-occipital subluxation. An ocular imbalance is usually due to superior oblique palsy, which is corrected surgically. Congenital muscular torticollis is thought to be due to fetal head descent or abnormal fetal positioning during the third trimester. Trauma during delivery is another potential cause. Treatment for torticollis is primarily physical therapy with passive range of motion and neck-stretching exercises. If torticollis persists after 6 months of physical therapy, then additional workup needs to be pursued, assessing for other potential causes such as a congenital vertebral malformation, or ocular imbalance. Botulinum toxin (botox) can also be used to assist in treatment. The botox enhances the effectiveness of stretching on the affected side, potentially making physical therapy more beneficial.

BIBLIOGRAPHY

A one-month old Caucasian boy is brought to his primary care provider (PCP) by his parents due to difficulty feeding. T is is their first child and they are very concerned. T e child has been bottle-fed since birth and almost every time he eats he has a bout of emesis. T ey state the emesis has gotten worse; it has remained non-bilious, but increasingly projectile. T e parents have tried changing formulas, but without relief. He continues to show interest in eating, as his PCP watches him vigorously drink from his bottle.

On exam the infant’s vitals are normal for his age, and he is afebrile. He is well-appearing, though small for his age. T e PCP attempts to do an abdominal exam and thinks he feels a mass in his right upper quadrant, but the infant begins to cry, making the exam more difficult.

1. What is the most appropriate method for diagnosis of infantile hypertrophic pyloric stenosis (IHPS)?
   A. Endoscopy
   B. Upper gastrointestinal contrast study (UGI)
   C. Physical exam
   D. Ultrasound
   E. Hypocholesemic, hypokalemic metabolic alkalosis with aciduria
   F. Hyochloremic, hyperkalemic metabolic alkalosis with aciduria

2. What is the usual acid-base dysfunction associated with this condition?
   A. Hyperchloremic, hyperkalemic metabolic alkalosis with alkalotic urine
   B. Hypochloremic, hypokalemic metabolic acidosis with alkalotic urine
   C. Hyperchloremic, hypokalemic metabolic acidosis with alkalotic urine
   D. Hypochloremic, hypokalemic metabolic acidosis with aciduria

3. When is an adequate pyloromyotomy achieved?
   A. When the submucosa bulges into the myotomy site and both edges of the divided pyloric muscle are freely mobile.
   B. Division through the outer longitudinal muscle followed by division through 2/3 of the inner circular muscle. Approximately 1/3 of the circular muscle should remain intact.
   C. Longitudinal incision through the pyloric sphincter followed by a transverse closure.
   D. When you can pass an appropriately sized bougie, based on the patient’s weight, through the pylorus without any resistance.

4. What is thought to be the pathogenesis of this syndrome?
   A. Congenital abnormality
   B. A deficiency in neuronal nitric oxide
   C. Bottle/formula feeding
   D. Increased testosterone levels in the infant

5. What is the most common complication to occur with this operation, whether the operation is performed open or laparoscopically?
   A. T e infant continues to vomit for 1 to 3 days after the operation.
B. Intra-operative perforation
C. Incomplete pyloromyotomy
D. Wound infection

**ANSWERS**

1. **D.** Infantile hypertrophic pyloric stenosis (IHPS) is most common in Caucasian first-born males. The differential diagnosis of non-bilious vomiting in an infant includes gastroenteritis, food allergies, gastroesophageal reflux, pyloric duplication, antral web, or increased intracranial pressure. T.ough a definitive diagnosis can be made in 75% of infants with IHPS by careful physical examination, it is becoming a lost skill and is technically difficult in cases presenting early. If the stomach is distended, aspiration with a nasogastric tube may assist in successful palpation of “the olive,” or enlarged pylorus on physical exam. However, ultrasound (US) has now become not only the most common initial imaging technique for diagnosis, but the gold standard. T. he specificity and sensitivity of US reaches 98% and 100%, respectively. T. ere continues to be some debate over the exact pathological pyloric measurements.

   Typically a muscle thickness of > 4.0 mm and a pyloric channel length > 15 mm are consistent with the diagnosis. However, when infants present younger than 22 days, a 3.5 mm thickness may be a more useful or a more accurate cutoff point. A muscle thickness measuring between 3.0 and 4.0 mm may be considered borderline and require repeat US a few days later if the clinical suspicion remains high. Figure 64-1 shows that the gallbladder is an important anatomic landmark, with the pylorus often found nearby. T. he most common reason for inability to visualize the pylorus is gastric overdistention, which displaces the pylorus dorsally.

2. **D.** Infants, if they present with electrolyte abnormalities, present with hypochloremic, hypokalemic, metabolic alkalosis, and paradoxical aciduria. T. ese infants have gastric acid loss from emesis, renal loss of potassium, and renal retention of bicarbonate. It is important to correct their abnormalities, specifically dropping bicarbonate levels to less than 30 mEq/L prior to going to the operating room in order to avoid intraoperative and postoperative apnea. T. e chloride level should be corrected to at least 90 to 95 mEq/L. Various intravenous fluid regimens have been described in the literature. Typically a 5% dextrose in 0.45 normal saline with 20 mEq/L of potassium has been most commonly used following a saline bolus of 20–30 mL/kg. Indirect hyperbilirubinemia also occurs in a small percentage of infants with IHPS. However, this invariably resolves postoperatively, so further evaluation at presentation is unnecessary. It is important to note that the majority of infants now present with normal laboratory values, and earlier diagnosis has led to fewer infants with electrolyte abnormalities.

3. **A.** T. e Ramstedt pyloromyotomy remains the operation of choice, whether open or laparoscopic. An adequate pyloromyotomy is achieved when the submucosa bulges into the myotomy site and the edges of the pyloric muscle are freely mobile. Figure 64-2 demonstrates an adequate pyloromyotomy, with visualization of bulging submucosa.

4. **B.** T. e exact etiology of IHPS is unknown and is thought to be multifactorial. T. e relative contributions of genetic and environmental factors and how they interact to cause the pylorus to hypertrophy during early infancy is unknown. T. ough environmental factors are associated with IHPS, the most commonly accepted pathogenesis is decreased neuronal nitric oxide. Nitric oxide is a mediator of relaxation in the

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Figure 64-1 Surgeon-performed US of IHPS. T. e muscle thickness (5.4 mm) and channel length (22.6 mm) are measured. GB indicates gallbladder; St = stomach; L = liver; D = duodenum. Reprinted from Journal of Pediatric Surgery vol 44, Copeland D.R. et al., Return of the surgeon in the diagnosis of pyloric stenosis 1189–1192, Copyright 2009, with permission from Elsevier.
digestive tract. It is thought that the lack of nitric oxide synthase in the pyloric tissue causes pylorospasm and subsequent hypertrophy. It is has been demonstrated in pyloric biopsies. Almost all patients with pyloric stenosis are not born with a hypertrophic pylorus. Though familial aggregation studies and twin reports point to a genetic involvement in the etiology of IHPS, the exact heritability remains unclear. Males are affected 4 to 5 times more than females, but there is no clear explanation for this difference. No differences in testosterone levels between IHPS patients and age-matched controls were found in a study of umbilical cord blood testing, and X-linked transmission patterns have not been shown to explain why IHPS occurs more in males. Breastfeeding has been indicated as a potentially protective factor but bottle-feeding is not a direct cause or etiology of IHPS.

5. B. The most common intra-operative complication is perforation. A distal perforation can be prevented by not carrying the distal part of the myotomy past the pyloric vein of Mayo. The incidence of duodenal perforation when pyloromyotomy was performed by general surgeons was found to be almost 4 times that of pediatric surgeons (relative risk 3.65; 95% CI 1.43–9.32). However, when adjusted for surgical volume this was not significant. In a large series of 1777 infants only 4 required repeat surgery because of an incomplete pyloromyotomy. General surgeons have an overall higher complication rate when compared to pediatric surgeons (4.18% vs. 2.58%), though not statistically significant.

There was a small (0.87%) but statistically significant increase in the incidence of incomplete pyloromyotomy in the laparoscopic vs. open group. In order to avoid an incomplete pyloromyotomy an incision length of 2 cm should be used. In a randomized control trial 200 patients underwent laparoscopic versus open pyloromyotomy. 2 patients in the laparoscopic group and 4 patients in the open group had post-operative wound infections, not statistically significant. Post-operative emesis is expected and is not a complication. Greater than 90% of patients in a series of 778 vomited for 1 to 3 days after surgery, and this is considered to be normal post-operatively. The vomiting is thought to be secondary to gastroesophageal reflux, discoordination of gastric peristalsis, or gastric atony. However, if frequent vomiting persists past 3 days, then an incomplete myotomy or a perforation needs to be considered.

BIBLIOGRAPHY


1. A newborn male infant has difficulty feeding the first day of life. This progresses to abdominal distension and bilious vomiting. The following plain X-ray is obtained on the second day of life.

The differential diagnosis includes which of the following:

A. Situs inversus
B. Pyloric stenosis
C. Cystic fibrosis
D. Duodenal atresia
E. Intestinal malrotation

2. The following contrast enema is obtained:

The diagnosis:

A. Requires tissue biopsy
B. Requires surgery prior to resumption of oral feeds
C. Is not associated with chromosomal anomalies
D. Typically has a family history of similar problems on the father's side
E. Is cured with a successful surgery
3. Technical considerations of the corrective surgery for Hirschsprung's disease include:
   A. Taking multiple biopsies to determine exactly when the first few ganglion cells are seen, in order to resect as little colon as possible
   B. Resection from the level of the dentate line to the ganglionated intestine
   C. Routinely performing a protective colostomy or ileostomy
   D. A tension free anastomosis

4. A 5-year-old patient who underwent a pull through for Hirschprung's as a newborn and did well for years, now presents with a 6 month history of abdominal distension and fecal incontinence. The most likely diagnosis is:
   A. Sphincter injury at the time of surgery
   B. Transition zone pull through at the time of surgery
   C. Hirschprung's associated enterocolitis
   D. Constipation
   E. Anastomotic stricture

5. A 6-month-old patient with Down's syndrome and Hirschprung's disease underwent a leveling colostomy (at the level of normal ganglionated bowel) shortly after birth, followed by pull-through one month ago. He presents now with fever, lethargy, abdominal distension, and bilious vomiting. Plain films reveal no free air, but multiple dilated loops of bowel. Rectal exam results in an explosive output of bloody stained, foul smelling stool. Which of the following is required for the management of this patient?
   A. CT scan to evaluate for intrabdominal abscess
   B. Immediate surgical intervention for a revision of the pull-through
   C. Lavage of saline through the anus
   D. Blood transfusion
   E. Nasogastric decompression

ANSWERS

1. C. The film is consistent with a distal intestinal obstruction. The differential diagnosis for this in the newborn period includes cystic fibrosis, incarcerated inguinal hernia, small left colon syndrome, meconium ileus, meconium plug syndrome, Hirschspring's disease, imperforate anus, and ileal or colonic atresia. In a stable patient without peritonitis the evaluation begins with a good physical exam. Patients with imperforate anus or hernias should be diagnosed readily at this time. Patients with Hirschspring's disease will often have explosive output of stool following rectal exam. The next diagnostic test should be a contrast enema with either isotonic or mildly hypertonic water soluble contrast. This is typically therapeutic and diagnostic for small left colon syndrome, meconium plug, and meconium ileus.

2. A. The enema is consistent with a diagnosis of Hirschspring's disease with a transition zone in the rectosigmoid area. While contrast enema is accurate approximately 75% of the time, tissue diagnosis or anorectal manometry are the only ways to definitively make the diagnosis. Anorectal manometry is not practical in the newborn period, but is a useful study in older children or adults. A suction rectal biopsy at the bedside can sample the submucosa in an infant and does not require anesthesia or sedation. Hirschsprung's disease is due to arrest of the caudal descent of ganglion cells which coordinate intestinal relaxation. Aganglionic bowel does not relax properly to allow propagation of intestinal contents and thus causes a functional obstruction. The biopsy should sample the submucosa 1 to 2 cm above the dentate line.

Findings of a lack of ganglion cells and nerve trunk hypertrophy are diagnostic. Patients with transition zones in the rectosigmoid can usually be temporized by rectal irrigations which allows for delayed surgical correction at several months of age, although surgery in the newborn period is also an acceptable treatment strategy. Most cases of Hirschspring's disease are sporadic, although some are familial. Several genes have been implicated, most notably the ret proto-oncogene. Hirschspring's has a strong association with Down's syndrome, Waadenburg-Shah, and others. Even patients who have successful surgeries have a high likelihood of fecal soiling (60%) and
constipation requiring chronic laxative use (30%) in the long term. Surgery essentially converts the disease to ultrashort segment Hirschsprung's while taking away the rectal reservoir.

3. D. Multiple intraoperative biopsies are required, but in order to avoid pull-through of the transition zone (where the bowel transitions from ganglionated to aganglionated), a level where plentiful ganglion cells are seen and no nerve trunk hypertrophy is present is the goal. Some authors advocate resection up to 10 to 12 cm above this level to more definitively ensure normal bowel is pulled through. It is critical to begin the dissection at least 0.5 to 1.0 cm above the dentate line in a newborn or 1.0 to 2.0 cm in an older child to preserve the anal canal and allow future continence. A protective ileostomy or colostomy is not typically done unless there is a technical concern about the anastomosis. The surgical principles of performing a tension free, well vascularized anastomosis should always be followed.

4. D. Persistent obstructive symptoms following a pull-through are not uncommon and all of the answers listed are possibilities. However, a patient that has done well for years and suddenly presents with distension and fecal soiling is likely to be constipated. Twenty to eighty-five percent of patients with Hirschprung's disease will have constipation following pull-through that may require chronic laxatives, and 60% to 75% will have intermittent fecal soiling. Fecal soiling tends to become worse during periods of severe constipation. These patients are best evaluated with a physical exam and a plain X-ray. If these are consistent with constipation then a clean out with enemas or oral laxatives can be initiated and incontinence will likely improve. Persistent obstruction after appropriate management or no significant improvement after pull-through should be evaluated with contrast enema, exam under anesthesia and repeat rectal biopsy.

5. C. This patient has Hirschprung's associated enterocolitis (HEC). Risk factors for this condition are Down's syndrome, diagnosis after one week of life, anatomic obstruction, and a history of previous HEC. Obstruction can be a result of an anastomotic stricture, swelling of the anastomosis in the early postop period and transition zone pull-through. However, HEC can also occur in the absence of these complications. This is one of the most feared complications of Hirschprung's, as if treatment is not initiated quickly patients may become severely ill and die. The etiology is bacterial translocation through the wall of the colon, presumably due to an ineffective mucosal barrier in the colon. Treatment involves fluid resuscitation, antibiotics, nutritional support and most importantly, rectal irrigations. This is done transanally with warm saline. Unlike an enema, a catheter is used to evacuate stool and gas, while gently irrigating stool out of the colon. In severe cases, colostomy may be required. Patients can present with HEC both before and up to 2 years after pull-through. This clinical presentation is much more consistent with enterocolitis than an abscess. A CT scan is not typically utilized to evaluate for intra-abdominal abscesses in infants. The lack of intra-abdominal fat makes it difficult to discern an abscess cavity from a fluid filled loop of bowel. If imaging is needed to evaluate for this, ultrasound is typically a better study. Neither blood transfusions or nasogastric decompression is required for treatment but they may be utilized.

BIBLIOGRAPHY
You are called to the delivery room to assist in management of the delivery of a child with a known anterior abdominal wall defect and maternal polyhydramnios.

1. Regarding the pathophysiology of pediatric abdominal wall defects, which of the following is correct?
   A. Polyhydramnios and intestinal atresia are not associated with omphalocele or gastroschisis.
   B. Gastroschisis is commonly associated with cardiac and chromosomal anomalies.
   C. A giant omphalocele is more likely to be associated with fetal aneuploidy than gastroschisis.
   D. Intestinal nonrotation is not associated with gastroschisis or omphalocele.
   E. Herniated liver indicates the defect is most likely an omphalocele.

2. Which of the following associations is correct regarding congenital abdominal wall defects?
   A. Since gastroscisis is commonly found off the midline, liver is often seen herniating through the defect.
   B. The most important prognostic factor for gastroscisis is the amount of bowel herniated.
   C. The most important prognostic factor for omphalocele is presence of other associated anomalies.
   D. Omphalocoeles are usually located at the umbilicus.

3. Which of the following is the most important aspect regarding the management of a newborn with omphalocele?
   A. Protection of the sac to help prevent heat loss and insensible fluid loss
   B. Establishing IV access
   C. Gastric (OG) tube placement for bowel decompression
   D. Airway stabilization
   E. Attempting to primarily repair all defects

4. Which of the following is correct regarding the management of a newborn with gastroscisis?
   A. An associated mid-gut volvulus is not a concern.
   B. Sequential closures should be avoided.
   C. The bowel tends to be less damaged than that of the omphalocele.
   D. Surgical management is urgent.
   E. The associated abnormalities are the bigger concern.

5. Omphalocele is associated with many syndromes like Beckwith-Wiedemann, the pentalogy of Cantrell, and CHARGE. Which of the following is a component of the pentalogy of Cantrell?
   A. Coloboma
   B. Gigantism
   C. Ectopic cordis
   D. Genital hypoplasia
   E. Ear abnormalities
ANSWERS

1. E. Before 12 weeks of gestation, the differentiation of an omphalocele and a physiologic midgut herniation cannot be made in the absence of herniated liver. Herniated liver appreciated on prenatal ultrasound is not a normal physiologic finding. Intestinal atresia is associated with gastroschisis in 10% to 20% of cases. Omphalocele has also been reported to be associated with intestinal atresias. Omphalocele has been associated with structural anomalies, chromosomal anomalies, and several syndromes. Small omphalocele sacs with an intracorporeal liver have a stronger association with chromosomal anomalies than larger defects.

2. D. Giant omphalocele is associated with herniated liver. Differentiating characteristics between gastroschisis and omphalocele are summarized in Table 66-1 below.

3. A. Initial resuscitation centers around ensuring a stabilized airway, fluid resuscitation, intestinal decompression via gastric tube, IV antibiotics, and preventing heat and insensible fluid loss. Protection of the sac is imperative. Some advocate for wrapping the bowel in thermoneutral, sterile saline soaked gauze and covering with a bowel bag. Primary closure of small and medium sized defects is preferred but attempts at closure of larger defects will need a sequential reduction and staged closure with a silo or other alternative.

4. D. While one should be cautious in preserving the omphalocele sac, extreme caution should be maintained when handling the bowel in gastroschisis because there is no sac. In gastroschisis patients, the bowel may be extremely edematous and friable. It may also be malrotated and prone to becoming a volvulus. Under most circumstances, gastroschisis intestines are placed in a warm saline filled plastic organ bags, secured at the nipple line. An initial careful attempt and reduction and operative closure is warranted by a trained surgeon, but a sequential reduction and staged closure may be necessary.

5. C. The pentalogy of Cantrell is comprised of omphalocele, ectopia cordis, intracardiac defect, sternal cleft, and an anterior diaphragmatic hernia. Beckwith-Weidemann syndrome composes of an umbilical defect which could be either a hernia or an omphalocele, macroglossia and gigantism. Coloboma (C) is a component of the CHARGE syndrome which also includes (H) Heart Disease, (A) atresia choanae, (R) retarded growth, development and/or CNS anomalies, (G) genital hypoplasia, (E) ear anomalies and/or deafness.

BIBLIOGRAPHY


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Trauma Surgery and Critical Care
Matthew J. Martin
During the annual Memorial Day parade of your hometown, a large explosion occurs along the parade route, with multiple injured persons and fatalities at the scene. Prehospital EMS providers, first responders, and bystanders begin to administer first aid to those injured and start transfer of patients to the local hospital. As an on-call general surgeon, you and your colleagues stand ready in the emergency department while preparing for a potential mass casualty event. Hospital administrators have activated the disaster/mass casualty plan, triage officers are designated, and the incident command plan is in effect.

1. A pre-hospital provider encounters an injured female with a below knee traumatic amputation and multiple truncal fragment wounds with labored breathing (Figure 67-1). The first priority in the initial care of this patient should be?
   A. Airway
   B. Breathing
   C. Circulation/control of life-threatening hemorrhage
   D. Disability
   E. Evacuation

2. Which of the following pairs of hemorrhage source and preferred management is correct?
   A. Junctional hemorrhage—Tourniquet placed directly over the injury
   B. Extremity hemorrhage—Hemostatic dressing and direct pressure
   C. Truncal hemorrhage—Permissive hypotension and hemostatic resuscitation
   D. Pelvic hemorrhage—Early use of rFactor VIIa

3. The principles of damage control surgery include which of the following?
   A. Primary focus upon control of hemorrhage only
   B. Avoiding the use of temporary abdominal closures
   E. Intra-cranial hemorrhage—Reversal of hypercoagulable state and neurosurgical intervention

Figure 67-1  Representative injury pattern of roadside bomb or improvised explosive device.
C. Appropriate triage based upon injuries and available resources
D. Colostomy for all colon injuries
E. Definitive repair of all abdominal injuries

4. The concept of damage control or hemostatic resuscitation includes which of the following?
A. Limited use of colloid solution resuscitation
B. 3:1:1 PRBC:FFP:Platelet transfusion strategy
C. Empiric transfusion of cryoprecipitate
D. Administration of tranexamic acid (TXA) for treatment of hyperfibrinolysis

5. Primary blast injuries include which of the following?
A. Damage to gas filled organs due to extreme pressure changes
B. Truncal injury sustained as victim is thrown through the air by blast
C. Crush injuries from structural collapse around the patient
D. Penetrating injury from debris and fragments propelled by the blast force

ANSWERS

1. C. Traditional teaching of advanced cardiac life support (ACLS) and advanced trauma life support (ATLS) concepts stress the “ABCDE” mantra (airway, breathing, circulation, disability, and exposure), in which airway control is paramount. However, in the setting of combat injuries and civilian catastrophes such as blast injuries, immediate control of life-threatening hemorrhage takes precedence as fatal hemorrhage can rapidly occur while addressing other elements of the primary survey. Hemorrhage remains the leading cause of potentially preventable morbidity and mortality in both military and civilian trauma, reinforcing the importance of pre-hospital efforts to control bleeding and prevent exsanguination after severe injury. The experiences gained during combat operations in Iraq and Afghanistan have led to a change in the priorities of treatment that are taught to combat medics and first-responders.

As the most likely cause of potentially preventable death in these scenarios is hemorrhage, the standard ATLS approach of focusing first on the airway has been changed to a primary focus on C, or the control of hemorrhage, as the first priority. The next priorities would be on assessing the airway and breathing for life-threatening issues such as airway obstruction, tension pneumothorax, or an open pneumothorax (“sucking chest wound”).

2. C. Major extremity hemorrhage can be effectively controlled in both the pre-hospital and hospital setting using an effective proximal tourniquet. Application of tourniquets to control major hemorrhage should be placed as distal as possible yet proximal to the site of injury, to control hemorrhage and limit the extent of tissue ischemia. Hasty tourniquets applied in combat under fire or prior to moving a patient to a safer location may be placed expeditiously anywhere proximal on the injured extremity and later moved distally. Approximately one-third of bleeding deaths after explosive events are due to extremity hemorrhage, with the remaining two-thirds attributed to junctional bleeding or non-compressible truncal hemorrhage (Figure 67-2). “Junctional” injuries are defined as injuries to the groin, axilla, neck, or perineum. These injuries present major challenges to hemorrhage control as damaged deep vascular structures transition from the extremities to major cavities beyond the effective reach of a proximal tourniquet. Direct pressure and topical hemostatic adjuncts are often the only currently available treatments of potential benefit before proximal surgical control can be achieved. Non-compressible truncal hemorrhage is the most feared and fatal type of bleeding as it is not amenable to pre-hospital hemorrhage control measures, and requires higher-level interventions such as surgery or angioembolization.

Significant pelvic hemorrhage may result from complex bony injuries and damage to the pelvic vasculature. Treatment of pelvic fractures may include pelvic sheeting, commercial or improvised binders, and forms of external fixation, that aim to stabilize the pelvic ring. Surgical control of pelvic hemorrhage

![Figure 67-2 Distribution of preventable bleeding deaths from battlefield wounds by the site of hemorrhage.](http://surgerybook.net/)

http://surgerybook.net/
includes open and catheter based therapies as well as pre-peritoneal pelvic packing to tamponade hemorrhage. Permissive hypotension is the concept that avoiding normal or elevated blood pressure in a bleeding patient prior to surgical hemorrhage control limits blood loss.

The goal is to maintain an adequate arterial pressure for critical organ perfusion while limiting over-pressurization from vigorous fluid resuscitation that may exacerbate hemorrhage. Although there was initial interest in the use of activated recombinant factor VII (rFactor VIIa) as an adjunctive therapy for bleeding, subsequent studies have found little to no benefit and it also would not be used as a pre-hospital therapy for pelvic bleeding. The treatment of traumatic intracranial hemorrhage begins with reversal of any identified coagulopathy, not hypercoagulable state, treatment of associated cerebral edema, and possible neurosurgical interventions.

3. C. Damage control surgery (DCS) is a concept that includes the principles of limiting further physiologic insult to a severely injured patient through the rapid surgical control of life-threatening hemorrhage and enteric spillage, to minimize further bleeding, restore tissue perfusion, and prevent sepsis. The goal is to avoid prolonged, initial operative procedures that may further exacerbate hypothermia, coagulopathy, and/or acidosis. Temporary closures of the abdomen and thorax may be employed to shorten the procedure length and allow for urgent or planned re-operation in this population. Once bleeding and gastrointestinal spillage are controlled, there are no further attempts to address other non-life-threatening abdominal injuries at the initial surgery.

The operation is terminated and the patient is returned to the ICU for resuscitation and restoration of normal physiology and coagulation. Following physiologic restoration these patients are taken back to the operating room for definitive treatments and closure. In mass casualty situations and resource-constrained environments, DCS allows limited surgical personnel to provide critical surgical procedures to severely injured patients rapidly, and then either evacuate them to higher levels of care or clear the operating room for additional patients.

4. D. Damage control resuscitation (DCR) or hemorrhagic shock is the concept of limiting further blood loss before surgical hemorrhage control is obtained, as well as replacing shed-blood volume with a balanced blood product based resuscitation that restores the capacity to carry and deliver oxygen and addresses derangements of the coagulation system. DCR research has focused upon improved morbidity and mortality with limitation of crystalloid infusion to prevent hemodilution (colloid solutions are, in general, not advocated for trauma resuscitations), acidosis and worsening of coagulopathy, in favor of transfusion ratios approaching 1:1:1 of packed red blood to fresh frozen plasma and platelets. Additional targeted treatment of specific coagulation abnormalities based upon traditional studies (PT/INR, PTT, fibrinogen) and point of care testing such as thromboelastography is recommended, to avoid unnecessary transfusion and appropriate resource utilization.

Permissive hypotension is the concept that avoiding normal or elevated blood pressure in a bleeding patient prior to surgical hemorrhage control limits blood loss. The goal is to maintain an adequate arterial pressure for critical organ perfusion while limiting over-pressurization from vigorous fluid resuscitation that may exacerbate hemorrhage. Previous studies in civilian trauma patients have confirmed a favorable survival advantage by limiting pre-hospital resuscitation but heterogeneity in clinical trials such as optimal blood pressure target and fluid resuscitation type have yet to yield definitive conclusions.

Current research has identified early derangements of the coagulation system that appear to confer an increased risk of morbidity and mortality after trauma, termed the acute coagulopathy of trauma. Hyperfibrinolysis is a key component of this condition, and targeted pharmacologic intervention with the antifibrinolytic agent, tranexamic acid (TXA), has been linked to a survival advantage in several studies of bleeding trauma patients. The use of TXA in the setting of major hemorrhage and massive transfusion situations is now recommended in the early treatment (< 3 hours from injury) in civilian and combat injuries.

5. A. Blast injuries are traditionally classified based upon the discrete mechanism of injury involved. Primary blast injuries involve damage to gas-filled organs such as the intestine, lungs, and middle ear as well as the brain. These injuries result from over-pressurization due to the blast force. Rupture of the tympanic membrane is a frequently encountered
primary blast injury, but the absence does not rule out other types of blast injury. Secondary blast injuries result from injury due to flying debris and fragments that are propelled by the blast. These are the most frequently sustained type of blast injuries. Tertiary injuries occur when a person is thrown through the air by the blast, while Quaternary injuries include other blast effects such as burn injury, inhalation of toxic gases, or injury due to collapse of structures around the person. Lastly, quinary injuries are the result of contamination by chemical, radiologic, or biologic materials from the blast itself or other injured persons.

In addition to the injury classification described above, the severity of injury sustained after a blast mechanism depends upon the patient's proximity to the blast, the energy of the blast itself, and whether or not the blast occurred in a closed space. Persons injured by a blast in an enclosed space such as a vehicle or building frequently sustain a higher rate of lethal primary blast injury as well as increased frequency of secondary penetrating injuries.

BIBLIOGRAPHY

A 35-year-old man is brought to the emergency department after an altercation at a bar. He has a 3 cm stab wound to his right chest, approximately 5 cm lateral to and just superior to his nipple. He is able to tell you that the wound is from a knife. He is oriented and appropriate, although intoxicated, and complains loudly of pain in his right chest. His initial vital signs are as follows: HR 96, BP 110/63, RR 20, 98% saturation on room air.

1. What is your first step in the management of this patient?
   A. Perform a tube thoracostomy.
   B. Perform the primary survey and examine for any other wounds.
   C. Perform a FAST (focused assessment with sonography for trauma) scan to identify intra-abdominal injury.
   D. Obtain a chest radiograph to identify presence of pneumothorax or hemothorax.
   E. Initiate a massive transfusion protocol to stabilize the patient for computerized tomography (CT) scan to identify the source of the hypotension.

2. Despite fluid resuscitation, the patient’s blood pressure suddenly becomes 60/palpable. His trachea is midline and his breath sounds are reduced over the right hemithorax, with dullness to percussion. What is the best next step in management?
   A. Place a 36F chest tube into the right pleural cavity at the 2nd interspace in the midaxillary line.
   B. Place a 36F chest tube into the right pleural cavity at the 5th interspace in the mid- or anterior axillary line.
   C. Place an 18 g angiocath into the 2nd intercostal space at the midclavicular line.
   D. Take the patient immediately to the operating room for thoracotomy.
   E. An entry wound medial to the midclavicular line—median sternotomy in the emergency room.

3. Which of the following is a correct indicator for operative intervention paired with an appropriate operative approach for this patient?
   A. Greater than 500 cc blood from the chest tube upon initial placement—right posterolateral thoracotomy in the operating room.
   B. Cardiac arrest in the trauma bay—left anterolateral thoracotomy in the emergency room.
   C. Persistent transfusion requirements to maintain stable blood pressure—median sternotomy in the emergency room.
   D. Second entry wound identified below the costal margin—transverse anterior thoracotomy (clamshell incision) in the operating room.
   E. None; manage expectantly with admission for serial exams.

4. If this patient’s wound were located in the neck above the cricoid cartilage (but below the angle of the mandible), which of the following diagnostic tests would be definitely indicated?
   A. CT angiography (CTA) of the cervical vessels.
   B. Computed tomography (CT) of the neck with CT angiography (CTA) of the cervical vessels.
   C. CTA or angiography plus bronchoscopy.
5. The patient has 800 cc initial drainage from the right-sided chest tube, which then slows down over the next few hours. He is admitted to the floor on telemetry for monitoring, and remains stable. A follow up chest radiograph the next morning demonstrates significant residual basilar fluid.

What is the most appropriate next step?

A. Go to the operating room for a video-assisted thoracoscopic surgery (VATS) to evacuate the retained hemothorax.
B. Go to the operating room for a right anterolateral thoracotomy.
C. Place a pigtail catheter to drain the residual hemothorax.
D. Observation and serial chest X-rays.

**ANSWERS**

1. B. In any trauma patient, the first priority is to ensure stable A,B,C's, airway, breathing, and circulation, which may include emergent interventions (e.g., tube thoracostomy). In this patient with stable vital signs, the initial step is to perform a primary and secondary survey—a brief head to toe physical exam. A common mistake in the setting of penetrating trauma is failure to identify multiple injuries. Common locations for missed penetrating injuries can be in the back, axilla, or perineum, so a complete head to toe survey is critical. Most patients can be stabilized enough to undergo a secondary survey, but any problems identified on the primary survey should be immediately addressed. Once all injuries are identified, they can be prioritized for diagnostic imaging or operative repair.

Both chest X-ray and FAST scan can be used as adjuncts to the secondary survey, but they do not replace the need for a head-to-toe assessment of the patient. In the initial evaluation of a trauma patient, priorities are: 1. identifying all wounds, 2. determining if urgent lifesaving intervention is indicated, and 3. determining if additional testing is needed.

2. B. In the setting of penetrating trauma to the chest, the differential diagnosis for hypotension includes tension pneumothorax, cardiac tamponade, and hemothorax. Classically, a tension pneumothorax will present with deviation of the trachea away from the injury, increased percussion and decreased breath sounds with distended neck veins. However, these can be late findings and may be difficult to appreciate in a busy and noisy trauma bay. If a tension pneumothorax is suspected, the first step would be placing an large bore (14 or 18 gauge) angiocath to needle decompress the thoracic cavity. The diagnosis would be confirmed by a rush of air from the needle, and a chest tube should then be placed.

In this patient, the absence of tracheal deviation along with dullness to percussion makes a hemothorax the more likely diagnosis, and a chest tube the appropriate next step. The preferred method for tube thoracostomy is to enter the “safe triangle” bounded by the anterior border of the latissimus, the lateral border of the pectoralis major, and a horizontal line at the level of the nipple (males) or infra-mammary crease (females). T is positioning minimizes the likelihood of entering the abdominal cavity, injuring muscle or breast tissue, or underlying structures such as the internal mammary artery, and avoids the major chest wall musculature that can cause significant pain with chest tube insertion.

3. B. Accepted indications for emergency department thoracotomy in the setting of penetrating thoracic trauma are loss of pulses with previously witnessed cardiac activity and unresponsive, persistent, hypotension. In blunt trauma, indications are rapid exsanguination from the chest tube (> 1500 cc on initial placement) with unresponsive hypotension. Survival rates after emergency thoracotomy are up to 30% for penetrating trauma, but closer to 1% for blunt trauma patients. The goals of an emergency department thoracotomy are to control hemorrhage (which may require cross-clamping the descending thoracic aorta), allow access for internal cardiac massage, and treat potential cardiac tamponade. Access to the heart, descending aorta, and mediastinum requires a left thoracotomy incision. Regardless of the side of injury, traumatic arrest warrants a left thoracotomy for access to the mediastinal structures. If necessary, the incision can be extended to the right chest (“clamshell” thoracotomy) for access to the right thoracic cavity.

Stable patients with penetrating trauma may still require exploration in the operating room. Traditionally, anterior abdominal stab wounds warranted mandatory laparotomy to rule out intraabdominal injury, although recent evidence has raised the possibility of expectant management for the stable patient with penetrating injuries. Thoracic injury to “the
4. **B.** Zone I of the neck extends from the clavicles to the cricoid cartilage, Zone II is from the cricoid cartilage to the angle of the mandible, and Zone III is from the angle of the mandible to the skull base. The majority of penetrating injuries, as with the patient in this case, occur in Zone II. For unstable patients with signs of major vascular or airway injury, management of penetrating neck trauma involves securing an airway and proceeding directly to the operating room for neck exploration. These signs include stridor, massive subcutaneous air, gurgling or bubbling through the wound, hemoptysis/hematemesis, and pulsatile bleeding or rapidly expanding hematoma.

Historically, all Zone II injuries that breached the platysma mandated operative exploration. This is no longer widely practiced, and stable patients with no hard signs of vascular or airway imaging can be managed expectantly with appropriate diagnostic tests. CTA has similar sensitivity to operative exploration for identifying vascular and soft tissue injuries. CT imaging can also provide valuable information about potential injuries to the esophagus or trachea that can guide the selective use of additional studies to evaluate these structures. Esophageal injuries are frequently asymptomatic, and morbidity significantly increases if repair is delayed beyond 24 hours. Contrast esophagography or esophagoscopy is recommended for all Zone II injuries that breach the platysma and have either physical exam or CT scan findings concerning for an esophageal injury. Similarly, flexible bronchoscopy can be used selectively based on any exam or CT imaging findings concerning for airway injury.

5. **A.** Retained hemothorax is a relatively common problem among patients who present with a moderate or large volume hemothorax with either blunt or penetrating trauma. Although observation only is an option, this carries the risk of developing an infected hematoma (empyema) or fibrinopleural. If there is still a significant amount of clotted blood in the thoracic cavity that is not adequately drained by the initial chest tube, then there are several options for management.

These include placement of a second chest tube (or removal and replacement of the initial chest tube) in a better position to evacuate the fluid collection or administration of local lytic therapy (TPA or urokinase administered through the chest tube) to attempt to break up the clot and allow drainage through the chest tube. Although these can be effective in select cases, they have been associated with relatively high failure rates. Since the retained hemothorax likely consists of clotted blood, a small-bore pigtail catheter is unlikely to achieve adequate drainage. There has been a trend toward the increased use of early VATS to evacuate the hematoma and place a well-positioned chest tube under direct visualization. This approach can also be useful if there is suspicion for an associated diaphragm injury that can be repaired simultaneously. Median sternotomy would not be indicated for evacuation of a retained hemothorax.

**BIBLIOGRAPHY**


You wake to the sound of your pager and the familiar refrain overhead, “Trauma team to the trauma room. Trauma team to the trauma room.” Your pager reads:

23YOM GSW TO CHEST/ABD/RT THIGH. GCS 15 HR 100 BP 90/P RR 30 98%/NRB ETA 3MIN.

As you reach the trauma bay, your patient arrives in extremis. He is unresponsive, his breathing is agonal with oxygen saturation in the low 80s despite ventilation with a bag valve mask, and his radial pulse is weakly palpable with a rate of 105 beats per minute. Paramedics have established two large bore peripheral IVs and have begun infusing two liters of normal saline. They report that the patient was shot three times at close range with unknown firearm. The first wound in the right upper chest was characterized as “sucking” on the scene and has been dressed with an occlusive dressing, taped on three sides. They have already performed a needle decompression. The second wound is in the left lower quadrant of the abdomen and is hemostatic. The final wound is located in the right mid-thigh and is presently hemostatic. Paramedics tell you that the bleeding was “pulsatile” prior to the application of a tourniquet.

1. Your first priority for this patient should be:
   A. Establishing a definitive airway.
   B. Performing a chest X-ray.
   C. Removing the tourniquet on the patient’s right lower extremity.
   D. Placing a left-sided tube thoracostomy.
   E. Placing a central venous catheter.

2. Your patient undergoes a rapid sequence intubation, a left-sided tube thoracostomy placed with prompt return of air and 1800 mL blood, and has the remainder of the two liters of crystalloid infused via EMS. You remove the tourniquet and immediately appreciate pulsatile bleeding. Distal right lower extremity pulses are not palpable prior to the re-application of this device and with resultant hemostasis. The patient’s heart rate has increased to 120 beats per minute with a blood pressure of 86/44. With your primary survey completed, which of the following injuries necessitates urgent operative intervention?
   A. Gunshot wound to the chest only.
   B. Gunshot wound to the abdomen only.
   C. Right lower extremity injury only.
   D. Right lower extremity injury and the chest injury.
   E. Right lower extremity injury, abdominal injury, and chest injury.

3. Regarding penetrating chest trauma, which of the following is correct?
   A. Tamponade physiology requires accumulation of at least 150cc of blood in the pericardial space.
   B. 85% of injuries can be managed with tube thoracostomy alone.
   C. Great vessel injuries are common in penetrating chest trauma.
   D. Lung injury that requires operative intervention is more common following blunt injury.
   E. Prophylactic antibiotic use reduces the incidence of post-traumatic empyema in the setting of retained hemothorax.
4. Regarding this patient’s penetrating abdominal wound, which of the following is correct?

A. Injuries to the bowel may be primarily repaired if less than 75% of the bowel’s circumference being involved.
B. The most common organ injured is the large bowel.
C. FAST (focused assessment with sonography for trauma) examination is poor at detecting hollow viscous injuries.
D. All patients with penetrating abdominal injuries that violate the posterior fascia must undergo an exploration but a laparoscopic one may suffice.
E. The operation of choice in an unstable patient having sustained penetrating abdominal injury is a limited laparotomy with extension only if injuries are suspected.

**ANSWERS**

Gunshot wounds fall under the broad classification of penetrating trauma and comprise up to 10% of all major trauma in the United States. The energy imparted to tissue can be calculated using the kinetic energy equation: 

\[ E = \frac{1}{2} m (\Delta v)^2 \]

where \( m \) is the mass of the projectile and \( \Delta v \) is the change in velocity before and after contact. Simplistically, it can be inferred that higher caliber firearms and those projecting higher velocities will cause more grievous injury. It is assumed, of course, that the entirety of the projectile’s kinetic energy is imparted to the tissue. Use bullets that enter and exit do not expend all of their kinetic energy on the body. Furthermore, the projectile’s behavior in the body is a function of its relative density. Lower density projectiles (e.g., lead or so-called “hollow-point” bullets) will tend to expand, creating a progressively enlarging wound tract with a comparatively small entrance wound and a large exit wound. High density and/or high velocity projectiles tend to pass directly through tissue but can cause significant indirect injury via cavitation. Even further, high density tissue like bone can dramatically alter the initial trajectory, deflecting the projectile in nearly any direction. It is imperative that patients who have sustained gunshot wounds undergo a systematic evaluation with complete anatomic exposure and physical examination.

1. A. The primary survey on trauma patients follows an algorithmic approach to prevent overlooking potentially life-threatening pathology. Patients with gunshot wounds are no exception. Evaluation and stabilization of the patient’s airway to ensure adequate oxygenation and ventilation represents the first step in resuscitation. T is sort of vignette is ubiquitous on board examinations and the admonition is to “Keep it Simple,” by following the algorithm delineated by Advanced Trauma Life Support. Remember the acronym “ABCDE” for the primary survey. T is involves assessing the patient’s airway and maintaining in-line cervical spine immobilization, ensuring adequacy of the patient’s breathing by assessing both oxygenation (via pulse oximetry) and ventilation (evaluating respiratory rate and effort), circulation (pulse examination, addressing life-threatening bleeding), disability (neurologic examination), and exposure (strip patient and perform rapid scan for injuries). It is important to be mindful that with a team approach in a working trauma, much of the above can be performed simultaneously.

For our patient, his unresponsiveness, agonal breathing, and oxygen desaturation are concerning and a definitive airway is indicated. While a chest X-ray will be performed and the left-sided needle decompression will need to be supplanted by a tube thoracostomy, these are of subsidiary importance to securing the patient’s airway. A central venous catheter is not necessary at this time given the presence of two large bore peripheral IVs. While it will be important to take down the patient’s tourniquet to perform a detailed extremity evaluation, the report of pulsatile bleeding in the field is suggestive of vascular injury and given present hemostasis, this can be deferred until the initial resuscitation has been performed.

2. E. Knowing the indications for operative intervention is essential to caring for patients having sustained traumatic injuries. For penetrating thoracic trauma, immediate resuscitative thoracotomy (the so-called “Emergency Department T oracotomy”) is indicated for witnessed pulseless electrical activity (overall survival 4% to 5% for gunshot wounds vs. 18% to 24% for stab wounds). Urgent thoracotomy (within 1 to 4 hours of admission) is indicated for: initial chest tube output > 1500 mL, evidence of ongoing bleeding at a rate of 200–300 mL/h, massive air leak, or cardiac tamponade.

For abdominal trauma, indications for laparotomy include hemodynamic instability, peritonitis on examination, or evisceration. Strong consideration should also be given to exploration for those patients...
with an abdomen that cannot be evaluated clinically (e.g., due to altered mental status, distracting injury, paralytic/sedative administration, etc.).

Hard signs of arterial injury include pulsatile hemorrhage, expanding/pulsatile hematoma, bruit or thrill over wound, absent distal pulses, or evidence to suggest extremity ischemia (pallor, poikilothermia, pain, paralysis). So-called “soft signs” include non-expanding hematoma, peripheral nerve deficit, history of pulsatile hemorrhage at the time of injury, and unexplained hypotension. Any patient presenting with hard signs of vascular injury should undergo prompt exploration as the positive predictive value of physical examination for arterial injury approaches 100%. In the absence of hard signs, an alternate means of performing a bedside evaluation is with the injured extremity index (analogous to an ankle-brachial index, also known as an arterial pressure index) with a normal value of > 0.9 having a reported sensitivity/speciﬁcity of 95/97% respectively for major vascular injury. A normal physical examination and injured extremity index virtually exclude major arterial injury.

3. B. Most thoracic injuries can be managed with tube thoracostomy; only 10% to 15% of thoracic trauma requires operative intervention. Tamponade physiology classically only requires 50 cc of blood in the pericardial space and is characterized clinically by Beck’s Triad (jugular venous distention, muf ed heart sounds, hypotension), occasionally with a narrowed pulse pressure, and the presence of an effusion on FAST examination.

Patients with tamponade physiology should receive aggressive volume administration because they will be dependent on their preload to generate cardiac output. Decompressive pericardiocentesis may be performed though in the setting of trauma, but this is often a temporizing measure. Deﬁnitive surgical management in this setting of trauma involves the creation of a pericardial window.

The reported incidence of great vessel injury in penetrating chest trauma is only 4% as the majority of these patients exsanguinate prior to presentation. Gunshot wounds to the mediastinum should raise suspicion and the diagnosis can be conﬁrmed with CTA angiography. If present, urgent exploration is warranted.

Lung injury that requires surgical intervention is more commonly encountered with penetrating trauma. The majority of these injuries can be managed with pulmonary tractotomy (for penetrating non-hilar injuries) or nonanatomic stapled resections. Inadequately evacuated hemothorax can result in secondary infection (post-traumatic empyema) or ﬁbrothorax (entrapped lung). Unfortunately, prophylactic antibiotics do not appear to prevent the secondary development of infection in this setting. Chest tubes are often unsuccessful in removing clotted blood and consideration should be given to operative exploration for patients with retained hemothorax.

4. C. While a FAST examination is a useful bedside adjunct to detect the presence of free intra-abdominal or pericardial ﬂuid, it is operator dependent and has a poor sensitivity with respect to hollow viscous, retroperitoneal, and diaphragmatic injuries. A negative FAST examination does not rule out intra-peritoneal injury. There is evidence to suggest that hemodynamically stable patients with abdominal gunshot wounds and no evidence of peritonitis on exam may undergo evaluation via computerized tomography of the abdomen to determine whether further operative intervention is required. Even if the posterior fascia is violated, elective non-operative management with observation and serial examinations is a safe alternative to reﬂex operative exploration in a major trauma center with in-hospital surgical support.

In general, primary repairs can be done on both small and large bowel if 50% or less of the circumference is damaged. The most commonly injured abdominal organ with penetrating trauma is the small bowel. For unstable patients with penetrating abdominal injuries, a full laparotomy incision should be made so that all of the injuries can be identiﬁed quickly.

**BIBLIOGRAPHY**


A 60-year-old male restrained driver is involved in a high-speed head-on motor vehicle collision. He is heavily intoxicated and uncooperative, therefore he is intubated at the scene and brought to the nearest Level I trauma center. Upon arrival he is able to shrug his shoulders to questions. Initial vital signs indicate a pulse of 48 bpm and a blood pressure of 78/39 mm Hg. His respiratory status appears stable on the current ventilator settings and initial primary trauma evaluation fails to reveal any major external signs of injury.

Subsequent secondary trauma survey reveals the patient is able to shrug his shoulders but demonstrates no motor or sensory function below his deltoids. Questionable rectal tone is present. A cervical collar is in place, but the patient demonstrates tenderness to palpation in the midline of the cervical spine.

1. What is the most likely cause of this patient's hypotension?
   A. Splenic rupture
   B. Acute blood loss
   C. Flail chest
   D. Spinal shock
   E. Beta-blockade

2. Which of the following is not a component evaluated by the NEXUS criteria for clearing a patient's cervical spine from injury such that the cervical collar can be removed?
   A. Pain with passive motion of the patient's neck
   B. History of Ambien use
   C. Any other injury
   D. Altered mental status
   E. High velocity mechanism of injury

3. Which of the following therapeutic measures is considered a current standard treatment option for this patient's spinal shock?
   A. Limited boluses of normal saline or LR to prevent spinal cord edema
   B. Bed rest
   C. Selective vasopressor treatment to keep MAPs > 85
   D. Administration of methylprednisolone bolus at 30 mg/kg followed by continuous infusion at 5.4 mg/kg/hr for 23 hours

4. Imaging reveals a fracture dislocation of the mid cervical spine with a resultant spinal cord injury. Computed tomographic angiography (CTA) reveals a traumatic vertebral artery dissection. Which of the following is associated with a markedly increased chance of cervical vascular injury and thus requires an evaluation with CTA?
   A. Neurological examination out of proportion with computerized tomography (CT) head findings
   B. Seat belt sign
   C. C5 spinous process fracture
   D. Glasgow coma scale < 10
   E. Le Fort I fracture

ANSWERS

1. D. Spinal cord injury following a traumatic cervical spine injury typically results from blunt compression injury to the cord itself. Typically the central grey matter is affected first while the peripherally located white matter fiber tracts may be relatively spared. If
the spinal cord injury is severe enough, neurogenic or spinal shock may occur. The most basic definition of this is inadequate tissue perfusion due to paralysis of vasomotor input, most commonly due to loss of sympathetic tone and significant disruption of the vasodilator and vasoconstrictor balance. It is commonly characterized by bradycardia, hypotension, decreased peripheral vascular resistance, and decreased cardiac output. Common physical examination findings demonstrate flaccid paralysis of the extremities with no sensory function, lack of rectal tone, lack of foley catheter sensation, and priapism in males. If the spinal cord injury occurs at C5 or above then respiratory depression may occur. As this patient demonstrates some deltoid function, this indicates a lower cervical cord injury. Presence of a shoulder shrug should not fool the examiner. T is motor function is provided by the 11th cranial nerve. T e most common classification of spinal cord injuries occurs via the ASIA system:

| A = Complete | No motor or sensory function is preserved in the sacral segments S4–S5 |
| B = Incomplete | Sensory but no motor function is preserved below the neurological level and includes the sacral segments S4–S5 |
| C = Incomplete | Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3 |
| D = Incomplete | Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade of 3 or more |
| E = Normal | Motor and sensory function are normal |

2. E. Any patient suspected of a cervical spine injury and therefore a potentially unstable cervical spine should be placed in cervical immobilization with a rigid collar. Maintenance of in-line cervical alignment during intubation as well as log-roll precautions must be upheld during transfers. Per the NEXUS criteria, a patient can be cleared with a 99.8% negative predictive value for cervical spine injury if the following criteria are met:

Meets all low-risk criteria?
1. No posterior midline cervical-spine tenderness
2. No evidence of intoxication
3. A normal level of alertness
4. No focal neurologic deficit
5. No painful distracting injuries

3. C. Current treatment protocols for spinal shock involve the mainstays of aggressive fluid resuscitation and vasopressors. Vasopressor choice is left to the discretion of the treating physician based on the patient's co-morbid factors. A goal MAP of > 85 sustained for 7 days has demonstrated some promise for improving a patient's outcome. Usage of high dose steroids in acute spinal cord injury is a controversial topic and has been for quite some time. Various large trials (NASCIS I, II, III) have demonstrated mild benefits with the administration of methylprednisolone bolus of 30 mg/kg followed by 23 hours of continuous infusion at 5.4 mg/kg/hour. However, these studies have also demonstrated significant deleterious side effects with high dose steroids leading to the Congress of Neurosurgeons to declare that high dose steroids’ risks outweigh their benefits, and are thus not recommended.

4. A. Blunt carotid or vertebral artery injuries can be a potentially lethal injury if missed upon initial trauma evaluation. Level II evidence exists neck CTA screening in trauma patients with an exam out of proportion to their cranial imaging (i.e., a comatose patient with minimal traumatic intracranial damage). Level III evidence exists for such screening in trauma patients with GCS 8 or below, petrous bone fractures, diffuse axonal injury, C1–3 fractures, any cervical spine fracture with subluxation, cervical spine fracture through the foramen transversarium, or Le Fort II/III injuries. Surprisingly, despite its widely believed association with cervical vascular injuries, presence of an isolated “seat belt sign” with no other above listed injuries is only associated with a 1% yield for blunt cervical vascular injuries. Treatment of such blunt injuries attempt to prevent intracranial ischemic injuries. Previously aggressive treatment with open surgical or endovascular repair, or en in the form of stenting or coiling, provided the mainstay of treatment. However, current emerging evidence suggests these lesions, if diagnosed prior to evidence of ischemia, can be quite benign if treated with antithrombotic medications. Currently, either anticoagulation via heparin/Coumadin or anti-platelet medications via aspirin 325 mg daily are widely used.

BIBLIOGRAPHY


A 32-year-old male, unrestrained driver, is involved in a high-speed motor vehicle collision. After a prolonged extraction, the patient is found to be somnolent and is intubated on the scene. After arrival in the trauma center, a complete evaluation reveals a non-displaced linear skull fracture and multiple areas of intracranial contusions with diffuse edema but no large mass lesions. No other systemic injuries are discovered. His neurologic exam demonstrates small but reactive pupils, presence of corneal, gag, and cough reflexes, lack of eye opening to voice or painful stimulation, brisk withdrawal of both legs and his right arm to painful stimulation as well as localization of his left arm to painful stimulation.

1. What is the patient’s Glasgow Coma Scale (GCS)?
   A. 5
   B. 6
   C. 7
   D. 8
   E. 9

2. Which of the following are indications for the use of intracranial pressure monitoring in traumatic brain injury?
   A. Intracranial injury demonstrated on computerized tomography (CT) scan and GCS of 8 or below.
   B. Lack of intracranial injury on CT scan, but age > 40, SBP < 90, and motor posturing on exam.
   C. Minor neurologic injury but lack of neurologic examination due to need for systemic paralytics in treatment of other injuries.
   D. All of the above.
   E. None of the above.

3. Which of the following should be implemented in this patient following external ventricular drain placement and admission to the ICU?
   A. Elevation of the head of bed to up to 10 degrees so measurement of the intracranial pressure (ICP) remains calibrated
   B. Maintain hemoglobin levels > 10 g/dL
   C. Maintenance of a cerebral perfusion pressure of 60 or above
   D. Allow hypercapnia
   E. Administration of high levels of positive end-expiratory pressure (PEEP) to aid in oxygenation

4. On post-admission day 2, the patient’s intracranial pressures rise to the low 30s. Which of the following maneuvers can be used to reduce his intracranial pressure?
   A. Increased sedation with propofol only because other sedatives can increase cerebral metabolic demand
   B. 3% hypertonic saline
   C. Permissive hypotension
   D. Transient periods of hypoventilation
   E. Administration of methylprednisolone

ANSWERS
1. C. The Glasgow Coma Scale (GCS) is the most basic method of quickly communicating a patient’s neurologic examination. It is comprised of three components:
Thus, a non-responsive comatose patient has a GCS of 3 while an awake, oriented patient would demonstrate a GCS of 15. Intubated patients automatically receive just 1 point or verbal response. If a patient’s motor exam is asymmetric, the best response is used for grading. Thus this patient’s exam is E1, V1, M5 for a total GCS of 7. For intubated patients, many providers use the convention of adding a “T” following the GCS score, so this patient would be described as a “GCS 7 T”.

2. D. Insertion of an intracranial pressure monitor can be used to evaluate and treat elevated ICP or as a surrogate for a neurologic examination in those who require sedation or chemical paralysis for other injuries (such as a trauma patient with an open abdomen on paralytics). The most common indication for an ICP monitor is a patient with a traumatic intracranial injury on imaging and a GCS of 8 or less. These patients will have an elevated ICP 60% of the time. Patients with a normal head CT scan will only demonstrate elevated ICP 13% of the time. This occurs most commonly in patients over 40 years of age who demonstrate posturing on examination and hypotension.

3. C. The Monro-Kellie doctrine states that the skull is a fixed compartment with 3 basic components: brain (80%), cerebrospinal fluid (10%), and blood (10%). An increase in any one of these components requires an equal decrease in one or both of the other two to prevent an increase in intracranial pressure. Typical cerebral blood flow compromises 15–20% of the cardiac output; a decrease in this may result in unmet cerebral metabolic demands. The primary goal of treatment of severe brain injury is to maintain adequate cerebral blood flow and oxygen delivery, but it is difficult to readily measure these parameters. However, cerebral blood flow can be roughly estimated by cerebral perfusion pressure (CPP = MAP – ICP), and is commonly used to guide therapy. In uninjured patients, the brain will maintain cerebral perfusion via autoregulation over estimated CPP ranges of 50 to 150.

However, patients with severe brain injury will commonly exhibit loss of autoregulation, which means that their cerebral blood flow will be directly dependent on an adequate mean arterial pressure (MAP) and a normal intracranial pressure (ICP). This is why there is so much attention paid to maintaining a normal to slightly elevated blood pressure and aggressive measures to avoid ICP elevations in patients with severe brain injury.

All attempts at treating elevated intracranial pressure keep this Monro-Kellie hypothesis and its relationship with cerebral perfusion pressure in mind. The first steps toward the treatment of a patient with elevated intracranial pressure begin with many simple bedside maneuvers. Initial steps should include elevation of the head of bed to aid cerebral venous outflow, seizure prophylaxis, maintenance of hemoglobin of at least 7 g/dL or above, avoidance of elevated intra-abdominal pressure, and adequate pulmonary support. Pulmonary support should focus of avoidance of hypoxia, hypercapnia, and excessive PEEP. Elevated levels of PaCO₂ lead to intracranial vasodilation and cerebral blood volume, thus elevated ICP. Excessive PEEP may lead to increased intra-thoracic pressure and thus impaired cerebral venous outflow.

4. B. If elevated ICP occurs, more aggressive methods of treatment include increased sedation (via propofol or barbiturates to decreased cerebral metabolic demands), paralytics, mannitol for both rheologic and osmotic effects, and hypertonic saline. Steroids should be avoided in intracranial trauma. Despite the usage of dexamethasone with other causes of cerebral edema, steroids are associated with elevated mortality in trauma patients with severe...
brain injury due to the myriad of side effects. Hypotension should be avoided to help maintain the CPP.

BIBLIOGRAPHY


A 27-year-old female presents to the emergency department after a motorcycle crash. She was hemodynamically unstable on arrival and is currently receiving 2L of crystalloid via large bore peripheral IVs. Glasgow Coma Scale (GCS) is 12. She is breathing spontaneously and has no obvious extremity trauma. Initial radiographs demonstrate normal cervical alignment without fracture, right side ribs 4 through 8 fractured, a small right side pulmonary contusion, no free air under the diaphragm, and a pelvis film that shows widening of the pubic symphysis by 4 cm along with diastasis of the left sacroiliac joint. Abdominal ultrasound is negative for free fluid. The patient is currently on her menses.

1. With regards to the pelvic injury, the patient's hemodynamic instability is most likely related to:
   A. Disruption of the anastomosis of the external iliac/deep epigastric and obturator vessels (the Corona Mortis)
   B. Arterial injury of the superior gluteal artery and vein at the level of the greater sciatic notch
   C. Post-traumatic closed soft tissue degloving injury in which the skin and subcutaneous tissue separate from the fascia superficial to the underlying musculature (Morel-Lavallee lesion)
   D. Disruption of the anterior sacral venous plexus.
   E. Rupture of the pelvic floor structures (sacrospinous and sacrotuberous ligaments) with vaginal laceration by the anterior pubic symphysis fragments

2. What percentage of vascular injuries from high-energy pelvic trauma are arterial in nature?
   A. < 5%
   B. 10% to 15%
   C. 50%
   D. 60% to 75%
   E. > 85%

3. Regarding the hemodynamic instability of pelvic fractures, what is the fracture pattern associated with the highest severity of hemorrhage?
   A. Anteroposterior compression (APC III) fracture patterns
   B. Lateral compression (LC III) fracture patterns
   C. Vertical sheer (VS) fracture patterns
   D. Combined APC/VS patterns
   E. Open pelvic fractures

4. Regarding the mortality of displaced pelvic fractures, the highest mortality rates are seen in:
   A. Anteroposterior compression (APC III) fracture patterns
   B. Lateral compression (LC III) fracture patterns
   C. Vertical sheer (VS) fracture patterns
   D. Combined APC/VS patterns
   E. Open pelvic fractures

5. Identification and management of open pelvic fractures depends on a high index of suspicion by the initial treating provider. Although this patient was on her menses and blood was to be expected on examination, a speculum examination of the vaginal mucosa demonstrates a 2 cm laceration on the left wall of the vagina and a proctoscopic exam showed a rectal laceration. To decrease the
risk for post-injury infection and sepsis, which of the following should occur early in the treatment of this injury?

A. Urgent gynecological consultation with primary closure of vaginal laceration
B. Exploratory laparotomy or laparoscopy with repair of rectal laceration and diverting colostomy
C. Exploratory laparotomy with repair of rectal laceration without diversion
D. Urgent urological consultation with repair of bladder and urethral injuries
E. Immediate placement of a suprapubic catheter

ANSWERS

1. D. Hemodynamic instability after blunt trauma is due to ongoing hemorrhage until proven otherwise, with the common locations being the chest, abdomen, pelvis, or extremity/external bleeding. The normal chest X-ray and abdominal ultrasound in conjunction with the abnormal pelvis X-ray make the pelvis the most likely source of bleeding in this patient. Although arterial injuries in association with major pelvic trauma can occur, the majority of bleeding occurs at the venous plexus located on the anterior aspect of the sacrum and sacroiliac joints. It is historically has responded best to pelvic packing or fracture reduction, rather than immediate angiography. Injuries to the superior gluteal arteries posteriorly and the Corona Mortis anteriorly have been reported and can be devastating, but they are far outnumbered by the venous lacerations of the presacral venous plexus. Morel-Lavaleve lesions are common after blunt force trauma, but do not typically lead to hemodynamic instability seen from the deep pelvic venous lacerations.

2. B. The current management of pelvic fracture patients who are hemodynamically unstable consists of aggressive resuscitation, mechanical stabilization, and angioembolization. Despite this multidisciplinary approach, mortality rates of these high-risk patients can exceed 40%. Initial maneuvers to reduce the pelvic fracture and decrease the pelvic volume include placement of a pelvic binder, wrapping the pelvis with a sheet, or application of an external fixation device. Preperitoneal pelvic packing (PPP) via laparotomy can directly address the venous bleeding that compromises 85% of pelvic fracture hemorrhage and does not respond to the initial maneuvers listed above. The remaining 15% of vascular injuries are arterial and may best be addressed via angiography in the event of continued hemodynamic instability following pelvic packing.

3. A. In an antero-posterior compression fracture (APC), the fracture propagates from anterior to posterior. It widens the symphysis pubis and depending on the level of force, can widen the anterior sacroiliac joint or disrupt it entirely. In an APC III injury, the pelvic floor ligaments (sacrocipinous and sacrotuberous) are disrupted and can lead to instability and increased volume in the pelvic cavity. Disruption and displacement of the sacroiliac joint has the potential to lead to massive hemorrhage from the anterior sacral venous plexus that is closely approximated to the joint. Major hemorrhage in patients with pelvic fractures can reliably be predicted based on a pulse greater than 130, a hematocrit of 30 or less, and wide diastasis of the pubic symphysis.

Although pelvic binders are now routinely applied for suspected or proven pelvic fractures, they may have no benefit or may even cause additional harm in select types of fractures. The AP pelvic radiograph will identify injuries that may benefit from provisional stabilization with external compression with a sheet or pelvic binder. In general, LC injuries will not respond to binder placement, whereas APC and VS injuries will. Compression of an LC injury is potentially damaging as it may induce additional lateral compression and fracture dislocation or bleeding. Occasionally, an LC injury in an elderly patient may have a hemorrhage associated with vascular or visceral disruption; these patients will not benefit from wrapping or binding, but may be candidates for angiography.

4. E. Open pelvic fractures are potentially lethal injuries with a reported mortality rate of 30% to 50%. Open fractures of the pelvis by definition communicate with the rectum, the vagina, or the outside environment by disruption of the skin. They are often associated with disruption of the pelvic floor, leading to loss of tamponade and persistent bleeding. An additional concern is pelvic infection and sepsis due to the open communication with the rectum, vagina, or skin. Clinical suspicion of an open fracture and any rectal or vaginal bleeding mandates a thorough examination of the pelvis, perineum, rectum/anal complex, and vagina in females.
In addition to visual inspection and digital examination, full evaluation should include rigid proctoscopy or flexible sigmoidoscopy, and speculum examination in females. Management of major open pelvic fractures includes administration of intravenous antibiotics, washout and debridement of open wounds, and consideration for a possible diverting colostomy to prevent fecal contamination of the open fracture.

5. B. Early diagnosis of an open pelvic fracture is essential and a thorough examination must be done so that no such injuries are missed. While it is not difficult to diagnose an open fracture when massive wounds of the skin and perineum are present, a small vaginal or rectal tear that communicates with and contaminates the fracture may be missed unless it is sought specifically. Rectal injuries must be sought, particularly in patients with a sacral fracture, because the fragments of bone frequently traverse the rectal wall.

Classically, an open pelvic fracture prompts recommendations for colostomy to prevent soft-tissue sepsis in an expanded perineum. It has recently been suggested that fecal diversion in an open pelvic fractures can be applied selectively, according to the actual location, nature, and size of the cutaneous wound. For open fractures with an associated rectal injury, immediate diverting colostomy and repair of the rectal laceration (if possible) are indicated. Anterior wounds of the groin, anterior thigh, iliac crest, or pubis do not require diversion.

**BIBLIOGRAPHY**


CASE 1

A 44-year-old female patient presented with a history of profuse bleeding from a scalp wound. She was brought to the emergency room by an attendant. She had direct trauma caused by falling and hitting her head on a large rock while hiking. She denied any loss of consciousness or seizures. The bleeding was controlled by a gauze dressing and compression bandage at the site of the injury. She was vitally stable with a Glasgow Coma Scale (GCS) of 15/15. On neurological examination, she had no motor deficit except for right sided lower motor neuron (LMN) facial palsy. A large, parietal lacerated scalp wound was visible 3 cm away from the midline on the left, measuring about 2 cm in length. A computerized tomography (CT) of her head was done after she complained of having an abnormal salty taste in her mouth. On leaning forward she had drops of clear fluid coming from her nose.

The head CT is shown in Figure 73-1.

1. Which of the following is an indication for surgical intervention?
   A. Depression that does not exceed the calvarial thickness
   B. Associated intracranial hematoma without a mass effect
   C. An isolated clean fracture overlying a dural venous sinus in an asymptomatic patient
   D. Dural injury with persistent cerebrospinal fluid (CSF) leak
   E. Because this is an open skull fracture then operative intervention is mandated.

2. Regarding the management of this type of fracture, which of the following is true?
   A. Early surgical intervention may decrease the risk of traumatic brain injury.
   B. Antibiotics are recommended in almost all cases.
   C. Even if there is evidence of a wound infection, primary bone repair will have a favorable outcome.
   D. Elevation of depressed fracture usually lowers the risk of post-traumatic seizures.
   E. Severe cosmetic deformity is an indication for urgent surgery.
3. Four hours later, another patient with the same type of head injury came to the ER but he deteriorated immediately after admission. His head CT (Figure 73-2) showed the following image:

![Figure 73-2](image-url)

**Figure 73-2**

**The main cause of deterioration of this patient is:**
A. Tension pneumocephalus  
B. Acute obstructive hydrocephalus  
C. Hydrocephalus ex vacuo  
D. Subdural hygroma  
E. Subdural hematoma

4. Regarding the CSF rhinorrhea/otorrhea, which of the following is true?
A. CSF has a lower concentration of glucose than does mucus.  
B. Magnetic resonance imaging (MRI) is the most sensitive procedure to localize the site of CSF fistula.  
C. Meningococci are the most common pathogen that may cause meningitis in this condition.  
D. Post-traumatic CSF rhinorrhea is more likely to persist compared to spontaneous CSF rhinorrhea.  
E. Post-traumatic CSF otorrhea is usually self-limited.

**CASE 2**

A 30-year-old male African patient presents to the emergency department with altered level of consciousness following direct trauma to the head by a heavy object about 3 hours prior to arrival. He was brought in by his friend, who said that he had transient loss of consciousness for about one minute after which he woke up complaining of headache and blurry vision. He vomited once before becoming somnolent and again about 30 minutes later.

On general examination, his vital signs were as follows: BP = 140/85 mm Hg, RR = 18 cycle/min, Pulse = 68 beat/min, and GCS = 10/15. Bruises were seen over the right temple. On neurological examination, the patient had a left hemiparesis with round, equal, and reactive pupils. The patient was mildly agitated with good localization of painful stimuli. Deep tendon reflexes (DTRs) were mildly exaggerated with a positive Babinski's sign on the left side.

A thorough examination was done to exclude associated injuries of the spine, chest, and abdomen. A rigid cervical collar had been placed in the field by EMS. Brain imaging via CT scan revealed a large, right parieto-temporal epidural hematoma. Cervical spine images were unremarkable. Emergent surgical intervention was performed with postoperative ICU admission for strict monitoring of vital signs and neurological status.

1. Regarding the etiology of cranial epidural hematoma (EDH), which of the following is correct?
A. The most common source of bleeding in this case of EDH is an injured anterior division of middle meningeal artery running beneath the pterion.  
B. EDH cannot be caused by injury of dural venous sinuses.  
C. An underlying fracture is not commonly found in cases of post-traumatic EDH.  
D. The bridging cortical veins are usually torn in cases of EDH with associated extensive brain lacerations.  
E. The source of bleeding in traumatic EDH and acute subdural hematoma (aSDH) is usually arterial.

2. Regarding the clinical presentation of patients with cranial EDH, which of the following is correct?
A. EDH is more common in older patients with a 1:3 male to female ratio.  
B. A lucid interval is reported in more than 80% of traumatic EDH.  
C. All cases of EDH present with altered level of consciousness.  
D. Anisocoria occurs in cases of rapidly expanding temporal EDH secondary to central transtentorial herniation.
E. Motor deficit (e.g., hemiparesis) may occur ipsilateral to the side of hematoma due to compression against Kernohan’s notch.

F. Symptoms of increased intracranial pressure (ICP; e.g., vomiting) are often more profound in supratentorial EDH compared to the posterior fossa EDH.

3. Regarding the diagnosis of cranial EDH, which of the following is correct?
   A. CT scan of the head is the standard imaging modality that reveals cranial EDH without the need for IV contrast.
   B. EDH is usually crescentic in shape on CT imaging, while aSDH is more lenticular with biconvex borders.
   C. EDH is usually diffuse beneath the cranial bone and appears limited by the falx.
   D. The fresh, undiluted blood of an EDH appears as a hypodense mass on head CT scan.
   E. A positive swirl sign on a CT scan of the head indicates a long-standing EDH, which can be treated conservatively.

4. Regarding the management of cranial EDH, which of the following is correct?
   A. Lumbar puncture is recommended to alleviate elevated ICP symptoms in cases of temporal EDH.
   B. In general, an epidural hematoma exceeding 30 cm$^3$ should be surgically evacuated regardless the conscious level of the patient.
   C. EDH maximal thickness > 3 mm on axial CT slices of the head is an absolute indication for surgical intervention.
   D. An acute rapidly expanding EDH is usually evacuated in the operating room by two widely spaced bur holes rather than a craniotomy.
   E. Dural tenting/tack-up/hitching stitches (that holds the dura to bone) should be avoided because it may increase the risk of dural stripping and post-operative EDH re-accumulation.

5. Regarding the complications and outcome of cranial EDH, which of the following is correct?
   A. Patients with aSDH have a better prognosis and outcome compared to those with EDH.
   B. Rapidly expanding temporal EDH may cause uncal herniation where the uncus compresses the medulla oblongata medially.
   C. Bradycardia and hypotension are both part of Cushing’s triad in markedly elevated ICP.
   D. Preoperative decerebration does not predict morbidity in closed head injuries.
   E. Presence of a skull fracture is a risk factor for the development of a delayed EDH.

CASE 3
A 21-year-old male Caucasian patient was brought into the emergency room by his girlfriend. She described an episode of a left facio-brachial seizure about 1 hour after he had a motorbike accident. The patient had shown a transient loss of consciousness at the scene. Upon regaining consciousness he complained only of a headache before he developed the seizure. On general examination, vital signs were found to be within normal limits. On neurological examination, he was found to still be in post-ictal status but without any motor deficit. Intravenous Fosphenytoin was administered and a non-contrast head CT was requested to exclude intracranial bleeding. The axial head CT can be seen in Figure 73-3.

Figure 73-3

1. What type of intracranial hemorrhage did he have?
   A. Epidural hemorrhage
   B. Subdural hemorrhage
C. Subarachnoid hemorrhage  
D. Hemorrhagic brain contusions  
E. Intraventricular hemorrhage

2. Regarding this type of intracranial hemorrhage, which of the following is correct?  
A. It occurs most commonly in the occipital and parietal poles of the brain.  
B. It occurs from an impact of the brain on bony prominences.  
C. Surgical evacuation is only indicated in case of progressive neurological deterioration.  
D. Temporal involvement has a lower threshold for surgery than the other sites.  
E. IV Dexamethasone is part of the medical management for this type of head injury.

3. Regarding elevated intracranial pressure (= ICP) and cerebral hemodynamics, which of the following is true?  
A. Normal ICP of adults should always be less than 10 mm Hg.  
B. Treatment of high ICP should be initiated for patients with sustained ICP ≥ 15 mm Hg.  
C. The goal of ICP management is to keep mean ICP < 20 mm Hg and cerebral perfusion pressure (CPP) ≥ 70 mm Hg.  
D. The cerebral blood flow (CBF) to white matter is higher than that of grey matter.

4. Which of the following will increase ICP?  
A. Mannitol 20%  
B. Saline 3%  
C. Saline 23.4%  
D. Dextrose 10%  
E. Furosemide

5. Which of the following is considered to be routine measures to control ICP?  
A. Elevation of the head to 75°  
B. Avoidance of hypotension, hypertension, or hypoxia  
C. Hyperventilation to keep PCO₂ ≤ 25 mm Hg  
D. Heavy sedation and paralysis  
E. Endotracheal intubation for patients with GCS ≤ 12

CASE 4
A 26-year-old Hispanic male was brought to the emergency room after being involved in a motor vehicle accident 2 hours prior. He complained of an intense headache, nausea, and was found to have memory troubles. He was a known cocaine addict. He was brought in by his roommate whom he could not identify during examination. The patient had unremarkable vital signs and a GCS of 14/15. On neurological examination, he was agitated and confused with post-traumatic amnesia. He had no apparent motor or sensory deficit except for right sided pupilary dilation and ptosis since the accident. A thorough examination was done to exclude associated injuries and a non-contrast CT study of the head was done, which revealed the image seen (Figure 73-4).

1. What is the most common cause of this type of intracranial hemorrhage?  
A. Trauma  
B. Aneurysmal rupture  
C. Ruptured arteriovenous malformation (AVM)  
D. Coagulopathy  
E. Pituitary apoplexy  
F. Cocaine abuse

2. Regarding the clinical presentation of this type of intracranial hemorrhage, which of the following is correct?  
A. The patient usually presents with high ICP symptoms secondary to hemorrhagic mass effect and not cytotoxic diffuse brain edema.
B. Seizures are not a part of the course of the disease.
C. Nuchal rigidity is mandatory to confirm the diagnosis.
D. Patients do not present with focal neurological deficits.
E. Sudden onset unilateral ptosis with pupillary dilation may raise the suspicion of cerebral aneurysm.

3. Regarding the diagnosis of this type of hemorrhage, which of the following is correct?
A. Lumbar puncture is a safe procedure to confirm the diagnosis by CSF analysis.
B. CT Head requires IV contrast to increase the sensitivity to 95% of cases within the first 24 hours.
C. Contrast enhanced head CT does not mimic the radiological image of this type of intracranial bleeding.
D. Fluid-attenuated inversion recovery (FLAIR) MRI is the most sensitive MRI sequence to detect bleeding.
E. MRI is a sensitive radiological study to detect the acute stage (within the first 24 hours) of this type of bleed.

4. If this patient had no obvious history of head trauma, what would be the gold standard study to identify the underlying cause of hemorrhage?
A. Magnetic resonance angiography (MRA)
B. Magnetic resonance venography (MRV)
C. Cerebral angiography
D. MRI diffusion study (DWI)
E. CT perfusion study
F. Transcranial doppler study

5. If the patient's conscious level deteriorates, what could be the underlying cause of this deterioration?
A. Hydrocephalus
B. Cerebral vasospasm
C. Hyponatremia
D. Rebleeding
E. Seizures
F. Any of the above

CASE 5
A 75-year-old female was brought to the emergency room by her daughter. The patient has been complaining of confusion, forgetfulness, and headaches over the last month and her symptoms got worse over the last week. Her daughter, who lives with her, said that she has not been herself for about a month. She denies vomiting, nausea, speech difficulties, or visual changes. The patient reports several episodes of transient orthostatic lightheadedness and had had several falls; she fell last about 2 months prior to admission and had a minor head trauma which was cared for without medical attention; the patient denies loss of consciousness before or after the falls. During history taking, the patient reported that she had a stroke 2 years ago which left her with slight weakness in the left upper and lower extremities.

On physical examination her vital signs show BP 135/90 mm Hg; temperature of 98°F (36.7°C); RR of 16/minute; HR is 76/minute and regular. Head, Eye, Ear, Nose, and Throat Exam (HEENT) is normocephalic but showing a large bruise on her left temple. PERRLA shows no fundoscopic abnormalities. Her neck is supple, with no carotid bruits and her heart rate and rhythm is normal S1/S2, with no murmurs, rubs, or gallops. The neurological examination shows mental status is alert and oriented × 3. The patient could spell words backwards, but recalled only 2/3 objects. Her GCS is 11/15 and the cranial nerves are 2–12 grossly intact. Her motor strength is 5/5 in all muscle groups except 3/5 in the left arm throughout. Her DTRs are asymmetric 3+ in left upper and lower extremities and 1+ on the right. There was no Babinski sign bilaterally. The cerebellar exam was negative, as was Romberg's test. Her gait is normal and her sensation is intact to pinprick and light touch.

A thorough physical examination was done to exclude skull bone fractures and spine injuries. Head CT-scan imaging showed the images provided below, revealing a crescent shaped, hypo-dense extra-axial collection as seen in Figure 73-5:

Figure 73-5
The patient was brought to the operating room for evacuation of a hematoma. She did well post-operatively and was discharged to rehabilitation at day-2 after surgery.

1. Which of the following is considered to be the highest risk factor for chronic subdural hematoma after head trauma?
   A. Seizure history
   B. Anticoagulation/antiplatelet therapy
   C. Gender
   D. Alcohol abuse
   E. Age > 65

2. Which of the following statements is correct with regard to the options for management of chronic subdural hematoma?
   A. Conservative treatment (e.g., corticosteroids and bed rest) is suitable in lesions with less than 1 cm thickness even with the presence of focal neurologic signs.
   B. Burr-hole drainage with the placement of subdural drain is not as effective as a craniotomy and should be avoided.
   C. Craniotomy is a suitable surgical intervention for loculated lesions.
   D. Percutaneous twist-drill bedside drainage is not indicated because of the risk of infection.
   E. Operating room twist drill craniostomy requires intubation or heavy sedation.

3. Which of the following correlates with the outcome of chronic subdural hematoma?
   A. Hematoma density on CT
   B. Traumatic etiology
   C. Male sex
   D. Hematoma location
   E. Age

4. Which of the following risk factors is associated with higher recurrence rate of chronic subdural hematoma (CSDH)?
   A. Bilateral hematomas with poor re-expansion rate after surgery
   B. Etiology
   C. Interval from trauma to first operation
   D. CT-characteristics (density)
   E. Age

ANSWERS

Answers to Case 1

1. D. Image 73-1 is an axial cut of CT head (bone window) showing a left parietal compound depressed bone fracture. It is a case of an open skull fracture or compound depressed skull fracture. It is recommended to manage patients with skull fractures overlying a dural venous sinuses conservatively provided that there is no neurological deficit or CSF leak. The high probability of vessel wall laceration with subsequent profuse bleeding during surgery is the main cause of perioperative mortality. Meier and his colleagues reported 100% mortality rate of cases with skull fractures lacerating the posterior third of the superior sagittal sinus and a 50% mortality rate in cases in which the middle third was affected. Their study showed an overall mortality rate of 41% for cases with major dural sinus injury. In a retrospective review of 27 patients with depressed compound skull fractures overlying but not disrupting a venous sinus, a management recommendation was made that wound washout with antibiotics is an adequate treatment as long as there is no mass effect or contamination deep to bone. A depressed skull fracture greater than the thickness of the calvarium, an intracranial hematoma with mass effect are considered possible indications of surgery.

2. B. There is no evidence that bone elevation following open skull fractures necessarily decreases the incidence of post-traumatic seizures which probably do occur as a direct result of the initial brain injury. Early surgery has been recommended to reduce the risk of infection but it does not affect the extent of a traumatic brain injury. Antibiotics are part of the management strategies of compound depressed fractures. Same session cranioplasty or repair of autologous bone is accepted only if there is no evidence of infection. Marked cosmetic deformity may warrant elective but not urgent surgical skull reconstruction.

3. A. Image 73-2 is an axial cut of CT head (soft tissue) shows a case of “Tension Pneumocephalus” with “Mount Fuji sign” due to collection of bifrontal subdural air compressing the brain. This image depicts a case of tension pneumocephalus. Pneumocephalus is defined as the presence of air within the
intracranial cavity and may include one or more of the following compartments: (a) epidural, (b) subdural, (c) subarachnoid, (d) intraparenchymal, and/or (e) intraventricular. Tension pneumocephalus is a term used when a considerable amount of air or gas is detected on a CT scan of the head with rapid clinical deterioration. T is scenario usually warrants immediate surgical intervention in order to avoid fatal brain herniation. T e CT here shows accumulation of trapped air in subdural and interhemispheric space with some resulting compression of the brain. T is radiological finding is called “Mount Fuji sign”. T e air usually appears black on CT scans with a density measuring – 1000 Hounsfield units. No hydrocephalus is seen as there is no ventricular enlargement. T e latter usually occurs due to obstruction of the CSF-flow resulting in CSF accumulation and subsequent ventriculomegaly from obstructive hydrocephalus. Hydrocephalus ex vacuo is a term that falsely describes relative ventricular enlargement that may occur in elderly patients secondary to brain parenchymal atrophy from the natural aging process.

T e presence of a subdural hygroma is a post-traumatic condition that develops due to a separation of the dura-arachnoid interface followed by a passive fluid accumulation secondary to decreased ICP or from excessive dehydration. Such a fluid collection overlying the brain convexity rarely shows any mass effect which makes surgery usually unnecessary. T e dynamics of alternating absorption and expansion is thought to be responsible for the occasional transformation of some SDHG cases into chronic subdural hematomas.

4. E. Most post-traumatic CSF leaks subside within 72 hours to 1 week without any need for surgical intervention. Daele and colleagues recommended surgery for spontaneous CSF fistula cases since they are more likely to persist. Post-traumatic CSF otorrhea on the other hand usually stops within 5 to 10 days. Detection of \( \beta_2 \)-transferrin in rhinorrhea-fluid corroborates the presence of a CSF fistula. Tahir and colleagues reported that CT-cisternography has the highest sensitivity and specificity when compared to CT- and MR-scanning to detect the site of a CSF leak. Pneumococci are the most common causative organisms in cases of meningitis following a CSF fistula. Glucose urine strips could help in identifying CSF due to its high glucose concentration (\( \geq 40 \text{ mg/dl} \)) when compared to low glucose levels (\(< 5 \text{ mg/dl} \)) found in mucus secretions.

Answers to Case 2

1. A. Tearing or avulsion of the bridging cortical veins is one of the causes of aSDH. Hemorrhagic brain contusions or lacerations might be another source of aSDH. EDH is commonly caused by an arterial injury of the middle meningeal artery which may progressively strip the dura from the inner table of the skull. EDH is sometimes caused by bleeding from dural veins, venous sinus or diploic channel injury following skull fractures. In a case series of 40 infants with EDH, Leggate and colleagues could identify the bleeding source in 31 cases. In 42.5% of those cases it was from the middle meningeal artery. Skull fractures were seen in 45% of cases in another series of 210 traumatic EDH cases.

2. E. T e false localizing sign, or Kernohan’s notch phenomenon, is a compression of the contralateral cerebral peduncle against the edge of the tentorial incisura which can lead paradoxically to an ipsilateral hemiparesis. It is an important motor localizing sign that appears false in topography, but may occur with any supratentorial mass during uncal herniation. Yoo and colleagues explored this state of the corticospinal tract in a patient with chronic SDH and ipsilateral hemiparesis by using diffusion tensor imaging (DTI) and transcranial magnetic stimulation (TMS).

EDH occurs less frequently in children and elderly patients likely due to adherence of the dura to the inner table of the skull, thus sealing firmly the epidural space. In an epidemiological analysis of 210 cases of traumatic EDH, 89.2% of cases were in males and the observed presenting GCS was between 13 and 15. T efore, it is not uncommon for patients with EDH to be fully conscious at the time of clinical assessment.

A classic lucid interval is seen in only 21% of traumatic EDH cases. Ipsilateral pupillary dilation mostly occurs following oculomotor nerve compression by the medially displaced uncus and hippocampal gyrus (called: uncal herniation).

In 27 posterior fossa EDH cases reported in a study by Su and colleagues, headache and vomiting
the most frequently seen symptoms. Rapid brainstem compression with respiratory depression and death may occur in posterior fossa EDH cases if not treated promptly.

3. A. CT scanning of the head usually shows a classic appearance of EDH which is a homogeneous hyperdense extra-axial lenticular mass with convex borders. IV post-contrast CT is very rarely needed in cases of isodense EDH. EDH is usually localized to a limited part of the calvarium since it is confined by the skull sutures (not the falx). On the other hand, a SDH is characterized on head CT as a crescentic mass with biconcave shape, diffusely spanning a large area of the brain convexity and is not limited by the sutures. This is illustrated in Figure 73-6.

A “swirl sign” is a distinct radiographic sign of active bleeding which may occur in different types of intracranial hemorrhage. It presents as an area of irregular density in the hyperdense clot and is typically of low attenuation (radiolucency). Its occurrence is associated with worse clinical outcomes and bigger sizes of intracerebral hematomas as reported by Selariu et al., as it represents an area of active ongoing bleeding.

4. B. An EDH measuring more than 30 cm$^3$ in volume must be surgically evacuated regardless the GCS. A midline shift of more than 5 mm is also a critical radiological sign of brain compression which usually indicates the need for surgical intervention. A patient with a GCS of more than 8 and a hematoma less than 30 cm$^3$, less than 15 mm in thickness, with less than 0.5 cm midline shift, and without focal deficit can be managed by close observation with serial scans and placement in a monitored neurosurgical unit. Acute intracranial hematomas are evacuated by craniotomies or craniectomies as the fresh blood is almost clotted. On the other hand, chronic SDH are usually liquified and can be surgically drained by one or two burr holes. Dural tenting/tack-up/hitching stitches (that holds the dura to bone) are advocated by many surgeons at the end of the surgical procedure as a routine to close the epidural space in order to prevent EDH reaccumulation. However, hemostasis is still the most relevant aspect to prevent rebleeding and there is no compelling evidence to support the role of dural tenting for all intracranial operations.

Lumbar puncture may lead to life threatening central or tonsillar herniation in cases in which there is high ICP and a pressure gradient between the intracranial and intraspinal compartments.

5. E. Uncal herniation usually occurs with middle cranial fossa masses where the uncus herniates medially compressing the oculomotor nerve, cerebral peduncles of mid brain, and posterior cerebral
arteries which may cause unilateral ptosis with mydriasis, hemiparesis, and hemianopia, respectively.

In a case series of 161 consecutive patients operated on for post-traumatic EDH, the overall mortality was 12%, which could be further lowered by early diagnosis and proactive management. The overall mortality in another study of aSDH was 66%. The Cushing's triad is a reflex triggered by markedly elevated ICP causing hypertension, bradycardia, and respiratory irregularities. Delayed EDH is defined as a radiologically evolving EDH during sequential neuroradiologic examination and which was not present initially. Detection of a skull fracture is an indication for hospital admission under neurologic observation for early detection of possible delayed EDH.

Answers to Case 3

1. D. Image 73-3 is an axial cut of CT head shows multiple hemorrhagic brain contusions (left frontal and bitemporal). It is a case showing a right temporal hemorrhagic brain contusion. It is also called diffuse post-traumatic intracerebral hemorrhage and usually appears on CT scanning during the immediate post-traumatic phase as an intra-axial hyperdensity indicating fresh blood within the brain parenchyma.

2. D. The degree of temporal involvement often plays a critical role due to its proximity to the brain stem, whereas mass effect is better tolerated in affected supratentorial brain areas. Therefore, the development of temporal hematomas carries a lower threshold for surgical intervention. The indications for surgery in cases of traumatic brain contusions include hematoma causing progressive neurological deterioration; signs of significant mass effect on CT; medically refractory intracranial hypertension; patients with GCS scores of 6 to 8 with a frontal or temporal contusion greater than 20 cm³ in volume and with a midline shift of at least 5 mm and/or cisternal compression on CT scan, and patients with any lesion greater than 50 cm³ in volume. Patients with such features should be treated operatively with decompression and possible resection of the affected area.

Cerebral contusions most frequently develop after a mechanical impact of distinct skull areas onto the rather soft brain substance in moments in which the brain bounces. Frontal and temporal lobe tips are most commonly affected by such focal hemorrhagic contusions following translational acceleration. Glucocorticoids are not recommended to improve the outcome or lower the ICP in patients with severe traumatic brain injury.

3. C. ICP is one of the most powerful predictors of neurological outcome in patients with traumatic brain injury. Normal values are variable among different age groups and are shown in the following table:

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Normal Range (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>&lt;10–15</td>
</tr>
<tr>
<td>Children</td>
<td>3–7</td>
</tr>
<tr>
<td>Term infants</td>
<td>1.5–6</td>
</tr>
</tbody>
</table>

Variable thresholds have been suggested for the initiation of treatment for raised ICP in patients with head injury. Most neurosurgical centers use a sustained ICP ≥ 20–25 mm Hg. An intraventricular catheter is the most accurate way of monitoring. The goal of ICP management is to keep it below 20 mm Hg provided that the CPP is not lowered below 50 mm Hg (not 70 mm Hg) to guard against cerebral ischemia.

\[
\text{CBF} = \frac{\text{CPP}}{\text{CVR}} = \frac{(\text{MAP} - \text{ICP})}{\text{CVR}}
\]

CBF is the cerebral Blood Flow
CVR is the Cerebrovascular Resistance
MAP is the Mean Arterial Pressure
CPP is the Cerebral Perfusion Pressure
ICP is the Intracranial Pressure

The average cerebral blood flow usually ranges from 50 to 60 mL/min/100 g of brain tissue during resting state. Normal white matter receives 18–25 mL/min/100 g, while normal gray matter receives 67–80 mL/min/100 g.

4. D. Hyperglycemia aggravates cerebral edema. Brain cell swelling is increased by hyperglycemia and ketosis especially during hypcapnia. Therefore, Dextrose 10% is not considered appropriate in cases of head trauma as it will further increase the ICP impeding both the CPP and CBF. Osmotic medical therapy includes mannitol and/or hypertonic saline (used to control the ICP in traumatic brain injury). Furosemide is a loop diuretic that can result in greater reduction of brain water content if administered in combination with mannitol as it enhances its effect on plasma osmolality.
5. B. It is not recommended to use hyperventilation vigorously to lower PaCO₂ to less than 25 mm Hg as a PaCO₂ of less than 30 mm Hg may lower the CBF or distort cerebral autoregulation without consistently lowering ICP. The goal is to keep PaCO₂ at the lower end of eucapnia (35 mm Hg). The other options that are considered routine measures to control ICP are head of bed elevation to 30°, light sedation, intubation for a GCS < 8.

Answers to Case 4

1. A. Image 73-4 is an axial cut of CT head shows diffuse post-traumatic subarachnoid hemorrhage. This is a case of subarachnoid hemorrhage (SAH) shown in the CT in the form of a hyperdense blood film in the subarachnoid cisterns. Trauma is still the most common cause of SAH. Aneurysmal rupture is the most common cause of spontaneous SAH. Ruptured AVM usually presents in the form of intracerebral hemorrhage or intraventricular hemorrhage. SAH occurs in about 5% of AVM cases. Other causes may include pituitary apoplexy, coagulopathy, and cocaine abuse.

2. E. Nuchal rigidity may occur in some cases of SAH due to meningeal irritation but it is not a “must” for diagnosis. Patients with SAH may present with increased ICP symptoms, seizures and/or neurological deficit. Unilateral ptosis with pupillary dilation may indicate oculomotor nerve compression secondary to a posterior communicating artery (P-comm) aneurysm. Nine percent of P-comm aneurysms present with unilateral oculomotor nerve palsy, which may indicate impending rupture and prompt intervention by a specialized neurovascular team. Cytotoxic brain edema is usually seen in head trauma patients (vs. vasogenic brain edema in brain tumor cases).

3. D. Lumbar puncture always carries the risk of re-bleeding in case of aneurysmal SAH. Therefore, LP is only needed to confirm the diagnosis of clinically suspicious cases of SAH with negative or equivocal CT scans. Sidman et al. reported that CT scans of the head had 100% sensitivity in detecting SAH within the first 12 hours. Morgenstern and his colleagues stated that 97.5% of patients with SAH presenting to the emergency room with “worst headache” symptoms were adequately diagnosed by CT imaging alone. MRI is valuable in demonstrating subacute and chronic hemorrhages due to Methemoglobin formation which may determine the source of bleeding in patients with multiple cerebral aneurysms. The FLAIR sequence has the highest sensitivity in detecting the cases with low-grade SAH. T₂⁺/Gradient echo sequence or Susceptibility Weighted Image (SWI) may be done as a complementary sequence. Post-contrast CT of the head may be misdiagnosed as SAH especially if the contrast is injected intrathecal.

4. C. The four-vessel cerebral angiogram or catheter cerebral angiography is the gold standard study for the evaluation of cerebral aneurysms. CT angiography (CTA) with 3-dimensional reconstruction imaging may be used instead of catheter angiography in some centers as the sole imaging diagnostic study before major surgical intervention. CTA is a non-invasive tool that may provide prompt, accurate, and versatile diagnostic and anatomical information on which clipping can be based. However, unnecessary craniotomies based exclusively on CTA findings were also reported.

MRA can also detect cerebral aneurysms, but it has lower sensitivity and specificity compared to the catheter cerebral angiogram especially for aneurysms less than 3 mm diameter. MRA is also useful in screening high-risk patients. MRI Diffusion (DWI) is the best imaging study for detection of acute brain ischemia within the first hours especially when it involves the brain stem or cerebellum. CT perfusion identifies the area surrounding the infarction called potentially salvageable penumbra that allows for better outcomes if interventional treatment modalities are available. Transcranial doppler (TCD) is a non-invasive semi-quantitative technique of ultrasound derived blood velocity measurements within major cerebral vessels (e.g., MCA) through thin regions of skull bones providing a window. TCD is usually used in SAH to detect cerebral vasospasm early prior to the clinical delayed ischemic neurological deficit. Theoretically, the higher the velocity of blood flow, the narrower the lumen of the cerebral blood vessel.

5. F. SAH has numerous possible complications that may cause neurological deterioration. It is believed that proteinaceous blood products may occlude the arachnoid granulations causing secondary communicating hydrocephalus in 20% of SAH survivors. Angiographic cerebral vasospasm is a contributing factor of delayed neurological deficit in patients with
SAH. Broderick and his colleagues reported on the causes of morbidity and mortality following aneurysmal SAH. In their study, re-bleeding was the most important preventable cause of death.

It is also well-known that seizures may occur early following SAH mostly due to the presence of blood in the cisterns which may irritate the cerebral cortex, but the explanation of late onset seizures remains unclear. The prevalence rate of hyponatremia following SAH is about 30% to 55%. Hyponatremia may lead to seizures, vasospasm, altered mental status, or death. It may occur due to syndrome of inappropriate ADH (SIADH) secretion or glucocorticoid deficiency. However, correction of hyponatremia should always be gradual and monitored, as rapid corrections may cause central pontine myelinolysis (osmotic demyelinating syndrome).

Answers to Case 5

1. B. Image 73-5 is an Axial cut of CT head shows right frontoparietal chronic subdural hematoma. Patients with chronic anticoagulation/antiplatelet therapies are considered to be at high risk for chronic subdural hematoma from trivial traumas. Those patients are prone to develop subdural bleeding within days or weeks after small head trauma. The mechanism is not yet very well understood, although alteration in the blood-hematoma components was found in most anticoagulation treated patients.

For answer A, although patients with uncontrolled seizure episodes are more prone to frequent head traumas from potential recurrent seizure episodes, those patients don’t have higher incidence of subdural hematomas after trivial trauma compared to patients with chronic anticoagulation therapy. For answer C, there is higher incidence of chronic subdural hematoma in male compared to female, but gender does not seem to influence the development of CSDH after slight head trauma. In answer D, history of alcohol abuse associated with coordination and motor problems, consequently more falls, that put the patient at risk for recurrent head trauma. But history of alcohol abuse does not show a strict correlation with CSDH after trauma as coagulation therapies do. For answer E, although old people (e.g., age > 65 years) have a higher incidence of CSDH compared to those with age < 65, age is not considered a risk factor for the development CSDH after head trauma.

2. C. Conservative treatment including bed-rest and corticosteroids have been shown to be very efficient in the treatment of patients with hematoma less than 1 cm without focal neurologic deficit or mental status changes. Corticosteroids have been posited as both an anti-inflammatory and anti-angiogenic agents. Answer B, Burr-hole drainage with the placement of subdural drain, was shown to decrease significantly the recurrence rate of CSDH after treatment. Answer C, Craniotomy with excision of subdural membranes, is indicated when the hematoma persistently recurs despite the treatment with twist-drill craniostomy or burr hole drainage. It has been shown to be safe and valid technique. Answer D, Percutaneous twist-drill bedside drainage, is the least invasive technique over the above mentioned techniques. It requires a 0.5 cm incision in the scalp and has been shown to be a safe technique. Operating room twist drill craniostomy, answer E, is a valid option for the management of CSDH, although, it does not offer any advantage over the percutaneous twist-drill drainage in terms of recurrence. However, given that CSDH is more frequent among the elderly, the treatments diverge regarding the perioperative risks related to general anesthesia; burr holes are frequently performed under general sedation, whereas a local anesthetic is usually sufficient with percutaneous drainage, so patients comorbidities have to be taken in consideration.

3. A. Brain atrophy, hydrocephalus, midline shift, and hematoma density on CT (e.g., high, iso, or low) all influence the outcome of CSDHs. Traumatic causes, sex, hematoma location and age have never been shown to correlate with CSDHs outcome.

4. A. The presence of bilateral effusion and poor re-expansion is associated with high rate of recurrence. For answers B, C, D, E, etiology (e.g., alcoholism, head injury, neurosurgery, anticoagulant, coagulopathy, subarachnoid cyst), interval from trauma to first operation, CT-findings (e.g., high, iso, or low density), and age are not associated with higher recurrence of rate of CSDH after surgery.

BIBLIOGRAPHY


A 38-year-old male presents to the trauma bay with a Glasgow coma scale (GCS) of 15 following a motor vehicle crash. The patient undergoes a computed tomography (CT) scan of the head that shows a small traumatic subarachnoid hemorrhage over the right frontal lobe and tiny contusions in the right frontal and left occipital lobes. Overnight the patient becomes slightly more agitated but his GCS remains stable at 15. A CT scan the morning after admission shows no change in his intracranial injuries. Additionally, his chemistry panel the following morning shows a sodium level of 130 mEq/L. His admission sodium was noted to be 139 mEq/L.

1. After determining that the effective serum osmolality was within the normal range and urine osmolality was greater than 100 mOsm/kg, the next step in determining the cause of the hyponatremia is:
   A. Assess the patient’s volume status.
   B. Determine the liver function and cardiac output.
   C. Check pituitary function assays for cortisol derangements.
   D. Draw an arterial blood gas to determine the pH of the blood.
   E. Determine the urine sodium level.

2. Your team has determined that the patient is euvolemic and has given him the diagnosis of syndrome of inappropriate antidiuretic hormone secretion (SIADH). His sodium on last draw was 128. On last exam, the patient shows no symptoms of hyponatremia. What treatment would you begin to correct the low serum sodium level?
   A. Fluid bolus
   B. Hypertonic saline
   C. Fluid restriction
   D. Vaptan therapy
   E. IV steroid dose

3. Which of the following statements is true regarding the neurological signs and symptoms associated with severe hyponatremia?
   A. Usually not apparent until Na drops below 115 mEq/L.
   B. If the hyponatremia is chronic (>48 hours in duration), the patient will be symptomatic.
   C. If symptoms are present, the physician should rapidly correct the sodium to near normal levels at a rate of 5–7 mEq/L/hr.
   D. Symptoms typically include headache and poor concentration.
   E. Hyponatremia can be fatal due to transtentorial herniation.

4. The patient’s neurological exam has now deteriorated requiring intubation, external ventricular drain placement, and aggressive intracranial pressure (ICP) management. The patient’s urine output has increased to over 300 cc/hr and the serum sodium has increased to over 150 mOsm/hr. What diagnosis would you assign the patient at this time and what is the likely cause?
   A. Nephrogenic diabetes insipidus due to medications
   B. Neurogenic diabetes insipidus due to undiagnosed skull fracture
C. Neurogenic diabetes insipidus due to herniation
D. Neurogenic diabetes insipidus due to underlying meningitis
E. Nephrogenic diabetes insipidus due to underlying kidney disease

5. Which of the following is part of the best treatment option for this patient?
A. Monitor fluid intake and output hourly and draw the serum sodium every 24 hours.
B. Place on a basal fluid rate with D5½ NS with replacement for urine output above the base rate.
C. Administer DDAVP first and assess impact on urine output.
D. Allow the patient’s thirst mechanism to control the Na level and treat with DDAVP as needed.

ANSWERS

1. A. The diagnosis for the cause of hyponatremia is generally reached in an algorithmic fashion. After a lab measurement shows serum sodium less than 135 mEq/L, you must determine the effective serum osmolality. It rules out hyperglycemia, hypertriglyceridemia, and hyperproteinemia (so-called pseudohyponatremia). The next step is to evaluate urine osmolality to ensure that the patient is not suffering from water intoxication. After these three steps are complete, the patient’s volumes status must be ascertained. It is extremely important in a neurologic patient as it will help differentiate the most common neurologic causes of hyponatremia: syndrome of inappropriate antidiuretic hormone secretion (SIADH) and cerebral salt wasting (CSW).

2. C. As with the diagnosis, the treatment for SIADH also runs as an algorithm. Again, the patient must be confirmed to be euolemic as the treatment for CSW involves fluid resuscitation and for SIADH often involves fluid restriction. In the case of a patient with mild hyponatremia (125–135 mEq/L) with no symptoms, treatment should involve fluid restriction. If there are symptoms, patients should receive saline infusion with 0.9% saline and Lasix. Finally, in cases with Na levels less than 125 mEq/L and symptoms, patients are treated 3% saline and Lasix. Newer medications such as the vaptan class, which act as a vasopressin antagonist, can be used in refractory cases.

3. E. T is question relates to the symptoms and general treatment options of hyponatremia. T e neurologic symptoms of mild hyponatremia or chronic hyponatremia involve headache, poor concentration, anorexia, and muscle weakness. T e more acute and severe hyponatremia cases can lead to cerebral edema, nausea, seizures, respiratory arrest, coma, and death from transtentorial herniation. Symptoms generally are easily diagnosed below 125 mEq/L. Symptoms are more apparent with acute onset (<48 hours in duration) as there is less time for mechanisms of the brain to compensate. For that reason, chronic hyponatremia (>48 hours) can be relatively asymptomatic even at low Na levels. T e rate of correction even in symptomatic and acute cases should not exceed 1 to 2 mEq/L/hr and 8–10 mEq/L in 24 hours to avoid central pontine myelinolysis.

4. C. Hyponatremia is defined as a serum sodium >150 mEq/L. In patients with neurologic injuries, this is commonly due to diabetes insipidus (DI). DI is due to low levels of ADH or renal insensitivity to ADH. T e diagnosis can be reached by high output of inappropriately dilute urine with high serum osmolality and high serum sodium. T e two major etiologies are neurogenic DI and nephrogenic DI. T e primary causes of nephrogenic DI are medications, renal disease, hypokalemia, and hypercalcemia. Neuropenic DI can be idiopathic, posttraumatic, tumors, infections, vascular, and autoimmune. In a posttraumatic patient who has worsening mental status, the cause is most likely due to herniation from pituitary stalk injury or hypothalamic injury from impending brain death.

5. B. After arriving at the diagnosis of central diabetes insipidus, it is essential to begin treatment of the patient. T e treatment of DI is based around antidiuretic hormone (ADH) analogues. Te e include Pitressin® and the longer acting, more potent form, DDAVP. In a conscious and ambulatory patient, often their thirst mechanisms will compensate for the hypernatremia. However, the patient in this scenario is unable to drink or compensate with his thirst mechanism, so D is clearly incorrect. If the patient is not able to drink, they should be monitored for Is and Os q1h with serum sodium draws every 6 hours. To deal with the fluid loss, the patient should be placed on a basal fluid rate with D5½ NS with replacement for urine output above the base rate. If the fluid replacement continues to fall behind and the hypernatremia worsens, Pitressin or DDAVP...
may be given. Though all the possible answers are treatments for DI, only the first three could be utilized for this patient.

BIBLIOGRAPHY


There is an ammonium nitrate explosion at a local fertilizer plant, with multiple injured persons and fatalities at the scene. Pre-hospital EMS providers, first responders, and bystanders begin to administer first aid to the injured and start transfer of patients to the local hospital. As the on-call emergency medicine physician, you and your colleagues stand ready in the emergency department while preparing for a potential mass casualty event. As part of the report for incoming injuries, you are notified that there are multiple face and eye injuries. The on-call ophthalmologist is on his way, but he is being delayed by the traffic that was caused by the explosion. You have been designated to manage ophthalmic injuries until he arrives.

1. A 35-year-old male involved in the explosion was splashed in the face with ammonia. His face was irrigated with water at the scene, but he complains of persistent eye pain and decreased vision. The first priority in the initial care of the patient should be?
   A. Obtaining visual acuity
   B. Neutralization of pH with an acidic solution
   C. Copious irrigation with non-caustic solution
   D. Obtaining eye pressure
   E. Pain control

2. You examine a 45-year-old female worker who fell during the explosion, striking her eye on the side of a work bench. On gently retracting the lids, the globe appears soft and irregular with diffuse subconjunctival hemorrhage and swelling. She can only count fingers with that eye. You suspect a ruptured globe and begin management until the ophthalmologist arrives. Which of the following would be contra-indicated in the initial management of this patient?
   A. Ultrasound
   B. Fox Shield/Rigid Eye Shield
   C. Antibiotics
   D. X-Ray/CT
   E. Tetanus shot

3. A worker is hit in the left eye/orbit with a large piece of flying debris. The patient is in severe pain, and is unable to open his eye. Gentle palpation of the left eye reveals a markedly swollen orbit that is difficult to retropulse. The eyelids are tense but you are able to gently open the lids with a retractor. Vision is light perception only. You note the pupil dilates when you shine light in it, but the contralateral pupil then constricts as you swing the light to it. Extraocular motility is severely limited. What is your diagnosis and plan for management?
   A. Open globe—lateral canthotomy and cantholysis
   B. Orbital blowout fracture—orbital decompression
   C. Retrobulbar hemorrhage—pressure patch in anticipation of surgical intervention
   D. Retrobulbar hemorrhage—lateral canthotomy and cantholysis
   E. Periorbital ecchymosis—ice packs and pain control

4. There is an elementary school next to the fertilizer plant. A 7-year-old child was struck in the right face.
and orbit with flying debris, resulting in a brief loss of consciousness. He has minimal bruising on his face and he has no complaints other than mild discomfort around that eye. As you conduct your exam, you note that he avoids looking at you, preferring to keep his eyes shut. His vision, intraocular pressure (IOP), and pupil exam appear normal, but when you instruct him to look up as part of the exam, he immediately vomits. You continue your exam and note that his heart rate drops dramatically whenever you ask him to move his eyes, prompting you to discontinue the exam. You suspect an orbital fracture but the eye and lid are otherwise unremarkable. What is your concern and urgency?

A. Intracranial hemorrhage: emergent
B. Orbital floor (“blowout”) fracture: emergent
C. Orbital floor (“blowout”): non-urgent
D. Retrobulbar hemorrhage: emergent
E. Carotid dissection: non-urgent

5. The on-call ophthalmologist has called to get an update on the patients you have seen. Which of the following physical exam or imaging techniques would be indicated for the given pathology?

A. Best corrected visual acuity in a retrobulbar hemorrhage.
B. Relative afferent pupillary defect (RAPD) with an open globe injury.
C. Intraocular pressure exam in a chemical burn.
D. Ultrasound when computerized tomography (CT) scan is not available in a suspected globe rupture.
E. CT scan of orbit and brain with intraorbital foreign body.

ANSWERS

1. C. A chemical injury is a true ophthalmic emergency. While visual acuity and IOP are the “vital signs” of ophthalmology, in the case of a chemical injury, diluting and removing the chemical agent takes priority. Copious but gentle irrigation with any non-caustic fluid should begin in the prehospital setting and continue at the hospital until the pH of the ocular surface has normalized to between 7.0 and 7.2. In an emergency department setting, Lactated Ringer’s or normal saline are the preferred fluids for irrigation, but tap water can be used, if necessary. Irrigation should last for at least 30 minutes and may require several liters of irritant.

2. A. A history suspicious for open globe will often include a blunt or penetrating trauma to the eye, a feeling of loss of fluid from the eye, pain, and decreased vision. Determining whether there is an open globe is one of the most important aspects of the ocular trauma evaluation, as this requires meticulous initial care to prevent additional injury and an emergent evaluation by an ophthalmologist. Signs that are concerning for open globe include a soft or irregular-appearing globe, an irregular or peaked pupil, hemorrhagic swelling of the conjunctiva (especially if 360 degrees), positive Seidel’s sign on the cornea (leakage of fluid seen upon staining with fluorescein), hyphema (blood in the anterior chamber),
a shallow or deep anterior chamber (compared to the uninjured eye), decreased extraocular motility, foreign body tract, and severe vision loss.

Figure 75-1 shows a patient who presented to the emergency department after being hit in the eye with a branch. He complained of fluid leakage from his eye, mild to moderate eye pain, and decreased vision. Note the irregular, cloudy pupil, flat anterior chamber, and the leakage of intraocular fluids (vitreous) at the 5 o’clock position of the eye. Also note the examiner’s finger positioning, minimizing pressure on the globe. T is allows for a proper examination without applying pressure to the globe, which could lead to further extrusion of intraocular contents.

Once the diagnosis of an open globe is made, further examination should be deferred to the ophthalmologist, who can address the injury at the time of surgical repair. A visual acuity may be obtained (light perception, hand motion, count fingers are appropriate measures if the patient cannot see letters on a near card) but measurement of IOP should not be attempted. No pressure should be applied to an eye with a suspected open globe, to include an ultrasound probe, especially when other clinical findings strongly point to the diagnosis and disposition. Ask the patient not to strain or squeeze their eyelids. Do not remove any penetrating objects.

A rigid eye shield should be applied over the patient’s eye to prevent further injury. If a rigid eye shield is not available, alternatives include the bottom of a paper cup, moldable splints (e.g., SAM® splints), or sunglasses/eye protection. Do not apply patches or gauze pads to an open globe. Do not use topical anesthetics or ointments. Anti-nausea medications should be given with any pain medications to prevent Valsalva and/or vomiting. Imaging (preferably an axial face and orbit CT scan with coronal reconstructions) should be obtained to rule out concomitant injuries or unidentified retained foreign bodies.

Antibiotics should be given within 6 hours of the injury (4th generation fluoroquinolones IV have excellent vitreous penetration are preferred in adults; Cefazolin 25 to 50 mg/kg/day IV in 3 divided doses and Gentamicin 2 mg/kg IV q8h for children). A tetanus shot should be given if necessary. Remembering how to deal with an open globe can be facilitated by using the acronym FACT: Fox shield, Antibiotics/Anti-emetics/Analgesia, CT scan, and Tetanus shot. T e eye should be shielded and the patient should be transferred immediately to the nearest ophthalmologist for further care.

3. D. In a patient who has had recent blunt trauma or surgery to the eye/orbit, findings of intense pain, decreased vision, an RAPD (the affected pupil paradoxically dilates to light, while the normal pupil constricts to it), inability to open eyelids due to swelling, and loss of color vision should raise a strong suspicion for retrobulbar hemorrhage, which is a true ocular emergency. In contrast to the open globe, the exam will reveal a tense, proptotic globe that is resistant to retropulsion on gentle palpation. In the case of an orbital blowout fracture, the globe is usually enophthalmic (sunken in) and there is pain on eye movement, but the visual acuity is usually normal or only slightly decreased. A patient with periorbital ecchymosis (“black eye”) may have some periorbital tenderness and swelling but should not have globe proptosis, significantly elevated eye pressure, or visual acuity changes.

Retrobulbar hemorrhage is an orbital compartment syndrome that can rapidly and permanently damage the optic nerve and retina leading to permanent vision loss if not identified and treated immediately. T e retina's ischemic tolerance time is roughly 90 minutes. Retrobulbar hemorrhage is a clinical diagnosis and does not require any additional imaging. T e key to effective management of a retrobulbar hemorrhage is timely and aggressive decompression.
with a lateral canthotomy and cantholysis by the first provider that is able to perform the decompression (see Figure 75-2). The goal is to disinsert the lower eyelid sling from its periosteal attachments at the lateral canthus. The only two instruments needed are tissue forceps, and blunt scissors. If available, local anesthetic and a hemostat can facilitate a smoother procedure.

A detailed description of lateral canthotomy and cantholysis is found within the article “Emergency lateral canthotomy and cantholysis: A simple procedure to preserve vision from sight threatening orbital hemorrhage,” by Ballard, et al. Following a successful lateral canthotomy and cantholysis, additional measures to reduce the orbital pressure should be instituted, including applying ice packs to the orbit, elevation of the head, and administration of systemic analgesia and anti-emetics.

4. B. This is what is known as a “white-eyed blow out fracture” or trapdoor fracture with oculocardiac reflex, and represents an ocular emergency.
Children's bones are flexible, and their orbital bones can break and bend, allowing the rectus muscle to pass below the broken but non-displaced bone. This can result in a fracture in which the rectus muscle is trapped below what appears to be an intact orbital floor. The external signs can be minimal: there may be no periorbital edema but the patient will exhibit significant extraocular muscle restriction. A child will often not complain of double vision, rather he may simply close one or both eyes.

The oculocardiac reflex can occur when extraocular muscles are pulled. Immediate signs and symptoms can include nausea, vomiting, and bradycardia with eye movement. Bradycardia can be so profound as to cause syncope or asystole. The manifestation of this reflex is an ocular emergency and an ophthalmologist should be consulted immediately for definitive management.

Adults with orbital floor fractures will complain of pain on attempted eye movement, binocular vertical diplopia, and hypoesthesia in the distribution of the infraorbital nerve V2 (ipsilateral cheek and upper lip). Signs may include enophthalmos, crepitus, subcutaneous emphysema, restricted eye movement, nosebleeds, bony point tenderness, and step-off deformities of the orbital rim. If the patient had an intracranial hemorrhage, dilated pupils and rapidly declining mental status should be expected. A retrobulbar hemorrhage or carotid dissection would cause an RAPD. Periorbital ecchymosis should not cause vomiting and/or bradycardia. While orbital blowout fractures in children can be an ocular emergency, in adults without an RAPD or oculocardiac reflex, ophthalmic referral can be delayed up to 24 to 48 hours. An RAPD, flashes, floaters, photophobia, or decreased vision should prompt an immediate ophthalmic consult.

5. E. Ultrasound is contraindicated in an open globe because pressure on the globe may lead to extrusion of intraocular contents. The initial visual acuity in an open globe correlates with trauma severity and is highly predictive of final visual outcome. The RAPD in a patient with a retrobulbar hemorrhage indicates ocular compartment syndrome, requiring emergent decompression. Fluorescein exam in a chemical burn indicates the extent of the corneal damage. In the case of penetrating ocular or orbital injury, a CT scan should always be obtained to determine the location of intraorbital foreign bodies and to rule out optic nerve or central nervous system involvement.

An eye exam can be broken down into a “primary survey” (identifying sight-threatening injuries) and a “secondary survey” (the complete ophthalmic exam). The primary survey is performed using a muscle light/penlight, fluorescein with Wood’s lamp, a visual acuity card, an intraocular pressure (IOP) instrument, and an ophthalmoscope. The secondary survey is performed using a slit lamp and an ophthalmoscope.

Key findings on the primary survey include:

- Best corrected visual acuity: Count fingers (CF), hand motion (HM), and no light perception (NLP) from best to worst if the patient is unable to visualize the far or near charts.
- IOP: not elevated (> 21) or decreased (< 10) (Note: do not perform if suspecting open globe).
- Globe: well formed, no leakage of fluid, free extraocular motility, no proptosis, not tense to retropulsion, no foreign bodies, enophthalmos/exophthalmos, no oculocardiac reflex.
- Cornea: fluorescein exam without evidence of uptake or leakage, no corneal clouding, no foreign bodies [NB: contact lenses should be removed].
- Conjunctiva: no swelling, no blanching, no subconjunctival hemorrhage.
- Anterior chamber: well formed, no inflammation, no blood (hyphema).
- Pupil: reactive to light and accommodation, not peaked/irregular/torn.
- Posterior segment: no optic nerve swelling, no vitreous hemorrhage.

Key findings on the secondary survey:

- Orbit/Globe: crepitus, step-offs/deformities, numbness on cheek, teeth, or forehead.
- Lids: laceration, medial canthus rounding, canalicular lacerations, epiphora, tense lids, ecchymosis, fornix evaluation, singed lashes.
- Conjunctiva: laceration.
- Cornea: corneal edema.
- Iris: iris tears, photophobia.
- Anterior segment: lens dislocation.
- Posterior segment: retinal detachment.

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Joint T eater Trauma System Clinical Practice Guideline. Initial care of ocular and adnexal injuries by non-ophthalmologists at Role 1, Role 2, and non-ophthalmic Role 3 Facilities. CENCOM. November 2014.

1. A 22-year-old male who sustained a gunshot wound to the chest arrives in the emergency room at your facility. He is hemodynamically stable and has an entry wound just below his right nipple and probable exit wound just below the tip of the left scapula. Supine chest film shows no retained bullet fragments, contusion of the lung and moderate left apical pneumothorax. A pericardial ultrasound shows no effusion or other abnormality. The initial diagnostic work-up and management of this injury should include:

A. Computerized tomography angiogram (CTA) of the chest after placement of left chest thoracostomy tube.
B. Placement of left thoracostomy tube and observation on the ward.
C. Trans-esophageal echocardiogram, non-contrast CT scan of the chest, and left chest thoracostomy tube.
D. Bronchoscopy, esophagoscopy, esophagography, a catheter angiogram of the thoracic aorta, and left chest thoracostomy tube.
E. Immediate surgical exploration via a median sternotomy.

2. A 50-year-old male is brought to a local emergency room after a motor vehicle collision. He is complaining of mild mid-sternal chest pain and has some bruising over the sternum. He is a healthy male with no cardiac history. CT scan of the chest, abdomen, and pelvis are unremarkable. Electrocardiogram shows normal sinus rhythm with a heart rate of 65 bpm. What is the most appropriate management of this patient?

A. Admission to the intensive care unit with serial cardiac panel and repeat chest film in 24 hours.
B. Echocardiogram performed in the emergency room to evaluate cardiac wall motion.
C. Discharge home with instructions to return to the hospital if the symptoms worsen.
D. Consultation with cardiologist for suspected acute coronary syndrome.
E. Repeat CT scan of the chest in 12 hours.

3. A 33-year-old female was admitted after being involved in a motor vehicle collision five days ago. She had a left chest tube placed upon admission for a hemothorax. Initially, 150cc of blood was evacuated but after 24 hours, only additional 100cc came out. A repeat CT scan of the chest now shows a retained hemothorax and there has been minimal drainage from the chest tube for the past 48 hours. The most appropriate management of this patient at this time would be:

A. Video assisted thorascopic surgery (VATS) to evacuate the hemothorax.
B. VATS if hemothorax does not resolve in three more weeks of observation.
C. Instill thrombolytic agent into the chest cavity via the chest tube to break up the clot.
D. Toracotomy for decortication and evacuation of hemothorax.
E. CT scan guided aspiration of retained hemothorax.
4. A 21-year-old male sustained multiple injuries after he struck a tree while riding a motorcycle traveling at 60 mph. He was intubated at the scene for unresponsiveness. He was transported to your medical center and trauma evaluation was significant for a 2 cm right-sided frontal cerebral contusion, fracture of ribs 2 through 6 on the right, right clavicle fracture and moderate right pulmonary contusion. A right-sided chest tube was placed for large pneumothorax. Repeat chest film shows a persistent pneumothorax so a second chest tube was placed. A third set of chest films show that the lung has re-expanded slightly but a moderate apical pneumothorax remains. The two chest tubes have a persistent large air leak present. The next step in this patient’s management should be:

A. Oxygenate with 100% oxygen for 24 hours to allow pneumothorax to resolve spontaneously.
B. Repeat chest film in six hours and planned VATS if pneumothorax persists.
C. Urgent bronchscopy.
D. Continued observation as long as the patient is stable and oxygenating well.
E. Thoracotomy for repair of probable large parenchymal lung laceration.

5. An 80-year-old male sustained multiple bilateral rib fractures and a mild pulmonary contusion after a motor vehicle collision. He is hemodynamically stable and oxygenating well in the emergency room but complains of chest pain upon deep inspiration. Trauma evaluation did not reveal any other injuries. The appropriate management of this patient should be:

A. Discharge to home on oral pain medications and instructions to return to the hospital if his condition worsens.
B. Admission to medical-surgical ward with supplemental oxygen and orders for repeat chest films in 12 hours.
C. Admission to intensive care unit, pain control with either a thoracic epidural or patient controlled analgesia (PCA) with ketorolac, and incentive spirometry.
D. Admission to intensive care unit and schedule operative fixation of rib fractures for the following day.
E. Admission to intensive care unit and electively intubate the patient as he is at significant risk for respiratory failure.

ANSWERS

1. A. Although majority of thoracic gunshot wounds will be localized to one side of the thoracic cavity, it is critical to identify the smaller subgroup of patients with a trans-mediastinal trajectory. Trans-mediastinal gunshot wounds carry a significantly higher mortality and morbidity, and can present a diagnostic and management dilemma due to the number of critical structures at risk of injury. Unstable patients require immediate intervention and surgical exploration based on the initial examination and imaging findings. Stable patients require further radiologic workup, with the goal of excluding injury to the heart, lungs, great vessels, esophagus, and tracheobronchial tree. Historically this mandated an exhaustive series of imaging studies including chest X-ray or CT scan, echocardiogram, esophagoscopy and esophagography, thoracic angiography, and bronchoscopy.

With the improved availability and image quality obtained with modern CT scanners, this exhaustive workup has largely been replaced by a single high-quality CT scan of the chest with intravenous contrast in most trauma centers. In addition to imaging the critical mediastinal structures of interest, the CT scan can be used to re-create the missile tract and assess the proximity to these structures and to identify any secondary signs of injury (Figure 76-1). Patients with a negative CT scan can be safely observe, while those with any concern for a potential
injury can then undergo additional focused evaluation based on the CT scan results. The patient has a left pneumothorax and thus a left tube thoracostomy should be placed prior to obtaining the CT scan. Immediate operative exploration is not indicated in the stable patient with no other obvious signs of injury to a mediastinal organ or structure.

2. C. The patient presents with mild symptoms after motor vehicle collision. Cardiac contusion should be suspected but unlikely given clinically presentation and normal electrocardiogram. Serial cardiac panel could yield mildly elevated enzymes but not clinically relevant data. Echocardiogram would not be indicated either given normal electrocardiogram. Cardiology consult is not necessary since the patient’s symptoms are not related to myocardial ischemia. A repeat CT scan of the chest will likely show no changes. The patient can be safely discharged home.

3. A. The patient has a retained hemothorax. There is a significant risk for this patient to develop a complicated fluid collection, fibrothorax, or empyema if the hemothorax is not evacuated in a timely manner. The instillation of thrombolytic agents into the chest cavity or CT scan guided aspiration of hemothorax may not result in complete evacuation of the hemotoma since much of the hemotoma is probably solidified clot at this point. Patients who received early VATS (within 5 days) had lower incidence of developing empyema in several studies. Thoracotomy would not be warranted at this time since the hemothorax can be evacuated less invasively with VATS. CT guided drainage is an option but a significant portion of the hemotoma has clotted; therefore, this will not likely be an effective therapy.

4. C. The patient has sustained significant chest trauma but tracheobronchial injury must be ruled out given persistent pneumothorax. It is particularly true in the presence of a large and persistent air leak and inability to re-expand the lung despite adequate mechanical ventilation and chest tube drainage. An urgent bronchoscopy will be needed to evaluate for a tracheobronchial injury that may require intervention or surgical repair. It would not be wise to perform a blind thoracotomy until bronchoscopy is performed first to identify and localize the injury. Observation is particularly dangerous in this situation since even a brief period of hypoxia is not tolerated well in a patient with traumatic brain injury. 100% oxygen therapy is usually reserved for non-traumatic pneumothoraces.

5. C. The patient is an elderly male who sustained chest trauma resulting in multiple rib fractures and pulmonary contusion. The patient is at a high risk for pulmonary complications, pneumonia, and death if not managed appropriately and aggressively. The patient should be admitted to the intensive care unit for close monitoring and pain management. Elderly patients often have limited physiologic reserve and unrecognized decompensation on a medical-surgical ward could have tragic implications. Pain control with either a thoracic epidural infusion or intravenous/oral narcotics supplemented with a non-steroidal anti-inflammatory agent such as ketorolac should be initiated, and titrated to allow full inspiratory effort without pain. Intubation should not be done until the patient has failed conservative management (including in selected cases a trial of non-invasive ventilator support). Operative fixation of rib fractures is usually reserved for patients who are difficult to wean from mechanical ventilation, and would not be indicated this early after the initial injury.

BIBLIOGRAPHY


A 68-year-old female is brought into the emergency department by her son for evaluation of altered mental status. The son reports that his mother rarely goes to the doctor, is an alcoholic, and has been a smoker as long as he can remember. She has occasionally had intermittent bouts of diverticulitis that have been treated with oral antibiotics. Her most recent bout was 2 weeks ago for which she recently finished a course of antibiotics. For the past two days she has had frequent stools and increasing abdominal pain over the past 48 hours. Today she was noted to be somnolent and difficult to arouse by her son.

On exam, her vitals show a temperature of 101.8°F, with a heart rate of 121. Her blood pressure is 83/54 and respiratory rate of 24, O2: 83% on RA. She is lethargic, lungs are coarse bilaterally; her abdomen is distended, and she grimaces with palpation of her lower abdomen. Her skin is pale and cool, and she has flat neck veins. Labs are significant for a white blood cell count (WBC) of 24, creatinine of 3.2, and lactate of 5.8. An arterial blood gas is obtained that pH of 7.30, pCO₂ of 80, and pO₂ of 67 with a base deficit of 10. Her central venous oxygen saturation (ScvO₂) is 55%.

1. The patient is intubated and transfer to the intensive care unit (ICU) is being arranged. Which of the following is true regarding the initiation of goal directed therapy?
   A. Antibiotic therapy should be delayed until all cultures are obtained and a causative organism is identified.
   B. Normalization of blood lactate is a poor guide for resuscitation.
   C. Goals of early goal directed therapy in sepsis are to achieve a central venous pressure (CVP) 8 to 12 mm Hg; urine output ≥ 0.5 mL/kg/hr; and ScvO₂ of 70% or greater.
   D. In intubated patients, a higher CVP (12 to 15 mm Hg) should be considered pathologic.
   E. Early initiation of targeted goal directed therapy in sepsis has not been definitively shown to improve survival.

2. Despite receiving 3 liters of crystalloid, the patient remains hypotensive with a systolic blood pressure of 75 and a ScvO₂ of 60. Her hematocrit is 41%.

Which of the following is the appropriate next step?
   A. Switch to using a hydroxyethyl starch solutions as they are considered equivalent to isotonic crystalloid in the resuscitation of septic patients, and are useful in patients in fluid refractory shock.
   B. Start a high dose phenylephrine infusion and titrate to a MAP of 65 mm Hg.
   C. Initiate a Levophed (norepinephrine) infusion and if the patient remains hypotensive consider starting a low dose vasopressin infusion.
   D. Start an infusion of intravenous hydrocortisone.
   E. Obtain an echocardiogram to determine if the patient is in cardiogenic shock prior to initiating a vasopressor.

3. Initial cultures were sent on admission. Because of a recent history of antibiotic use and diarrhea, a polymerase chain reaction (PCR) based
clostridium difficile toxin test was sent as well. Despite initiating broad spectrum antibiotics the patient remain in shock. Twelve hours after admission the labs calls and tells the nurse that the test is positive for clostridium difficile (C. difficile) toxin. Which of the following statements is true regarding the management of this patient?

A. Repeat the test for C. difficile because PCR based tests have a high false positive rate.
B. In addition to broad-spectrum antibiotics, antifungal agents should be routinely started on admission of septic patients.
C. After a patient is asymptomatic, low pro brain natriuretic peptide can help the decision to discontinue antibiotics.
D. Surgical intervention for this pathology would include a total abdominal colectomy and end ileostomy.
E. Once a source of infection is identified, source control should be initiated after antibiotics have taken effect and the patient is no longer septic.

4. Upon arrival to the ICU a chest X-ray is obtained and is shows bilateral infiltrates. The ventilator is set to assist control mode with a peep of 5, tidal volume of 8 cc/kg, and FiO$_2$ of 60% On these setting her most recent PaO$_2$ is 55. You suspect acute respiratory distress syndrome (ARDS). Which of the following is true regarding ARDS?

A. ARDS requires the presence of a focal and unilateral infiltrate or consolidation on chest X-ray.
B. In patients with ARDS, routine corticosteroid use has been shown to reduce the overall mortality rate compared to placebo.
C. Use of high tidal volumes and low positive end-expiratory pressure (PEEP) is the traditional ventilator strategy used to ventilate patients with ARDS.
D. Treatment options for refractory ARDS that has failed conventional ventilation include airway pressure release ventilation (APRV), high frequency ventilation, and extra-corporeal membrane oxygenation (ECMO).
E. Airway pressure release ventilation has been shown to improve mortality in patients with ARDS.

5. In patients treated for septic shock, there are consequences of a prolonged ICU stay and can include progressive dysfunction and even failure of multiple organ systems. Regarding outcomes of multi-organ dysfunction syndrome (MODS), which of the following is true?

A. For septic patients that develop agitation and delirium, the use of benzodiazepines has been shown to reduce length of ICU stay, making them preferred over other agents.
B. Acute kidney injury is an independent risk factor for death in patients with multi-organ dysfunction syndrome.
C. Because septic patients are hypermetabolic, parental nutrition has been shown to be beneficial when initiated early.
D. Stress ulcer prophylaxis with proton-pump inhibitors is not associated with any adverse events or complications.
E. Critical illness polyneuropathy does not result in difficulty weaning a patient from a ventilator because it results in peripheral nerve dysfunction but preservation of the diaphragm.

ANSWERS

1. C. The main principles of sepsis therapy are to begin both treatment and resuscitation immediately upon identification of sepsis or suspected sepsis. Treatment should consist of early initiation of empiric broad spectrum antibiotics and initial antibiotic administration does not require identification of the exact causative organism. When sepsis is suspected early initiation of resuscitation with the goal of reversing tissue induced hypoperfusion has been shown to improve patient survival in patients presenting with septic shock. The goals of resuscitation should be to achieve a CVP 8–12 mm Hg, MAP ≥65 mm Hg, urine output ≥0.5 mL/kg/hr, and SvO$_2$ of 70% or ScvO$_2$ of 65% within 6 hours. In mechanically ventilated patients venous return can be impeded and as a result a higher target for CVP (12 to 15 mm Hg) is recommended. Note that there is no arbitrary systolic blood pressure as a primary goal of resuscitation.

Lactate is also a marker of metabolic acidosis and tissue hypoperfusion, and is seen in a majority of patients presenting in septic shock. When a patient presents with hypotension and an elevated lactate (≥4) they have an increased mortality over elevated lactate or hypotension alone. If a patient presents with an elevated lactate it can be monitored until it reaches normal levels and can be used along with
other markers, to guide resuscitation. Base deficit is another measure of metabolic acidosis that may be used to gauge the severity of illness and to guide resuscitation. It is often used as a surrogate for lactate, but there are many other factors that can impact the base deficit (renal failure, alcohol, bicarbonate losses), making it a less specific measure of tissue hypoperfusion and lactic acidosis.

In addition to restoring tissue hypoperfusion, a source of the patients sepsis should be sought and appropriate antibiotics should be administered. Each hour antibiotics administration is delayed results in a measurable increase in patient mortality. Ideally, cultures should be obtained prior to giving antibiotics with the goal of administering antibiotics within one hour of presenting with sepsis. However if obtaining appropriate cultures would delay the administration of antibiotics beyond one hour, then antibiotics should be given prior to obtaining cultures.

2. C. Many studies have been conducted comparing synthetic starches to isotonic crystalloid based solutions. The results of these studied have varied. Some studies have shown no mortality difference, others have shown increased mortality or increased rates of renal replacement therapy. None have shown a benefit, and recent data suggest increased renal failure and mortality with administration of hydroxyethyl starch solutions. There is also a concern for the potential impact of these solutions on platelet function and coagulation. As a result, starch-based solutions are not recommended for resuscitation.

Vasopressor therapy is recommended for use in hypotensive septic patients after adequate volume resuscitation to maintain perfusion pressures. Norepinephrine (Levophed) is currently the initial vasopressor of choice for septic shock, as it provides a balanced pressor and cardiac inotrope effect. Dopamine is associated with increased short-term mortality and serious adverse events compared to norepinephrine. Pure vasopressors such as phenylephrine should be avoided as the unopposed vasoconstriction can often further worsen the ongoing tissue hypoperfusion and lead to severe extremity or bowel ischemia. If the patient remains hypotensive after starting norepinephrine then starting a low dose infusion of vasopressin at 0.03 U/min can be used to decrease the dose of norepinephrine and enhance organ perfusion. If the patient remains in septic shock despite fluids and appropriate vasopressor therapy then corticosteroid administration can be considered.

Based on the presentation, there is a high suspicion of septic shock and no clinical or physical exam signs of cardiogenic shock. While an echocardiogram may be useful in certain situations, the treatment for septic shock should not be delayed. Delaying treatment of septic shock and can result in increased patient mortality.

3. D. T is patient has a C. difficile infection and likely toxic megacolon secondary to the infection. PCR based C. difficile toxin as well as most current test for C. difficile are extremely sensitive and specific for the diagnosis of an active C. difficile infection and repeat testing is not necessary. The severity of C. difficile infections can range from mild to severe. In very severe cases, patients can present with shock and sepsis known as fulminant C. difficile colitis or toxic megacolon. Over the past two decades this diagnosis has become more common, and more and more patients are requiring surgical intervention.

While we do not know from the description if there is perforation or peritoneal signs, this patient is clearly in shock. Antibiotic therapy should be targeted at the suspected diagnosis and the patient should be immediately evaluated for surgical intervention. Surgical intervention for toxic megacolon from any cause typically mandates resection of the entire colon (total abdominal colectomy) and placement of an end ileostomy. Anti-fungal agents should not be routinely started in septic patients. They should be used only in patients that are at risk of or suspected of having a fungal infection. Patients that are immunocompromised, neutropenic, or live in at risk areas should be considered for the implementation of anti-fungal agents. However, there is nothing in this patients history that would lead us to suspect she is at an increased for a fungal infection.

Once a source of infection is identified then antimicrobial therapy should be targeted at the suspected source. If there a specific anatomical source of infection such as an abscess, cholangitis, and so on, that is driving a patient’s sepsis, then emergent-targeted therapy should be initiated within 12 hours; not after antibiotics have taken effect. However, if no source of infection is identified and the patient improved with empiric anti-biotic therapy, then procalcitonin levels (not pro BNP levels) can be used to help a clinician determine when to stop anti-microbial therapy.
4. D. In 2012, an updated clinical definition of ARDS (known as the Berlin Definition) was published. The presence of bilateral chest opacities is needed to make the diagnosis of ARDS, and either a chest radiograph or a CT scan is an acceptable way to evaluate for this. A focal unilateral infiltrate or consolidation on chest X-ray would be more consistent with lobar pneumonia than ARDS. According to the most recent ARDS definition outlined by the ARDS task force the diagnosis of ARDS must be made within one week of a known clinical insult, and typically the diagnosis is made within 72 hours. After the diagnosis is made, the use of low tidal volumes (4 to 6 mL/kg) should be initiated as this is the only mode of ventilation shown to improve mortality in randomized controlled trials of patients with ARDS. As part of this strategy, high PEEP is often utilized to increase alveolar recruitment and improve oxygenation, but has not been shown to improve overall mortality.

Many other strategies are utilized to try and improve outcomes in patients with refractory ARDS. One treatment that has been studied is the use of corticosteroids. The ARDSNet trial showed that while corticosteroids reduced the mean number of days on a ventilator and increased the number of shock-free days, they had no effect on overall survival and were harmful when given more than two weeks after the diagnosis of ARDS was made. Meduri et al. used low dose corticosteroids, and while ICU mortality was significantly reduced overall mortality was not. For the patient in ARDS who is refractory to standard mechanical ventilation, salvage or rescue options include switching to APRV, high frequency or “jet” ventilation, and even ECMO. Other rescue therapies include prone positioning, neuromuscular blockade, and inhaled nitric oxide. While these treatments are used as rescue therapies in severe ARDS and have been shown to produce improved oxygenation, they have not been shown to improve mortality in controlled trials.

5. B. There are many challenges that are encountered when managing a critically ill patient, and delirium is a commonly encountered complication in the ICU setting. Severely ill and older patients are at particularly high risk for developing delirium, and this has been shown to adversely impact morbidity and mortality. While benzodiazepines are effective for delirium acutely, their use has been shown to increase ICU length of stay and as a result they should be avoided whenever possible. Rather the primary treatment for agitation and delirium is non-pharmacologic and includes reorientation and maintenance of sleep-wake cycles. If this is ineffective then antipsychotics such as haloperidol or the newer atypical antipsychotics are preferred to benzodiazepines.

Another area that can challenge the management of septic patients is predicting which patients are likely to have a worse outcome. There are many scoring systems that are utilized to predict outcomes in these patients, including the well-described APACHE score. One such system that is specific for multi-organ failure is the Sequential Organ Failure Assessment or SOFA score. This system independently grades the severity of organ dysfunction for 6 different organ systems: respiratory, coagulation, liver, cardiovascular, central nervous system, and renal. The individual scores are then added to give a total score.

Higher overall SOFA scores directly correlate with a worse outcome (Figure 7.1-1). Mortality has been shown to directly increase with the number of organ systems that are failing, and approaches 100% when 4 or more organ systems have failed. Among individual organ systems, one of the strongest predictors of ICU morbidity and risk of mortality is the development of acute kidney injury and/or renal failure.

Many critically ill patients are at increased risk of upper gastrointestinal bleeding, and stress ulcer prophylaxis is indicated for patients with prolonged mechanical ventilation (>48 hours) or other risk factors. The risk of bleeding from stress ulceration or gastritis in this patient population must be weighed against the risk of treatment with either proton pump inhibitors (PPI) or histamine receptor blockers (H2 blockers). Multiple studies have shown that patients that receive stress ulcer prophylaxis are at increased risk of adverse events and complications such as C. difficile infections, ventilator associated pneumonia, and thrombocytopenia (H2 blockers).

Although hypermetabolism and a prolonged catabolic state are characteristic of sepsis and MODS, there has been no demonstrated survival benefit of administration of parenteral nutrition. Multiple series have demonstrated that overall infectious complications are lower among patients given enteral nutrition versus total parenteral nutrition, and the gut should be the preferred route for nutritional support whenever possible. Another important problem that is seen in patients with septic shock is critical
illness polyneuropathy. The highly morbid condition is more common in patients with prolonged ICU stays and among patients who received steroids and/or neuromuscular blocking agents. It can present with muscle atrophy, limb weakness, peripheral sensory deficits and difficulty weaning patients from mechanical ventilation. However, cranial nerve function is usually spared.

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A 25-year-old man arrives in the emergency department after being pulled from a house fire. On initial evaluation in the emergency room, he is noted to be agitated, with singed hair around his mouth and coughing up black sputum. The right half of his torso and back are covered with thick leathery skin, as are his right arm, thigh, and leg. His right arm is burned circumferentially. The left half of his torso and back are erythematous, with no blisters. His vital signs are showing a temperature of 95.3°F with a heart rate of 120/min. Blood pressure is 110/50 mm Hg with a respiratory rate of 20, and Sat 89% on 6 L/min by nasal cannula. The patient is intubated and placed on mechanical ventilation. A secondary survey is performed, which reveals no additional injuries. The patient’s weight is 70 kg.

1. The patient is placed on 100% FiO2. An arterial blood gas is performed with the following results: pH: 7.24; pCO2: 32 mm Hg; pO2: 460 mm Hg; HCO3: 16 mEq/L; Base Excess: –12 mEq/L; Lactate: 8 mmol/L. Which of the following is the most appropriate next step in management?
   A. Intravenous methylene blue
   B. Hyperbaric oxygen
   C. Activated charcoal
   D. Hydroxocobalamin
   E. Decrease FiO2

2. Following the appropriate intervention in Question 1, the patient is started on 800 cc/hr of lactated ringers and transferred to the intensive care unit (ICU). A foley catheter is placed and after 4 hours he is noted to have 20 cc of urine output for 2 hours. Select the next most appropriate step in management.
   A. Continue lactated ringers (LR) at 800 cc/hr for 8 hours total, then decrease to 400 cc/hr for the following 16 hours.
   B. Increase LR to 1000 cc/hr then monitor urine output over the next hour.
   C. Bolus LR and titrate to a urine output of 30 to 50 cc/hr.
   D. Bolus LR and titrate to a urine output of 100 to 200 cc/hr.

3. After 4 hours in ICU, the patient’s right hand is noted to be cold. You are unable to palpate a radial or ulnar pulse. His vitals at this point are: Temperature: 97.5; HR: 140/min; BP: 90/40 (mean arterial pressure (MAP): 57) mm Hg; Sat: 100% on assist control/volume control (AC/VC) mechanical ventilation: FiO2: 60% RR: 20/min; tidal volume (TV): 400 cc; positive end-expiratory pressure (PEEP): 5 mm Hg. Which is the next most appropriate step in management?
   A. Bedside escharotomy of right arm.
   B. Immediate transfer to the operating room for fasciotomy.
   C. Initiation of vasopressor therapy to target a MAP of 65 mm Hg.
   D. Excision of right arm burns with split thickness skin graft from left thigh.

4. After ICU admission, topical mafenide acetate (Sulamylon) is placed on the burn wounds. On hospital day 3, labs are performed and enteral
feeding is started. Labs reveal a normal white blood cell (WBC) count at 10 K/µL, normal glucose at 110 mg/dL, and a chemistry panel remarkable for a HCO₃ of 12 mEq/L. An arterial blood gas demonstrates pH: 7.22; pCO₂: 24 mm Hg; pO₂: 200 mm Hg; HCO₃:12 mEq/L; Base Excess: –16 mEq/L, and Lactate: 2 mmol/L.

Which of the following is the next most appropriate step in management?
A. Decrease tube feeding rate.
B. Initiate systemic antibiotics.
C. Discontinue any topical antimicrobial treatment.
D. Change topical antimicrobial to silver nitrate.
E. No change in management is indicated.

5. On hospital day 4, the patient is doing well and the decision is made to perform excision and grafting of his burns. Which of the following statements about excision and grafting is true?
A. Excision and grafting of deep burns should be delayed at least 2 to 3 weeks to ensure that the burns have fully demarcated.
B. The ideal graft for burn excision wounds is a widely meshed full thickness skin graft.
C. Split-thickness skin graft sites may be re-used for additional graft harvesting on a weekly basis.
D. Negative pressure wound therapy (NPWT) has no place in the management of burn wounds.
E. Human cadaver allograft may be grafted to a burn wound to protect it until an appropriate autograft can be placed if there is not enough donor skin is available.

ANSWERS
1. D. Smoke inhalation injury is primarily a chemical injury to the tracheobronchial tree. Most thermal energy is dissipated in the upper airway. Inhalation injury increases mortality in burns by 20% and increases pneumonia risk by 40%. Cyanide poisoning in particular is frequently fatal and there is no easy method of diagnosis. Cyanide binds to cytochrome oxidase and stops cellular respiration. The diagnosis is suggested in any enclosed space fire where patients have evidence of smoke inhalation and suffer from altered mental status, and have a lactic acidosis; it may present with variable signs or symptoms from mild confusion and hyperventilation to complete obtundation, tachyarrhythmia, and cardiac arrest. Because of the difficulty with diagnosis, a high index of suspicion is necessary and treatment should be started immediately. Hydroxocobalamin should be administered to any patient who has suffered smoke inhalation and demonstrates signs of cardiovascular instability.

Carbon monoxide poisoning is the leading cause of death due to unintentional poisoning in the United States. Carbon monoxide binds to hemoglobin to make carboxyhemoglobin with an affinity 200 times higher than oxygen. The most common symptom of carbon monoxide poisoning is headache, however, similar to cyanide poisoning, the symptoms may be nonspecific, but severe poisoning leads to coma, arrhythmias, and death. Treatment involves 100% oxygen at normal atmospheric pressure with a tight-fitting mask (normobaric oxygen) or via ventilator in the intubated patient. Hyperbaric oxygen (HBO) may be indicated for severe carbon monoxide poisoning.

2. B. The rule of nines is used to calculate the percentage body surface area (BSA) burned in adults. Only second and third degree burns are included in the calculation of total BSA burned; first degree burns are not.

The most commonly used formula for calculating crystalloid resuscitation needs in the first 24 hours is the Parkland formula:

First 24 resuscitation = 4 cc × tBSA% burn × body weight (kg).

Half of this fluid is given in the first 8 hours after injury, and half in the next 16 hours.

It is important to note that the Parkland formula is only a guideline and intravenous fluid needs should be titrated to urine output of 30 to 50 cc/hr in most adults. If this urine output range is not achieved, the IV fluid rate should be adjusted −/+ 25% each hour until the desired urine output is reached. Fluid boluses should be avoided unless the patient is hypotensive as it could lead to overresuscitation.

3. A. Full thickness or deep partial thickness burns that are circumferential around an extremity or chest will prevent normal elastic movement of the skin. Edema after fluid resuscitation can cause tissue pressure to rise underneath this leathery skin and impair
circulation. The treatment is escharotomy, which involves a full thickness incision through the burned skin (epidermis and dermis down to subcutaneous fat). The incision is made along the medial or lateral aspect of the limb, or in the chest, in the mid-axillary line, to decompress underlying structures. The incisions should only be through the eschar, as they should not involve the deeper fascia. Although escharotomy is often confused with fasciotomy, the majority of circumferential extremity burns resulting in signs of elevated compartment pressures require only an escharotomy, and not a fasciotomy.

4. D. The patient has a severe metabolic acidosis that is likely due to treatment with Mafenide acetate (Sulfamylon). Mafenide acetate is a weak carbonic anhydrase inhibitor and can produce a non-gap metabolic acidosis. Silver sulfadiazine has broad spectrum activity and some activity against pseudomonas, but has poor eschar penetration. Mafenide acetate has good eschar penetration. Silver nitrate has broad spectrum activity and good eschar penetration, but stains skin and sheets black, and can cause hypotremia by leaching sodium from tissues. Silver nitrate however is the best alternative topical agent in this situation. Systemic antibiotics should not be given prophylactically, only for treatment of proven infections.

5. E. One of the greatest achievements in burn care was the adoption of early excision and grafting of deep burns. Early excision and grafting of burn wounds is associated with decreased mortality and decreased hospital length of stay.

Ideally, all devitalized tissue should be removed in the first week. Excision can be performed either by tangential excision (layers of burned tissue are excised until a bleeding wound bed is reached) or by fasic excision (excision to the layer of the fascia). Fascial excision results in less bleeding but can cause significant cosmetic deformities.

Skin coverage of excised areas is best done with meshed split thickness skin grafts but should be avoided in cosmetically sensitive areas (e.g., the face). Meshing allows a larger surface area to be covered as well as allowing space for blood and fluid to leak through the graft lessening the risk of hematoma or seroma formation under the graft. Donor sites may be recropped after they have healed, usually around 2 to 3 weeks. If there is a shortage of donor skin, skin substitutes may be used. Cadaver allograft is a good option for temporary coverage.

BIBLIOGRAPHY


A 49-year-old woman who has medically refractory Crohn's disease and high ileostomy output (2200 mL/day) is referred to your clinic. She has undergone several abdominal surgeries for complications of her Crohn's and she currently has a diverting ileostomy and approximately 120 cm of her small bowel. Of note, she has been unable to tolerate any inflammatory bowel disease medications aside from corticosteroids.

The patient was admitted to an outside hospital twice in the past 3 months for rehydration and repletion of sodium, potassium, and magnesium. She now comes to your institution complaining of increased ostomy output, lightheadedness, fatigue, and nausea. She reports a recent weight loss of approximately 20 pounds (approximately 15% of total body weight). A Hickman catheter is placed in her right subclavian vein and she receives 3 days of parenteral nutrition without complications. Insurance coverage for teduglutide is pending and she is discharged home on parenteral nutrition. You would like to perform an ileostomy takedown but would like to improve her nutritional status first.

1. Compared to enteral nutrition, parenteral nutrition (PN):
   A. Is less expensive
   B. Does not suffer from product shortages
   C. Preserves immunologic function of gut
   D. Is not associated with metabolic bone dysfunction
   E. Is less likely to cause diarrhea

2. Basic parenteral nutrition formulations include:
   A. Sucrose
   B. Amino acids
   C. 30% IV fat emulsion
   D. Omega-3 fatty acids
   E. Insulin

3. After 8 weeks at home receiving parenteral nutrition, your patient develops hair loss, a pustular rash around her mouth, and darkening of her skin creases. The most likely cause is:
   A. Copper deficiency
   B. Hyperkalemia
   C. Hyperglycemia
   D. Magnesium deficiency
   E. Zinc deficiency

4. All individuals who receive total parenteral nutrition for >13 weeks will develop:
   A. Venous thrombosis
   B. Steatohepatitis
   C. Gallbladder sludge
   D. Cholelithiasis
   E. Refeeding syndrome

5. If your patient on parenteral nutrition suddenly spikes a fever, the most important entity to rule out is:
   A. A Crohn's disease flare
   B. A catheter line infection
   C. An infection at the ostomy site
   D. Clostridium difficile colitis
   E. A urinary tract infection
ANSWERS

1. E. Compared to enteral nutrition, PN is less likely to cause diarrhea. Enteral nutrition is delivered directly to the GI tract and its hyperosmolality may result in diarrhea, especially in patients with an underlying condition that causes malabsorption. Diarrhea has been shown to occur in as many as 95% of patients who receive enteral feeds. PN is considerably more expensive than enteral nutrition. Shortages of many forms of product, especially vitamin and trace mineral components, has been causing delays in initiation of PN as well as inconsistent “mixing and matching” of different brands of product, which may result in certain micronutrient deficiencies if the provider does not have expertise with PN. Because it completely bypasses the GI tract, PN does not preserve the immunologic function of gut. PN has been associated with metabolic bone dysfunction and abnormal bone metabolism and some patients have been shown to develop osteoporosis and osteomalacia.

2. B. Standard components of PN formulas include amino acids, dextrose, a 10% or 20% IV fat emulsion to provide essential fatty acids, electrolytes (sodium phosphate, sodium chloride, sodium acetate, potassium phosphate, potassium chloride, potassium acetate, magnesium sulfate, and calcium gluconate), multi-component vitamins and multi-component trace minerals. Some potential additives include cysteine, regular insulin, and additional trace vitamins or elements as required. Although omega-3 fatty acid-enriched PN formulations have been studied as a potential means of decreasing inflammation and increasing immune function in certain subsets of patients, standard PN formulations do not contain them at this time.

3. E. Because copper works with iron to form red blood cells, an early sign of copper deficiency is anemia. Low body temperature, osteoporosis, low white blood cell count, irregular heartbeat, loss of skin pigmentation, and thyroid problems may also occur due to a deficiency of copper. Hyperkalemia is associated with a slow or irregular heartbeat and weakness. Signs of hyperglycemia include weakness, nausea, excessive thirst/urination/appetite, headache, irritability, and abdominal pain. Severe hyperglycemia can lead to unconsciousness. A magnesium deficiency often manifests as cardiac and muscle irregularities, including arrhythmia, weakness, muscle cramps or spasms, restless leg syndrome, and general agitation; additional signs and symptoms of low magnesium include nausea, vomiting, insomnia, and confusion. A pathognomonic sign of zinc deficiency is hair loss. Skin lesions, including acne, a perioral pustular and darkening of skin folds, are frequently observed. Loss of appetite, decreased motor skills, and decreased immunity may characteristic of low dietary zinc. PN must be formulated to address deficiencies at initiation as well as those that may occur over the course of hyperalimentation. While electrolyte levels are routinely monitored, one should be aware of the potential for vitamin and trace mineral deficits. Individual with high output fistula or ostomy can develop metabolic disturbances. T is patient may have had a zinc deficiency prior to receiving PN which should have been addressed and monitored.

4. C. Catheter-related venous thrombosis is a fairly rare complication of PN, occurring in 1% to 3% of individuals per catheter-year. Deleterious effects of PN on the liver and gallbladder are well known to clinicians. Hepatic steatosis, which may manifest as fatty liver infiltration, may occur in PN patients within 1 to 2 weeks of initiating PN. It is reversible and can be managed by limiting the fat content. Liver function tests (LFTs) should be checked weekly for individuals on PN and if they are elevated, lipids should be minimized to <1 g/kd/day and total or peripheral PN should be cycled over 12 hours to rest the liver.

If total bilirubin is >5–10 mg/dL due to hepatic dysfunction, trace elements should be discontinued due to the potential for toxicity of manganese and copper. Cholestasis is inevitable during PN because there are no intestinal nutrients to stimulate hepatic bile flow. Cholestasis typically occurs 2 to 6 weeks after starting PN and is indicated by progressive increases in total bilirubin and elevated serum alkaline phosphatase. While cholelithiasis is not uncommon during PN, it is certainly not ubiquitous. Re-feeding syndrome is a complication that begins rapidly after starting PN in a severely malnourished individual, typically a person who has been in a starvation state for >7–10 days. T is syndrome is characterized by a severe shift in fluid and serum electrolyte levels, especially hypophosphatemia, resulting from intracellular electrolyte movement. Severe systemic complications, and even death, can result from re-feeding syndrome. Correcting electrolyte abnormalities prior to initiating PN is preventative for re-feeding
syndrome. Although the previous complications may occur for some individuals on PN, all PN patients will develop gallbladder sludge after receiving PN for 13 weeks.

5. B. Any of the entities listed in question 5 may cause your patient to become febrile but catheter-related bloodstream infections (CR-BSI) are the most common and most serious complication of PN. Adequate nutrition is a cornerstone for strength preservation and immune system function in patients with serious gastrointestinal illnesses and proper training of family members and ancillary health personnel for home PN is essential. Sterile technique when manipulating the catheter is imperative. Not all patients with a CR-BSI will present with pyrexia but a sudden increase in body temperature and an elevated C-reactive protein provide a high index of suspicion. High white blood cell count, low albumin, and/or elevated total bilirubin may be present. Catheter maintenance for home parenteral nutrition patients and repeated removal/reinsertions can result in loss of venous access. Whenever possible, salvage of an infected tunneled catheter, such as the Hickman catheter used in this patient, should be attempted. The most effective way to prove the existence of a CR-BSI is to simultaneously draw blood cultures from the central catheter and from a peripheral source. Other sources of fever should be investigated.

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Mirtallo JM. Consensus of parenteral nutrition safety issues and recommendations. JPEN. March 2012;36(2 Suppl):62S.


A 33-year-old female (G3P2) 31 1/7 weeks pregnant, with severe vaginal bleeding is taken emergently to the operating room for cesarean section. Intraoperatively, a percreta is identified with involvement of the bladder and pelvic wall. After delivery of the baby, an emergent hysterectomy is performed for massive bleeding. Blood loss was estimated at 15 liters. The patient was given 7000 mL of crystalloid, along with 40 units of packed red blood cells, 10 units of fresh frozen plasma, and 20 units of platelets.

1. Which of the following is an indication for blood transfusion?
   A. Serum hemoglobin < 10 g/dL
   B. Central venous oxygen concentration < 55%
   C. Trauma score > 14
   D. Loss of 20% of total body blood volume
   E. Ongoing bleeding with tachycardia, systolic blood pressure < 90 mm Hg, oliguria, acidosis, and/or elevated base deficit

2. Which of the following is true of transfusion-related acute lung injury (TRALI)?
   A. Improvement when well-resuscitated, takes > 2 weeks.
   B. It is caused by anti-HLA-antibodies in blood products that activates recipient leukocytes.
   C. Acute respiratory illness arises within 2 days of transfusion of blood products.
   D. Is easy to differentiate from acute respiratory distress syndrome (ARDS).
   E. It is not associated with the number of transfusions or the age of blood.

3. Which of the following non-transfusion strategies is of proven benefit in reducing blood product transfusion in stable trauma patients?
   A. Minimize blood loss, use of autologous blood salvage, avoidance of coagulopathy and hypothermia, and damage control techniques
   B. Pelvic binders
   C. Blood substitutes
   D. Factor V concentrate
   E. Tranexamic acid, if used more than 12 hours after the traumatic event

4. Which of the following statements regarding heparin-induced thrombocytopenia (HIT) is true?
   A. HIT is an IgA antibody mediated response to heparin-platelet factor IV complexes.
   B. Procine unfractionated heparin (UFH) is more likely to cause HIT than bovine UFH.
   C. The combined sensitivity and specificity of ELISA and serotonin functional assay is about 70%.
   D. Treatment of confirmed HIT involves stopping heparin and initiation of warfarin therapy.
   E. Patients with remote history of HIT can be safely treated with heparin.

5. Which of the following statements regarding complications of blood transfusion is true?
   A. Risk of hepatitis C infection per unit of packed red blood cells is 1 in one million.
   B. Hyperkalemia is a rare but frequently fatal disorder seen in massive blood transfusion.
   C. Citrate can lower serum calcium and magnesium.
D. Massive transfusion frequently causes acidosis.
E. ABO incompatible blood transfusion is a rare cause of hemolytic reaction.

**ANSWERS**

1. E. Specific triggers for blood transfusions have been the subject of a large amount of research, and the decision to transfuse is not always clear. Data indicate that in a patient without cardiac or lung disease and hemodynamic stability, a hemoglobin ≥ 7 g/dL is satisfactory to minimize blood transfusion without adversely affecting mortality. What is clear from these studies is that a liberal transfusion strategy is not helpful for oxygen delivery but has a negative effect on the immune system. In addition, class of hemorrhage by itself is not an indication for transfusion unless systemic hypotension, refractory tachycardia, oliguria, lactic acidosis are present with evidence of ongoing bleeding.

   Systemic venous oxygen saturation (SvO₂) is an attractive measure of oxygen consumption, but cannot be associated with parameters of blood loss or severity of injury and so, by itself, cannot represent a reason to transfuse a patient.

   The trauma score is a physiologic score that represents the sum of scores for respiratory rate and effort, capillary refill, systolic blood pressure, and Glasgow coma score. In this scoring system, a higher number is a less severe injury. Recent data suggest that over 90% of patients with a trauma score > 14 did not need a blood transfusion. Both the revised trauma score and the ISS have been shown, interestingly, to predict the need for transfusion is severe pelvic trauma.

   The only reliable criteria for the need to transfuse include clinical criteria, like ongoing bleeding, refractory tachycardia, decreased systolic blood pressure, oliguria, lactic acidosis, and elevated base deficit. A single criterion has been elusive.

2. B. TRALI is an acute respiratory complication of blood transfusion that occurs within 4 to 6 hours of transfusion of product and cannot be traced to another acute lung injury risk factor. The syndrome is very similar to ARDS of other etiologies, and often cannot be differentiated. Overlapping syndromes include transfusion associated circulatory overload (TACO). TRALI is an anti-HLA-antibody mediated reaction from recipient leukocytes. Once complement is activated, acute lung injury ensues. Other theories, including the roles of non-polar lipids and activated platelets are less well supported in the literature. Resolution in a well resuscitated patient normally occurs within 48 hours. Mortality is around 6% (as compared to much higher mortalities in ARDS). Risk factors for the development of TRALI include increased number of transfusions, possibly age of blood transfused, female plasma donor, and anti-HLA-antibody complement. Patient risk factors include higher IL-8 level, shock, liver surgery, cirrhosis, positive fluid balance, elevated peak airway pressures, and current smoking.

3. A. There are multiple non-transfusions options in surgical patients, many of which have proven beneficial in decreasing number of transfusions required. Initially, careful surgical technique (minimize blood loss, avoid hypothermia and coagulopathy, damage control, etc.) and careful treatment of preoperative anemia are clearly associated with decreased need for transfusion. While pelvic binders are recommended by the American College of Surgeons there are no clinically relevant data to support their use. Blood substitutes, including human products, bovine products, and genetically engineered hemoglobin are available. Of these products, the genetically engineered hemoglobin is promising, in that the cross-match is avoided (timely administration), osmotic pressure is increased (resuscitative fluid) and blood pressure is increased (vasopressor activity), but it remains to be determined that these products are beneficial in reducing blood transfusions in traumatically injured or critically ill patients.

   Recombinant factor VII concentrate, not factor V, enhances thrombin generation and platelet activation and has been shown to decrease the need for massive transfusion of the severely injured trauma patients. A multicenter Phase III trial demonstrated a decrease in blood product usage, but did not demonstrate a mortality difference from placebo. It seems reasonable to avoid its use in elderly patients (> 75 years old) as they have increased risk of arterial thrombosis. Tranexamic acid is an antifibrinolytic agent that blocks binding of plasmin to fibrin. In the CRASH-2 trial, over 20,000 major trauma patients were evaluated. Early use of tranexamic acid decreased death rate without demonstrated major side effects. Use after 3 hours is not beneficial. Tranexamic acid has also been shown to decrease the size of intracranial bleeding lesions in trauma patients (CRASH-2 collaborators).
4. HIT is an IgG mediated disease directed at heparin-platelet factor IV (PF-4) complexes. Bovine UFH increases risk of HIT compared to porcine derived UFH. Orthopedic surgery/injury, cardiac surgery, especially heart transplant, the use of UFH as compared to low molecular weight heparin all increase the risk of HIT. Obstetric patients are at very low risk of developing HIT. T e ELISA test for HIT detects antibodies that react with the heparin-PF-4 epitope while functional platelet assays (like the serotonin assay) use radiolabeled platelets mixed with patient’s serum and heparin.

T e supernatant is then evaluated for radiolabeled material. Specificity and sensitivity of the ELISA test is 50% to 70% and 90%, respectively. Specificity and sensitivity of functional assays are 95% and 90%, respectively. Used in conjunction, the sensitivity and specificity for HIT approaches 100%. T e results must be put into clinical context because between 20% to 60% of patients will form the heparin-PF-4 complexes that can be seen on the ELISA test without the clinical syndrome. Once the diagnosis has been made, all heparin must be stopped. Even after stopping heparin, patients are at increased risk for thrombotic complications for up to 100 days while the complexes persist, and require treatment with a direct thrombin inhibitor (only argatroban and lepirudin are FDA approved). Factor Xa inhibitors (dancaparoid) are options, but not available in the United States.

Ancrod (pit viper venom), a glycoprotein IIb/IIIa inhibitor, has been evaluated in HIT, and was found to be without efficacy and may increase thrombotic risk. Vitamin K antagonists are contraindicated in the acute phase of HIT, but have a role in the long-term management of thrombotic complications. After about 100 days free from heparin, the heparin-PF-4 complexes have cleared and patients with previous episodes of HIT can be safely treated with heparin provided ELISA testing is negative. T e IgG response is not amnestic and previous HIT does not increase risk for future HIT.

5. Transmission of infectious diseases by transfusion in the United States is rare. Bacterial infection is clinically apparent in 1:80,000 cases. Storage of platelets at room temperature may increase risk of bacterial infection after infusion of platelets. Current rates of viral transmission are as follows (per unit transfused): Hepatitis A (1:1 million), Hepatitis B (1:250,000), Hepatitis C (1:150,000), and HIV (1:2 million). Cytomegalovirus (CMV) is present in 50% of the population, and is transmitted in 5% in the infected units. T e rate of transmission of prion disease is not known, but is presumably very, very low. Hyperkalemia after massive transfusion can be seen in up to 38.5% in trauma patients but is rarely associated with clinical sequelae. After transfusion, new red blood cell counts can take up potassium resulting in post-transfusion hypokalemia, so electrolytes should be closely monitored before, during, and after transfusion. Citrate (3 g/unit) is used in stored blood, and can bind calcium in the blood, resulting in hypocalcemia after massive transfusion.

Clinical signs of hypocalcemia include widened QT interval, decreased ventricular contractility, hypotension (related to a decrease in peripheral vascular resistance), muscle tremors and even PEA arrest. Hypomagnesemia can also be responsible for prolonged QT seen after transfusion. T e pH of stored blood often decreases to 6.6 to 6.8 because of increasing CO2. However, the most frequent acid-base problem seen after massive transfusion is alkalosis because of the large amount of citrate in stored blood. Acidosis seen after massive transfusion should be concerning for ongoing tissue hypoperfusion rather than a result of the transfusion itself. ABO incompatible transfusion and the resultant hemolytic reaction is the most common preventable potentially fatal complication of blood transfusion. T e most common cause is error along the chain of identification of the unit, the patient, or both.

**BIBLIOGRAPHY**


A 33-year-old female with a 19 year history of type 2 insulin dependent diabetes complicated by peripheral neuropathy, peripheral vascular disease, and chronic kidney disease presents to the emergency room complaining of worsening right foot pain and swelling over the past 3 days. She has a history of Charcot deformity to her right foot with a chronic right foot ulceration that has been treated with weekly debridements and wound care. She endorses subjective fevers and chills.

On examination she has a 1 cm × 1 cm × 3 cm deep plantar midfoot ulceration with probing and tracking noted dorsally to the midfoot. There is a strong malodor and her entire foot is significantly edematous and erythematous with significant pain on palpation of the midfoot and lower leg. She has biphasic dopplerable pulses.

1. Regarding clinical presentation, which of the following is true?
   A. Necrotizing fasciitis has the same incidence in both adult and pediatric populations.
   B. Initial signs of necrotizing fasciitis include skin necrosis with a blue or purple discoloration, crepitus and bullae.
   C. The most constant clinical feature is pain, out of proportion, to physical findings.
   D. When the borders of infection appear ill-defined, erysipelas diagnosis is more likely than necrotizing fasciitis.

2. With regards to the diagnostic tools that are available, which of the following is true?
   A. Plain radiographs demonstrating subcutaneous gas is present in about 25% of cases.
   B. A computerized tomography (CT) scan has a sensitivity of about 50%.
   C. A laboratory risk indicator for necrotizing fasciitis (LRINEC) score of 4 indicates an over 50% chance of necrotizing fasciitis.
   D. A good physical exam will differentiate amongst cellulitis, an abscess and necrotizing fasciitis.

3. When necrotizing fasciitis is suspected, immediate operative debridement is indicated. Which of the following is true regarding surgical exploration?
   A. Surgical exploration should be delayed until vascular status can be evaluated and optimized.
   B. In dubious cases, surgical exploration should be avoided until the diagnosis is confirmed to limit unnecessary large incisions and tissue debridement.
   C. Repeated surgical debridements are not necessary if the patient is on appropriate intravenous antibiotics.
   D. Macroscopic findings include gray necrotic tissue, “dishwater” pus, and a positive “finger test.”

4. Which of the following is true regarding isolated organisms and antibiotic therapy?
   A. Broad spectrum intravenous antibiotics are enough to stop the spread of infection.
   B. The most commonly isolated organism is Clostridium, and antibiotic therapy should always include coverage for this organism.
C. Long term intravenous antibiotics for > 4 weeks is standard practice when necrotizing fasciitis has been diagnosed and the patient is free from systemic symptoms.

D. Clindamycin may be useful in controlling exotoxin production especially in cases complicated by streptococcal toxic shock syndrome.

5. In regards to prognosis, which of the following is true?

A. Patients infected with Clostridia have lower mortality and limb loss rates compared to those with a polymicrobial or other monomicrobial infection.

B. The single most important factor that negatively influences prognosis is delayed surgical debridement.

C. Hyperbaric oxygen therapy (HBO) has been shown to dramatically decrease limb loss.

D. Diabetes, even in those presenting in diabetic ketoacidosis, does not have higher mortality or longer hospital stays.

ANSWERS

1. C. Pain, out of proportion to physical findings, has been well documented as a constant recurring feature of necrotizing fasciitis. When present, necrotizing fasciitis should always be considered in the differential diagnosis. Keys that lead to diagnosis include pain out of proportion to the degree of dermal involvement as well as severe pain that appears to extend beyond the apparent borders of infection.

Necrotizing fasciitis is more common in the adult population, with a reported incidence of 0.40 cases per 100,000 as compared to 0.08 per 100,000 pediatric cases per year. While skin necrosis with a blue or purple discoloration, crepitus and bullae are perhaps the more well recognized signs and symptoms of necrotizing fasciitis, these are late features of the disease, not initial presenting symptoms. Initial presenting signs are of en less specific and include erythema, warmth, myalgia, edema, and pain out of portion. As such, this of en can lead to delayed diagnosis and delayed surgical debridement. Erysipelas is different from necrotizing fasciitis in that erysipelas involves infection of the superficial layers of the skin and cutaneous lymphatics, leading to a well-demarcated and of en raised border.

2. A. Subcutaneous gas seen on plain radiographs is a specific, but not sensitive finding. It has been documented that subcutaneous gas on radiographs is found in as low as 25% of cases, and its absence should not exclude the diagnosis of necrotizing fasciitis.

The diagnosis of necrotizing fasciitis can of en be delayed and mistaken for cellulitis or abscess. Given many of the initial signs and symptoms are non-specific, both clinical findings and laboratory values in addition to advanced imaging if needed should be used in conjunction to help assist in early diagnosis. In 2004, Wong et al. developed a scoring system LRINEC, which classifies patients into risk categories that determine necrotizing fasciitis probability, as seen in Table 81-1 below. LRINEC scores greater than or equal to 6 have a positive predictive value (PPV) of 92% and a negative predictive value (NPV) of 96% for necrotizing fasciitis.

Magnetic resonance imaging (MRI) has been documented to be the most useful imaging technique when differentiating necrotizing from non-necrotizing infections. Specific findings on an MRI include thickening of the soft tissue and a hyperintense signal on T-2 weighted images at the level of the deep fascia and muscle. CT imaging has been reported to be more sensitive than plain radiographs,

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<th>Variable, Units</th>
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with the ability to identify abscesses and other inflammatory changes, with up to 80% sensitivity.

3. D. Gross intraoperative findings include thin, watery gray necrotic fluid of an described as “dishwater pus,” a foul smelling odor, and necrotic muscle which fails to respond to electrocautery. A positive “finger test” is also characteristic, in which there is ease of dissecting the subcutaneous layer off of the deep fascia with the surgeon’s fingers.

Surgical debridement should never be delayed for optimization of vascular perfusion, nor until there is a definitive diagnosis as delay in surgical management has been shown to be both limb and life threatening. A delay in surgical debridement more than 24 hours has been shown to be an independent risk factor for mortality. Furthermore, repeated surgical debridement may be necessary in order to remove all necrotic tissue, lessen the bacterial load, expose the tissues to oxygen to aid in reduction of anaerobic bacteria, all helping to facilitate more rapid recovery.

4. D. Clindamycin is a protein synthesis inhibitor that inhibits M protein and exotoxin production. As such, administration of clindamycin has been shown to be especially useful in cases with severe inflammatory responses, which include cases complicated by streptococcal toxic shock syndrome. Initial management of suspected necrotizing fasciitis cases include broad spectrum IV antibiotics. Duration of IV antibiotics after the source has been controlled and the patient is free of systemic signs of inflammation and infection, is typically 14 days.

It should be noted that IV antibiotics alone are not enough to control infection. Using only IV antibiotics, mortality approaches 100% because the antibiotics may not reach the affected area due to the thrombosis of vessels. As a result of improved sanitation, Clostridium species are now a rare cause of necrotizing fasciitis. Rather, Streptococcus is the number one isolated organism, followed by the staphylococcus species.

5. B. HBO therapy has been considered as an adjunct therapy in the treatment of necrotizing fasciitis. It is based on the theory that necrotizing infections are associated with decreased oxygen tension and ischemia. As such, it is believed that HBO treatment can reverse these effects by increasing oxygen tension and helping to deliver antibiotic therapy across the bacterial cell wall. However, various studies have failed to show any benefits, including mortality or hospital stay, with the addition of HBO treatment.

As previously mentioned, delay in surgical debridement is the single most important factor with regards to a negative prognosis; a delay of over 24 hours is an independent predictor of mortality. It is well known that diabetes in itself is a risk factor for necrotizing fasciitis. Those with a history of type 2 diabetes and who present in diabetic ketoacidosis have been shown to have longer rates of hospital stays and higher rates of mortality. Those is likely due to poor glycemic control which contributes to the pathogenesis and has been correlated to the extent of disease and poor outcomes. Similarly, in a large retrospective cohort study, patients with isolated Clostridium infections have been shown to have increased mortality rates, up to four times that when compared to other monocorial or polymicrobial infections.

BIBLIOGRAPHY


A 35-year-old man presents to the emergency department as a trauma alert, after falling 40 feet from a scaffold. On primary survey he has no life threatening injuries. His vital signs are stable, with a heart rate of 85, blood pressure of 126/84, and a room air oxygen saturation of 99%.

On secondary survey he is noted to have blood at the urethral meatus. In addition, he has bruising over the left flank. He has pain over the pubic symphysis, but his pelvis is grossly stable. His abdomen is mildly distended. His rectal examination reveals no blood, normal rectal tone, and a normal prostate exam. He has not voided since the incident.

1. What is the next step in diagnosis and management of blood at the urethral meatus?
   A. Passage of a coude-c tipped Foley catheter
   B. Passage of a three-way Foley catheter
   C. Placement of a suprapubic catheter
   D. Retrograde urethrography
   E. Voiding cystourethrogram

2. After concluding his urethra is uninjured, a Foley catheter is placed and grossly bloody urine is obtained. Which imaging test is most appropriate in evaluating his other possible genitourinary injuries?
   A. Fluoroscopic cystogram
   B. FAST (focused assessment with sonography for trauma) scan
   C. Computerized tomography (CT) scan of the abdomen and pelvis with IV contrast and CT cystogram
   D. CT cystogram
   E. CT scan of the abdomen with and without IV contrast

3. What is the appropriate management of a simple extraperitoneal bladder rupture?
   A. Suprapubic tube placement for 7 days
   B. Large bore Foley catheter placement for 10 to 14 days
   C. Open exploration and cystorrhaphy
   D. Laparoscopic exploration and cystorrhaphy
   E. Bilateral percutaneous nephrostomy tube placement

4. CT scan of the abdomen and pelvis with IV contrast is indicated to rule out a renal injury in which clinical scenario(s)?
   A. Blunt trauma with gross hematuria
   B. Blunt trauma with microscopic hematuria and normal blood pressure
   C. Blunt trauma with microscopic hematuria and shock (SBP < 90)
   D. High energy mechanism of injury
   E. A, C, and D

5. This patient has a Grade 3 left renal injury and is hemodynamically stable. What is the appropriate initial management of that injury?
   A. Open renal exploration
   B. Renal angiography
   C. Serial examination, serial vital signs, and serial CBC monitoring
   D. Ureteral stent placement
   E. Nephrectomy
ANSWERS

1. D. Retrograde urethrogram is essential in any case of blood at the urethral meatus, as blood at the meatus may be a sign of a urethral disruption or laceration. Passage of a Foley catheter blindly in the setting of a urethral injury may exacerbate a laceration or lead to placement of the catheter outside of the bladder. If the retrograde urethrogram shows the urethra is intact, then Foley placement can be attempted.

2. C. T is patient is at risk for both bladder and renal injury, so imaging will be required to assess those organs. T e bladder is best imaged with either a retrograde gravity cystogram or a CT cystogram. T e kidneys are best imaged with a contrast enhanced CT scan of the abdomen and pelvis, as well as with delayed images of the ureters to assess for ureteral injury.

A gravity cystogram can also be done with a c-arm in the operating room if the patient needs operative intervention. It is critical that gravity cystography involve oblique views as well as a post drainage film, to assess for leakage posterior to the bladder. Also, the patient should be filed via gravity to a volume of at least 300 to 400 mL, to adequately distend the bladder. Awake patients should be filed to a sense of bladder fullness.

Roughly 90% of all patients with a bladder injury in a blunt trauma setting will have both gross hematuria and a pelvic fracture. Additionally, nearly 30% of patients with gross hematuria and a pelvic fracture will have a bladder injury, so imaging the bladder is essential in those patients. A minority of patients with a bladder injury will have only hematuria or only an isolated pelvic fracture, so the decision to image the bladder in those situations is based on clinical judgment. Certainly any signs or symptoms of bladder perforation, such as low urine output, abdominal distension, or acute kidney injury would warrant cystography.

T e indications for renal imaging in blunt trauma patients include gross hematuria, microscopic hematuria (3 to 5 RBC’s per high power field on urinalysis) with systolic BP < 90 mm Hg, and a mechanism with high energy that could lead to renal injury. A contrast enhanced CT scan with delayed images of the ureters is the best imaging test in a trauma setting. In the event of urgent exploration, a 1 shot intravenous pyelogram (IVP) can be performed with 2 cc/kg of IV contrast and a single plain abdominal film 10 minutes later, to assess for the presence of two kidneys and to provide a pyelogram of each renal unit.

3. B. A simple extraperitoneal bladder injury can be readily managed with Foley catheter drainage alone. T e catheter must be large enough to allow the egress of clots and be unlikely to occlude. Most clinicians would allow 2 weeks of drainage for healing to occur and would perform a cystogram prior to catheter removal.

Operative management is only needed if the patient is otherwise being explored or if there are mitigating factors that will preclude healing, such as fragments of the bone in the bladder injury. In addition, if there are lacerations to the rectum, vagina, or the bladder injury involves the bladder neck, operative repair is best performed to prevent a fistula and allow appropriate healing.

4. E. T e guidelines for renal imaging in blunt trauma are very well established. In the absence of gross hematuria, with an insignificant mechanism of injury, and without a systolic blood pressure < 90 mm Hg and microscopic hematuria (> 3–5 RBC’s per HPF), there is a 99.7% chance the patient does not have a significant renal injury. A contrast enhanced CT with delayed images is the optimal imaging test in this setting.

5. C. Most renal injuries can be managed with non-operative intervention. Operative intervention, including open exploration with repair of a renal injury or nephrectomy, ureteral stent or percutaneous nephrostomy placement for urinary extravasation, or angiography, is required for patients with hemodynamic instability or for urinary leaks that do not heal or are complicated by issues such as infection.

T e majority of renal injuries, especially grade 1 to 3 injuries can be managed without surgical intervention.

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A 64-year-old male with a history of spinal cord injury, hypertension, DM2, and tobacco abuse is scheduled to undergo a video-assisted thoracoscopic surgery (VATS) for resection of a suspicious lung mass. He voids using clean intermittent catheterization (CIC) and has been doing so for the past 8 years. Prior to the start of the case, the nurse attempts to insert a Foley catheter. She meets resistance while advancing the catheter and does not get return of urine.

1. **Which of the following is true?**
   A. A history of prolonged CIC does not increase the risk of Foley trauma.
   B. Voiding symptoms help identify patients who are more likely to have difficult catheter placement.
   C. The incidence of urethral stricture as a complication of chronic catheterization decreases with duration.
   D. Women experience similar rates of urethral stricture as men.

2. **Which of the following is true?**
   A. In patients with known stricture disease, catheter placement requires direct visualization.
   B. Using CIC to void rather than an indwelling catheter does not increase risk of false passage.
   C. Indwelling catheters have a lower risk of developing a urethral stricture.
   D. Resistance or obstruction encountered less than 16 cm from the meatus may suggest urethral stricture or other anterior urethral pathology.

3. **The next best step for the nurse would be to:**
   A. Slowly force the catheter past the resistance.
   B. Dilate a possible stricture by slowly inflating the catheter balloon.
   C. Assume the positioning is correct and inflate the catheter balloon.
   D. Remove the catheter.

4. **The nurse repeatedly tries to force the catheter without success before removing the catheter. The urology team is called for consultation. Which of the following is the next best step?**
   A. Attempt to blindly dilate the urethra.
   B. Perform cystoscopy.
   C. Attempt to pass a larger size catheter.
   D. Perform a retrograde urethrogram.

**ANSWERS**

1. **B.** Urethral catheterization is not a benign procedure and can result in numerous complications to include hematuria, urinary tract infection, and urethral stricture, perforation, or erosion. The incidence of urethral stricture in women is significantly less than that in men and is primarily related to the shorter length of the urethra, 3.5 to 4 cm in women, versus 18 to 20 cm in men. It is important to do a thorough history and physical to identify patients at risk for difficult catheter placement. Urologic procedural history should be reviewed along with any documentation of prior difficult catheter placement. In men, voiding symptoms such as decreased or intermittent urinary
stream, valsava to initiate urination, and nocturia may indicate obstructive pathology such as benign prostatic hypertrophy. History of repeated urethral manipulation with CIC or indwelling catheter such as the patient in our scenario should prompt suspicion for prior urethral trauma and possible difficult Foley placement.

Incidence of urethral injury and chronic complications increases with prolonged duration of CIC. Alternate catheter types can provide advantages over straight-tipped catheters such as Foley’s catheter. For example, a Coudé catheter which has a curved tip assists in traversing the prostatic urethra in gentlemen with benign prostatic hyperplasia (BPH) whereas a Council open-tipped catheter can be placed over a guidewire in patients with urethral stricture.

2. B. Considering the patient’s known history of prolonged CIC, urethral stricture would be high on the differential for the etiology of the encountered resistance during the nurse’s attempt at Foley placement. Studies comparing long term CIC use versus indwelling catheter for urinary drainage reveals an increased risk for development of urethral stricture in patients with an indwelling catheter, but interestingly no significant difference in the risk for false passage between the two groups. The first 16 cm of the urethra is the anterior portion and would be the most likely location for urethral stricture related to Foley trauma. The remaining 2 to 4 cm corresponds to the posterior urethra and resistance at this distance may reflect BPH. Had the patient been previously diagnosed with urethral stricture or if the provider’s suspicion for stricture was high, they may choose to use a smaller silicone catheter to more easily traverse the narrowed segment without direct visualization. This technique would be most effective in the hands of a urologist or other provider well trained in urinary tract pathology and anatomy.

3. D. The most appropriate course of action would be to remove the catheter. Confirmation of appropriate catheter placement requires flow of urine and the balloon should not be inflated until this time. Continuing to advance the catheter after meeting resistance could result in creation of a false passage. You should never inflate the balloon intentionally within the urethra. If a stricture is identified it may require dilation by a urologist with urethral sounds or dilators.

4. B. The safest option would be to examine the urethral anatomy using cystoscopy. This facilitates placement of a guidewire beyond any identified stricture over which a catheter can be placed or dilation of a stricture under direct vision. Attempting to pass a larger catheter in a patient who is suspected to have a stricture would likely result in further trauma. A smaller bore catheter would be the appropriate choice. Retrograde urethrogram is a contrasted X-ray study to evaluate the urethra that is often ordered when urethral trauma is suspected. Although this study could show evidence of urethral stricture, it would not be the best choice while in the operating room. This study may be obtained as a follow up study to further assess the anatomy of the urethra particularly if surgical intervention is planned to treat urethral stricture.

BIBLIOGRAPHY


SECTION 2

Surgical Subspecialties
Transplantation Surgery
Ronald A. Gagliano, Jr.
A 61-year-old patient with insulin dependent diabetes mellitus and end-stage renal disease on hemodialysis presents for evaluation for kidney transplantation. A suitable cadaveric donor is found, and the patient undergoes transplantation at another hospital; the immediate post-operative course is uncomplicated. Ten days later, the patient presents to your hospital and is noted to have an abrupt decrease in urine output with a creatinine elevation to 1.5 mg/dL, and has graft tenderness on exam. A fever of 100.9°F is noted.

1. Which of the following is true about the initial management of this patient's oliguria and elevated serum creatinine?
   A. Renal biopsy should first be performed to differentiate between acute rejection and acute interstitial nephritis.
   B. Doppler ultrasound should be performed to evaluate vessel patency and rule out ureteral obstruction.
   C. The dose of cyclosporine should be increased to treat possible acute rejection.
   D. Angiography is indicated to evaluate the vascular supply to the graft.
   E. The patient should be promptly taken back to the operating room for re-exploration in order to salvage the graft.

   Cyclosporine levels are drawn on the previous patient and found to be at therapeutic levels. A Doppler ultrasound is obtained and shows patent arterial and vascular flow with no perinephric fluid collection. Subsequently, a percutaneous biopsy of the graft shows lymphocytes within the renal tubules and vascular endothelium. Immunophenotyping of the biopsy demonstrates T-cell preponderance.

2. Which of the following is true regarding the post-operative complication experienced by this patient?
   A. This complication is mediated by anti-HLA antibodies and is likely related to a clerical error during the pre-transplant cross-match.
   B. The presence of Epstein-Barr virus (EBV) is strongly associated with the development of this neoplasia, and treatment involves decreasing immunosuppressive therapy.
   C. Failure to treat this condition will increase the risk of graft loss. Management consists of pulse corticosteroids and changing maintenance therapy from cyclosporine to tacrolimus.
   D. Risk factors for this complication include perioperative hypovolemia, ischemia-reperfusion injury, and the use of an extended-criteria donor.
   E. This viral infection was likely transmitted via leukocytes within the donor; treatment includes ganciclovir and IntraVenous ImmunoGlobulin (IVIG).

3. Which of the following is correct regarding post-transplant technical complications?
   A. Thrombosis of the transplanted renal artery in the early post-operative period should be urgently treated with heparin infusion and angioplasty.
B. Renal vein thrombosis may manifest with hematuria in the first week following transplantation.
C. On Doppler ultrasound, identification of a round, sonolucent, septated mass medial to the renal allograft with associated ureteral compression is most consistent with a urine leak.
D. Initial management of a lymphocele involves intra-peritoneal marsupialization (i.e., creation of peritoneal window).
E. Presence of multiple strictures in the transplanted ureter during the early post-operative period is associated with polyoma BK viral infection.

4. Regarding the mechanism and use of various immunosuppressive agents, which of the following is correct?
   A. Cyclosporin binds cyclophilin protein and blocks IL-2 production.
   B. Azathioprine binds antigens on T cells, causing altered T cell function as well as T cell depletion.
   C. Rituximab binds to FK binding protein, and is used in maintenance immunosuppression.
   D. Sirolimus inhibits the function of NF-ƙB, diminishing the response to cytokines.
   E. ATGAM binds to CD20, leading to initial cytokine release followed by B cell depletion.

5. With regards to complications arising from prolonged immunosuppression, which of the following is correct?
   A. The most common malignancy associated with post-transplantation immunosuppression is lymphoma.
   B. Mycophenolate mofetil and azathioprine are associated with diarrhea and leukopenia.
   C. Antithymocyte globulin is associated with gingival hyperplasia and hirsutism.
   D. Post-transplant activation of cytomegalovirus (CMV) occurs most commonly in patients who tested seropositive for CMV IgG preoperatively.
   E. Tacrolimus and sirolimus are associated with nephrotoxicity and post-transplant diabetes.

ANSWERS
1. B. Post-transplant oliguria with elevated creatinine has multiple possible etiologies to include hypovolemia, urinary catheter occlusion, calcineurin inhibitor toxicity, viral infection, delayed graft function, hyperacute or acute rejection, renal artery thrombosis, renal vein thrombosis, urine leak, or ureteral obstruction (e.g., by stricture or lymphocele). The most frequent cause of an elevated creatinine level post-transplant is calcineurin inhibitor toxicity. After this is ruled out, the next step is to evaluate blood flow and rule out structural problems with Doppler ultrasound. If the ultrasound is normal, it is then appropriate to perform a renal biopsy, which can differentiate rejection, post-transplant lymphoproliferative disorder (PTLD), acute tubular necrosis (ATN), among other diagnoses. If arterial/venous thrombosis, arterial stenosis, or aneurysm is on the ultrasound, angiography is then indicated to confirm the diagnosis. If no blood flow is seen to the transplanted kidney on ultrasound or a nuclear medicine renal scan, then re-exploration is indicated.

2. C. T-lymphocytes within the renal tubules and vascular endothelium are characteristic of acute cell-mediated rejection. Each rejection episode decreases the long-term function of the graft, and should be treated with pulse corticosteroids. Also, if the episode of rejection occurred on therapeutic calcineurin inhibitor levels, the maintenance therapy should be changed. In contrast, hyperacute rejection occurs within minutes to hours of reperfusion, manifests with rapid mottling and often graft rupture, and is mediated by pre-formed anti-HLA antibodies due to ABO incompatibility. Hyperacute rejection is rare due to pre-transplant cross-matching, and is usually due to clerical error. Post-transplant lymphoproliferative disorder (PTLD) is associated with EBV, and can be differentiated from acute rejection on biopsy by the preponderance of B lymphocytes; treatment is to decrease immunosuppression. Acute tubular necrosis (ATN) may cause oliguria and elevated creatinine, and risk factors include hypovolemia, reperfusion injury, and use of an extended-criteria donor. Biopsy would show injury of tubular cells and casts within the tubule lumen. CMV infection may be transmitted within donor leukocytes and also can cause oliguria with creatinine elevation; treatment is with ganciclovir. On biopsy, intranuclear or cytoplasmic inclusions are characteristic of viral infections including CMV.

3. B. Renal artery thrombosis is a rare complication occurring in 1% of cases, and necessitates return to the operating room for urgent exploration. New onset
hematuria may be the first sign of a renal vein thrombosis. Lymphoceles are the result of intra-operative lymphatic disruption and are identifiable on ultrasound as a round, multi-septated mass medial to the graft that may compress the ureter. It is differentiated from urine leak sonographically in that a urine leak would be a non-septated fluid collection in the pelvis. Lymphocele is initially managed with percutaneous drainage; creation of a peritoneal window can be helpful for drainage if percutaneous drainage does not resolve symptoms. Presence of multiple ureteral strictures in the late post-operative period may be due to polyoma BK virus, but early ureteral stenosis is usually due to ischemia or extrinsic compression.

4. A. Cyclosporine is a calcineurin inhibitor which functions by binding cyclophilin protein and blocking IL-2 production. Azathioprine functions by converting 6-mercaptopurine to 6-thioguanine-5′-monophosphate, which interferes with DNA and purine synthesis; T-cell antigens are bound and blocked by antilymphocyte globulins such as ATGAM, as well as OKT-3 and several monoclonal antibodies (e.g., basiliximab, dacluzimab). Rituximab binds to CD20 on B cells, causing depletion; tacrolimus and sirolimus (a.k.a. rapamycin) both bind FK binding protein. Corticosteroids bind a nuclear receptor, inhibiting NF-κB and blocking T-cell activation.

5. B. Immunosuppression is associated with both drug-specific toxicity as well as susceptibility to infections and malignancy. The most common malignancy associated with post-transplant immunosuppression is skin cancer, specifically squamous cell carcinoma. Post-transplant activation of CMV actually occurs most commonly in patients who tested sero-negative for CMV pre-operatively and received a graft from a CMV-seropositive donor. Mycophenolate moefetil and azathioprine are both antiproliferative agents with associated GI toxicity and leukopenia. Antithymocyte globulin is associated with cytokine release syndrome, leukopenia, and serum sickness; gingival hyperplasia and hirsutism are both associated with cyclosporine. Like cyclosporine, tacrolimus is a calcineurin inhibitor associated with nephrotoxicity, but sirolimus is not, and tacrolimus is more strongly associated with post-transplant diabetes than sirolimus.

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A 52-year-old patient with a long history of hepatitis C (HCV) presents with vague epigastric pain and reports weight loss of 10 pounds over the past 4 months with a serum AFP level of 600 mcg/L. Contrast computerized tomography (CT) scan of the liver shows multiple nodules in the hepatic parenchyma.

1. Which of the following is true regarding liver transplantation in a patient with chronic hepatitis C?
   A. Preoperative treatment with lamivudine may decrease the rate of HCV recurrence after transplantation.
   B. HCV is second to hepatitis B (HBV) as the most common indication for liver transplantation worldwide.
   C. Up to 30% of patients with active hepatitis C at the time of transplant will experience recurrence of HCV in the transplanted liver.
   D. The Model for End-Stage Liver Disease (MELD) score assessment predicts perioperative mortality of transplant recipients.
   E. Post-transplantation, progression of HCV infection to cirrhosis is more aggressive than the original infection.

2. Which of the following is a contraindication to liver transplantation in a patient with hepatocellular carcinoma (HCC)?
   A. Portal vein thrombosis
   B. Presence of hepatorenal syndrome
   C. Three tumors within hepatic parenchyma measuring 2.7 cm, 2 cm, and 1.5 cm
   D. Solitary HCC nodule in peripheral lung measuring 1 cm
   E. HIV infection

A previously healthy 24-year-old patient is admitted with a two-day history of malaise, nausea, vomiting, jaundice, and epigastric pain. Over the next three days, she becomes increasingly confused, then obtunded, with associated marked elevation in liver enzymes, bilirubin, and ammonia levels. INR rises to 7.1 and Cr is 4.3 mg/dL.

3. Which of the following is true with regards to liver transplantation in this patient?
   A. Alcohol-induced hepatitis is the most likely underlying etiology of this patient’s condition.
   B. Without transplantation, the mortality rate associated with this condition approaches 80%.
   C. Emergent transplantation is contraindicated due to severe coagulopathy.
   D. The MELD score assessment will be used to determine the patient’s priority on the transplant waiting list.
   E. One-year survival is higher after transplantation for fulminant hepatic failure than for chronic liver failure.

The above patient undergoes orthotopic liver transplantation. On the first post-operative day, the patient demonstrates no improvement in mental status. Laboratory analysis is notable for acidosis, marked elevation in liver enzymes, elevated INR, and hyperkalemia. Minimal output is noted from the T-tube biliary drainage catheter.
4. The most likely etiology for this clinical presentation is:
   A. Acute cell-mediated rejection.
   B. Bacterial sepsis.
   C. Primary non-function of graft.
   D. Biliary anastomotic leak.
   E. Acute viral hepatitis.

5. The best treatment for the above condition is:
   A. Increase in tacrolimus dose.
   B. High-dose intravenous corticosteroids.
   C. Interferon with ribavirin.
   D. ERCP with biliary stenting.
   E. Re-transplantation.

ANSWERS

1. E. Worldwide, HCV is the most common indication for liver transplantation. Following liver transplantation, the majority of patients with positive HCV titers will experience recurrence of hepatitis C in the transplanted liver. Pre-operative therapy with interferon and ribavirin is helpful in managing symptoms of early HCV infection, but will only achieve viral clearance from serum in a small percentage of patients. Lamivudine is used in post-transplant patients with HBV and has been shown to significantly improve survival rates and overall outcomes. When hepatitis C recurs in the transplanted liver, the progression to cirrhosis is much more aggressive than the original infection, and patients can progress to end-stage liver failure in 6 months. The MELD formula is calculated using logarithms of the serum creatinine, bilirubin, and INR. The MELD score predicts the likelihood of death if the patient does not receive liver transplantation, but does not correlate with non-transplant post-operative survival rates.

2. D. The majority of HCC tumors develop in patients with cirrhosis. While liver resection is the treatment of choice for HCC in patients without cirrhosis, orthotopic liver transplantation (OLT) has evolved as the preferred treatment for HCC in the setting of advanced cirrhosis as OLT treats both the tumor and underlying liver dysfunction. The Milan criteria guides patient selection for liver transplantation; patients with a solitary tumor up to 5 cm or three tumors up to 3 cm each are eligible for OLT. Metastatic HCC is an absolute contraindication to transplantation. Portal vein thrombosis is not a contraindication to OLT because the thrombus can be extracted, or a jump graft can be placed to the superior mesenteric vein (SMV). Patients with hepatorenal syndrome may experience recovery of renal function following liver transplantation; even in advanced cases the patient may be a candidate for combined liver-kidney transplantation. HIV is no longer considered an absolute contraindication to OLT provided it is well controlled with antiretroviral therapy, but active sepsis remains a contraindication.

3. B. Fulminant hepatic failure is defined as the presence of encephalopathy within 8 weeks of the development of jaundice in the absence of previous liver disease. In the United States and Europe, the most common cause of fulminant hepatic failure is acetaminophen overdose. The King's College criteria are the most widely accepted guideline for transplantation of patients with fulminant hepatic failure. According to the King's College criteria, a patient with fulminant hepatic failure secondary to acetaminophen overdose qualifies for transplantation if either pH < 7.3, or all three of the following criteria are met: grade 3–4 encephalopathy, PT > 100 s or INR > 6.5 (choice C is false), or Cr > 3.4 mg/dL. In non-acetaminophen overdose, the criteria are either PT > 100 s (i.e., INR > 6.5), or any three of the following: age < 10 or > 40 y, non-A/non-B/drug-induced/Wilson disease hepatitis, greater than 7-day transition from jaundice to encephalopathy, PT > 50 s (i.e., INR > 3.5), or total bilirubin > 17.5 mg/dL. Regardless of etiology, the patient in this scenario meets King's College criteria for transplantation based on her severe encephalopathy, INR, and creatinine level. Without transplantation, the mortality from fulminant hepatic failure approaches 80%. While the MELD score can be additive to the King's College criteria in predicting mortality, and is used to assign priority on the transplant waiting list for patients with chronic liver failure, patients with fulminant hepatic failure are listed as status 1A (highest priority), which supersedes the MELD score assessment. Survival after transplantation for fulminant hepatic failure is lower at 1 year compared to transplantation for chronic liver failure: 73% versus 85%.

4. C. Primary non-function of the transplanted liver occurs in 2% to 10% of cases and is characterized by absence of bile production, severe acidosis, elevation of liver enzymes, hyperkalemia, hepatic
encephalopathy, and eventually multi-organ failure. Possible etiologies are early hepatic arterial thrombosis, prolonged ischemia of the donor liver, poor preservation, advanced donor age, or allograft steatosis. Acute cell-mediated rejection after liver transplantation is a less common cause of graft loss than primary non-function or hepatic artery thrombosis. Rejection may be asymptomatic, or may present with mild symptoms mimicking hepatitis. In fact, recurrent hepatitis C may occur in the early post-operative period due to the immunosuppressive regimen and be difficult to distinguish from acute rejection, although a biopsy can be helpful in this regard. Intra-abdominal sepsis may occur, manifesting with fever and peritonitis, and is most often due to biliary anastomotic leak. Biliary leak or stricture is a common post-operative complication occurring in 10% to 30% of cases, and is diagnosed via cholangiography.

5. E. Patients with primary non-function of the graft are essentially anhepatic, and a majority require re-transplantation; patients are relisted as Status 1A. High-dose intravenous corticosteroids are the treatment for acute cell-mediated rejection, except in patients with underlying hepatitis C. These patients should minimize steroids as much as possible to decrease viral replication, and should instead receive an increase in their tacrolimus or mycophenolate mofetil dose. Patients with recurrent hepatitis C may be treated with a combination of interferon and ribavirin. ERCP with biliary stenting is the treatment of choice for a biliary leak or stricture.

BIBLIOGRAPHY
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A 62-year-old male is referred to your office for evaluation of an asymptomatic left carotid bruit. He has no history of transient ischemic attack (TIA) or stroke. Carotid duplex scanning reveals an occluded right internal carotid artery, and elevated flow velocities in the left internal carotid (peak systolic of 510 cm/sec and end diastolic of 185 cm/sec). Computerized tomography (CT) angiography confirms occlusion of the right internal carotid artery and > 80% stenosis of the left internal carotid artery. An EKG and a nuclear medicine cardiac stress test are both normal.

1. The best treatment option for this patient is:
   A. Right carotid endarterectomy
   B. Left carotid endarterectomy
   C. Staged bilateral carotid endarterectomy
   D. Bilateral carotid stents
   E. Medical treatment without surgery will give pt the best chance for avoiding a stroke

2. The patient did not want surgery and opted for medical management. One week later he presents to the emergency room ten hours after experiencing a left hemispheric TIA. He now has no neurological deficits. CT scanning shows no evidence of cerebral infarction. Duplex scan now shows occlusion of both internal carotid arteries. The best treatment plan is:
   A. Treat the patient with anti-platelet therapy and manage non-operatively.
   B. Fully anti-coagulate the patient with heparin/Coumadin and manage non-operatively.
   C. Obtain a CT angiogram. If the internal carotid is patent, even if 99% stenotic, perform an urgent left carotid endarterectomy.
   D. Obtain a CT angiogram. If the left internal carotid is indeed occluded, wait 4 weeks and perform a left carotid endarterectomy.
   E. Obtain a CT angiogram. If the left internal carotid is indeed occluded, perform a left extracranial to intra-cranial bypass.

3. The patient eventually undergoes carotid endarterectomy (CEA) with prosthetic patch closure. He is initially awake and alert in the recovery room but 1 hour later he develops new onset aphasia and right arm weakness. What do you recommend as the next step?
   A. Observation
   B. Systemic anticoagulation administration
   C. Systemic thrombolytic administration
   D. Immediate return to the operating room
   E. CT angiogram

4. During surgical exposure of the carotid artery the patient becomes severely bradycardic. Only occasional beats with long pauses are visible on the cardiac monitor. Which of the following is the most appropriate next step?
   A. Abort procedure
   B. Administer IV atropine
   C. Electrical cardioversion
   D. Administer norepinephrine
   E. Transect the vagus nerve
5. Which of the following is an indication for emergency carotid endarterectomy?

A. Asymptomatic patient with an 80%–99% internal carotid artery stenosis.
B. Severe stroke with an 80%–99% stenosis.
C. Transient monocular blindness (amaurosis fugax) with an 80%–99% stenosis.
D. Crescendo transient ischemic attacks (TIA) with a 60%–79% stenosis.
E. TIA due to tandem lesions of the carotid bifurcation and intracranial carotid siphon.

ANSWERS

1. B. The correct answer is a carotid endarterectomy (CEA) on the side with high grade stenosis. CEA is not indicated on occluded carotid arteries. Even if CEA is possible on total occlusions, the patient would be at a higher risk for perioperative stroke due to reperfusion injury, thus a CEA should not be performed on a chronic occlusion. The same holds true for carotid stenting. Due to the severity of disease, CEA is a better option than medical management alone as many randomized clinical trials have shown.

2. C. Because it is often difficult to differentiate between occlusion and near occlusion (string sign) with carotid duplex scanning, best practice is to confirm with angiography (usually CTA) whether the ICA is patent or not. If there is a string sign with trickle carotid flow, urgent carotid endarterectomy is indicated. If the carotid is indeed occluded, most vascular surgeons would choose antiplatelet therapy for long term treatment. CEA is not performed on occluded ICAs due to increased risk for stroke secondary to reperfusion injury. Extra-cranial to intracranial bypass has no benefit over medical therapy alone. This procedure is rarely performed today, with only very few indications.

3. D. Most surgeons recommend immediate re-operation for patients with new onset neurological events in the recovery room following CEA. The purpose of operative exploration is to correct any surgical defect and to restore blood flow as soon as possible if thrombotic occlusion is found. Intraoperative angiography is preferred by many surgeons either before or after surgical re-exploration. Intraoperative duplex ultrasound may also be used to examine the operative site for abnormal flow or intimal flaps. Magnetic resonance imaging (MRI) and/or CT scans are generally reserved for further evaluation after confirmation of a patent carotid repair. Most surgeons would not recommend systemic thrombolytic agents due to the risk of hemorrhage.

4. B. The carotid sinus, located in the distal common carotid artery, is a collection of baroreceptor tissue that, when stimulated by increased pressure, produces bradycardia and hypotension. The carotid sinus is innervated by the carotid sinus nerve (nerve of Hering), which arises from the glossopharyngeal nerve. During a carotid endarterectomy, particularly during dissection near the bulb or with manipulation of the plaque, the carotid sinus may be stimulated leading to bradycardia and even asystole. Some surgeons routinely inject the tissue near the sinus with lidocaine. If bradycardia occurs in a bulb that has not been anesthetized, lidocaine can be employed. If the patient experiences severe bradycardia and loses a pulse, atropine should be administered immediately along with epinephrine as needed.

5. D. Crescendo TIAs represent unstable plaque and call for an emergent carotid endarterectomy. Retinal infarction from carotid stenosis is certainly an indication for carotid endarterectomy but not necessarily on an emergent basis. Asymptomatic high grade carotid artery stenosis does not require emergent surgery. After a severe stroke, there is usually an interval of recovery before endarterectomy should be considered, the exact length of which remains debated. Most now believe that waiting longer than 2 to 4 weeks places the patient at an unnecessary risk of recurrent stroke. TIAs with a carotid stenosis should be treated aggressively whether it is associated with an intracranial stenosis or not, but this is not considered an indication for emergent surgery.

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A 63-year-old male with past medical history significant for well controlled hypertension, hyperlipidemia, and a remote history of smoking is referred for evaluation of a 5.7 cm infrarenal abdominal aortic aneurysm (AAA) found incidentally on a CT scan of the abdomen during a recent emergency room visit for abdominal pain. The patient recently underwent a cardiac stress test by his primary care physician, which was normal and is now being considered for open versus endovascular repair.

1. Which of the following is considered a major risk factor in the development of AAA?
   A. Diabetes mellitus
   B. Hypertension
   C. Smoking
   D. Collagen vascular disease
   E. Obesity

2. For patients with major risk factors, what would be the best method to screen for AAA?
   A. Physical exam
   B. Abdominal ultrasound
   C. CT scan
   D. MRI
   E. Angiography

3. Regarding the size of his aneurysm, when should an elective abdominal aortic aneurysm be repaired?
   A. 4.5 cm
   B. 5 cm
   C. 5.5 cm
   D. 6.0 cm

4. Regarding survival after endovascular repair (EVAR), compared with open repair, which of the following is true?
   A. EVAR demonstrates equal survival both in the first 30 days and long term.
   B. EVAR demonstrates better long term survival and equal 30 day survival.
   C. EVAR demonstrates better 30 day survival and no difference in long term survival.
   D. In patients with minimal, well-controlled comorbidities, EVAR provides the better long-term results.
   E. In patients with poorly controlled co-morbidities, the open repair has a 15% mortality rate.

**ANSWERS**

1. C. The major risk factors associated with increased likelihood of aneurysm formation include: age > 65, male gender, history of smoking, and family history of AAA in a first degree relative.

2. B. For patients with major risk factors, the question becomes what is the best methodology to detect aneurysms in regard to screening? In the U.S. Preventive Services Task Force (USPSTF) January 2014 bulletin, the following recommendations were made: the Task Force found that one-time AAA screening can be effective and recommends it for men ages 65 to 75 who have ever smoked. This is a B recommendation. For men ages 65 to 75 who have never smoked, the Task Force recommends that these men talk to their doctor or nurse about whether one-time
AAA screening might be right for them based on their health history and the potential benefits and harms of screening.

For women, the Task Force found that the benefits and harms of screening are different. In the draft recommendation statement, the Task Force calls for more research to determine if AAA screening is beneficial for women ages 65 to 75 who smoke or have smoked in the past. Based on the lack of evidence, the Task Force determined it could not recommend for or against screening older female smokers and issued an I statement (issued when evidence is insufficient to fully assess benefits and harms). Research is critically needed in this area to determine if AAA screening could be beneficial for women who smoke or who have ever smoked. Among nonsmoking women, the chance of developing AAA is extremely low (well under 1%), and the Task Force found that AAA screening is very unlikely to benefit these women and may even cause harm. The Task Force recommends against screening for AAA in these women; this is a D recommendation.

Physical examination is highly dependent upon the experience of the examiner and on patient body habitus. As a general rule, patients with a 5.0 cm AAA are palpable 75% of the time and those measuring 3.0 to 3.9 cm are palpable 25% of the time. Abdominal ultrasound has been evaluated in numerous studies and has been found to be available, accurate, and low cost. CT and MRI are excellent modalities for evaluating the aorta regarding accuracy, but fail on cost effectiveness and availability. Angiography actually underestimates the size of a AAA because it only outlines the arterial lumen. It is also not cost-effective as a screening tool.

3. C. The natural history of AAA is such that most aneurysms expand at a rate of 0.3 cm/year. Two randomized, prospective trials have demonstrated that there is no survival benefit to repairing AAA < 5.5 cm, even in well selected patients who are considered to have a favorable operative risk. All aneurysms greater than 4.0 cm should be followed on a yearly basis. For patients who have an aneurysm that measures greater than 4.0 cm, but less than 5.5 cm, their aneurysm should be followed every six months as approximately 25% of those aneurysms will expand at a rate greater than or equal to 0.5 cm in six months, an indication for repair. Other indications to repair an AAA less than 5.5 cm include embolization, occlusion, symptoms (back/abdominal pain/tenderness on exam), and patients located in a remote area.

4. C. As a general rule, patients may be considered for open aortic surgery if they are under the age of 65, provided they are an acceptable surgical risk. EVAR may also be considered, but multiple anatomic considerations must be taken into account to include: neck diameter, neck length, angulation of neck, reverse taper of neck, calcification, thrombus, diameter of common femoral/iliac arteries, distal seal length, iliac tortuosity, and renal/splanchic blood flow. Given all of the technical considerations associated with EVAR, there are significant immediate and late complications that include device failure, arterial embolization, limb thrombosis, graft migration, graft infection, and endoleaks.

Two trials (EVAR I and DREAM) have compared open aortic surgery versus EVAR in patients considered fit for open surgery. In both studies (EVAR I/DREAM), open surgical repair was found to have increased 30 day mortality (4.7%/4.6% vs. 1.7%/1.2%), increased blood loss, longer operative time, and increased blood transfusion. The long term survival between open surgery and EVAR have been shown to be equal. EVAR demonstrates significant graft related complications (41% vs. 9%) and higher revision rates (20% vs. 6%) making open surgery in this case a better long term option. The EVAR 2 trial found patients deemed unfit, defined somewhat nebulously, for open surgery had the substantial operative mortality of 7%, indicating that those patients that are high risk will remain high risk regardless of what procedure is chosen. Of note, both EVAR I and DREAM excluded emergent cases.

BIBLIOGRAPHY


1. A 65-year-old male with end-stage renal disease has recently had an autogenous right radial-cephalic arteriovenous (AV) fistula performed. The patient will require temporary dialysis access until the fistula matures. The best option for temporary access is:
   A. A cuffed, tunneled central venous dialysis catheter in the ipsilateral internal jugular vein.
   B. A cuffed, tunneled central venous dialysis catheter in the contralateral subclavian vein.
   C. A cuffed, tunneled central venous dialysis catheter in the contralateral internal jugular vein.
   D. An uncuffed central venous dialysis catheter in the right femoral vein.
   E. An uncuffed central venous dialysis catheter in the contralateral internal jugular vein.

2. You are evaluating a patient for an autogenous AV fistula for long-term dialysis access. The patient has no Doppler signal in the right palmar arch and further work-up confirms stenosis of the ulnar artery on that side. The patient has a left subclavian central venous dialysis catheter currently. Vascular evaluation of the left arm and hand was unremarkable. What is the best option for long term dialysis access in this patient?
   A. Placement of a radial-cephalic AV fistula in the contralateral arm.
   B. Placement of a brachial-basilic AV fistula in the ipsilateral upper arm as the more proximal location will not be affected by the ulnar artery stenosis.
   C. Placement of a long term central venous dialysis catheter (Permacath).
   D. Placement of a femoral-saphenous AV fistula in the left groin.
   E. Transfer the dialysis catheter to the ipsilateral internal jugular vein and placement of a radial-cephalic AV fistula in the contralateral arm.

3. A 67-year-old male with end stage renal disease returns to your vascular clinic six weeks after he had a left autogenous radial-basilic AV fistula performed. He complains of intractable pain in his left hand and that hand is colder. He also has dark, dry ulcers of the distal end of fingers 2 to 4. What is the most likely cause of this condition?
   A. Emboli that has travelled from plaque that has formed in the radial artery.
   B. Arterial flow is being shunted away from the radial artery into the venous outflow of the AV fistula.
   C. An air embolus inadvertently formed in the radial artery from air trapped in the dialysis circuit that has travelled to the arterial system of the hand.
   D. An unrecognized arterial stenosis in the radial artery that has become symptomatic.
   E. Intermittent vasospasm of the radial artery brought on by hemodialysis.

4. The most appropriate treatment for the condition in question # 3 is:
   A. Angioplasty and possible stenting of any stenosis in the arterial limb of the AV fistula.
B. Intra-arterial injection of papaverin into the AV fistula and a three month course of an oral calcium channel blocker post-procedure.

C. Ligate the radial artery distal to the AV fistula.

D. Therapeutic heparinization and then Warfarin therapy for 3 months for treatment of embolic disease.

E. Reassure the patient that the condition is self-limiting and will improve over the next few weeks.

5. A 50-year-old male presents with fever to 102.5°F and malaise two months after placement of a prosthetic AV fistula in his right forearm. The patient has erythema around the AV fistula incision site and the AV fistula is warm and painful upon palpation. Blood cultures were obtained and preliminary Gram's stain show large amount of Gram positive cocci in clusters. A course of intravenous Vancomycin and Cefepime was started. What is the next step in the management of this patient?

A. Schedule surgery urgently for the removal of prosthetic material from the right forearm.

B. Continue intravenous Vancomycin for a four week course in an attempt to “sterilize” the AV fistula.

C. Inject Vancomycin and Cefepime into the AV fistula directly and place a tourniquet above the fistula for 30 minutes.

D. Start an eight day course of Vancomycin and Cefepime and then repeat blood cultures. No additional therapy is needed if blood cultures are negative.

E. Surgically remove prosthetic material from the right forearm and placement of an autogenous ipsilateral brachial-basilic AV fistula concurrently during this operation.

ANSWERS

1. C. Cuffed, tunneled dialysis catheter can be maintained for 6 weeks or more while uncuffed catheters will need to be replaced at 3 weeks. An autogenous AV fistula will usually take 4 to 6 weeks to mature. Catheters placed in the ipsilateral internal jugular vein or either subclavian vein are associated with higher rates of AV fistula failure due to partial venous outflow obstruction. There is negligible risk of venous outflow obstruction with temporary dialysis catheter placed in the contralateral internal jugular vein. Catheter placement in the femoral vein is not ideal especially in patients who are ambulatory. Femoral venous catheters have been associated with higher rates of venous thrombosis and blood stream infections in several reports.

2. E. AV fistula placement anywhere in the ipsilateral arm is not prudent given the stenosis of the ulnar artery on that side. This option has a high risk of graft failure. Femoral-saphenous AV fistula is an inferior option due to increased risk of graft thrombosis and infection in this location. AV fistula placement in the contralateral arm is the best option but the temporary dialysis should be transferred to the right internal jugular vein to maximize long term patency.

3. B. The arterial insufficiency that is seen in this patient is an example of “ischemic steal syndrome.” Arterial flow is being diverted away from the hand into the venous outflow (in this case the basilic vein). This phenomenon occurs in all AV fistulas to some degree but in rare cases the arterial insufficiency is to such a degree that the condition becomes symptomatic. Patients usually present with severe pain in the hand (or foot in the case of femoral-saphenous AV fistulas). This can progress to ischemic ulcers forming on the distal extremity. The diagnosis can be confirmed by Doppler imaging or venography.

4. A. Before ligating the radial artery, standard of care is for an arteriogram of the inflow artery with possible balloon angioplasty and/or stenting. If treatment of the arterial inflow with angioplasty and/or stenting does not correct the problem, then either a distal revascularization and interval ligation (DRIL) procedure or Proximalization procedure would be indicated. Ligation of the radial artery should only be considered a last resort. Ligation will allow arterial flow to be restored to the palmar arch and hand. Alternatively, for more proximal upper extremity and lower extremity AV fistulas, “distal revascularization with interval ligation” or DRIL procedure can be performed. In this procedure, a conduit (usually the saphenous vein graft) is created from the proximal portion of the arterial limb of the AV fistula to an area on the artery distal to the fistula. Afterwards, the artery is ligated between the fistula and the bypass graft. This procedure will usually allow preservation of the AV fistula as well as treat the arterial steal. If
these measures fail to correct the problem, the AV fistula will need to be ligated. Banding or plication of the venous outflow limb are less invasive procedures that have been used to treat this condition.

5. A. The patient in question #5 has an infected AV fistula graft. The patient also has bacteremia as result of the graft infection and is at risk to develop severe sepsis which can lead to death if not treated appropriately and expeditiously. Antibiotic therapy should be introduced immediately and empiric broad spectrum antibiotics are advised since the patient has likely been exposed to resistant hospital pathogens. In this case methicillin-resistant Staphylococcus Aureus (MRSA) is the most likely pathogen and Vancomycin is directed against it. The prosthetic material in the graft is the source of the infection and therefore must be removed. Any attempt to eradicate the graft infection with antibiotic therapy alone will fail. The placement of a new autogenous AV fistula should be postponed until the infection is adequately treated.

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A 66-year-old male with end-stage renal disease, coronary artery disease, diabetes, and hypertension presents to his outpatient clinic for regularly scheduled hemodialysis. He has a functioning left brachiocephalic arteriovenous fistula that his nurse accesses without difficulty. His “dry weight” is 80 kg.

1. After initiating hemodialysis, the patient begins to complain of muscle cramps in his legs. Which of the following is an effective treatment for this condition?
   A. Having the patient drink water during hemodialysis
   B. Hypertonic saline
   C. A low-sodium dialysate
   D. Increasing the ultrafiltration rate
   E. Permissive hypotension

2. The patient continues his hemodialysis. He becomes acutely hypotensive. Which of the following could be a cause of hypotension?
   A. Fasting in the peri-hemodialysis period
   B. Increased sympathetic tone
   C. Hemolysis
   D. Low ultrafiltration rate
   E. Cooling of the dialysate solution

3. The patient’s hypotension has resolved, but he is now experiencing dyspnea and chest pain. What is the appropriate management for this patient?
   A. Electrocardiogram and serum cardiac enzymes
   B. Continuation of dialysis
   C. Reduction of ultrafiltration rate
   D. Both A and C
   E. All of the above

4. Another patient who undergoes peritoneal dialysis for end-stage renal disease develops peritonitis. The patient is otherwise hemodynamically normal, without volume overload or significant electrolyte abnormality. What is the recommended treatment?
   A. Laparotomy and peritoneal washout
   B. Peritoneal dialysis catheter removal
   C. Empiric gram negative and gram positive coverage with intraperitoneal and oral antibiotics
   D. Empiric gram negative, gram positive, and antifungal intravenous coverage
   E. Emergent temporary dialysis catheter placement and initiation of hemodialysis

5. The patient’s peritonitis does not improve, and yeast is isolated on the gram stain. What is the recommended management of this patient?
   A. Peritoneal lavage, intraperitoneal fluconazole, and catheter removal
   B. Catheter removal and intravenous fluconazole
   C. Intraperitoneal amphotericin B followed by catheter removal
   D. Peritoneal lavage followed by catheter removal
   E. Catheter removal and immediate hemodialysis

ANSWERS
1. B. Dialysis-associated muscle cramps is a common problem that affects up to 86% of patients. The true etiology of the muscle cramps is not well understood,
but is likely related to electrolyte and fluid fluctuations. These reactions can occur when a low-sodium dialysate is used resulting in hyponatremia or hypo-osmolar plasma states. It is can be avoided by using a dialysate with a higher concentration of sodium. Cramps often occur due to rapid increase of interdialytic weight gains leading to intravascular volume contraction and hypo-osmolality as a result of high ultrafiltration rates. Hypertonic saline or hypertonic dextrose in a non-diabetic patient have been shown as effective treatments to counteract the hypo-osmolar state of the intravascular fluid, and also be helpful in hypovolemic states that may precipitate cramping or other serious reactions. Drinking water would not be effective in reversing a hypo-osmolar state and would not alleviate muscle cramps.

2. C. Intradialytic hypotension is one of the most common complications of hemodialysis, occurring in up to 30% of patients. There are many causes of hypotension in the dialysis patient that can lead to life-threatening scenarios such as arrhythmia, bleeding, infection, and myocardial infarction, among others. Hypotension can occur from aggressive ultrafiltration or hypo-osmolar dialysate resulting in weight gain. Low ultrafiltration rates do not typically cause hypotension (Choice D). Ingestion of a large meal immediately prior to or during dialysis can direct blood flow to splanchnic circulation and result in peripheral hypotension; as a result, eating in the peri-dialysis period is not recommended (Choice A). Autonomic dysfunction and neuropathy related to long-standing diabetes mellitus often results in hemodynamic instability during dialysis, which has been reported in up to 50% of patients (Choice B). Hemolysis can occur if the dialysate solution is contaminated with bacteria or other minerals, as well as if the solution is hypotonic. If hemolysis occurs, the pathognomonic sign is a port-wine appearance of blood in venous lines (Choice C). Hemolysis is usually accompanied by other symptoms such as nonspecific chest pain and dyspnea. Hemolysis can lead to hyperkalemia and arrhythmia if not properly identified and treated. Hypotension can be precipitated by warm dialysate and cooling of the solution is known to prevent such a complication. Fixed reduction of body temperature by 1°C has shown a statistically significant reduction in systolic blood pressure in several studies. The mechanism is not fully understood but lower temperatures are thought to increase sympathetic activity, thereby maintaining adequate systemic vascular resistance (Choice E).

3. E. The patient has coronary artery disease so angina or myocardial infarction should be ruled out but all of the above treatments are appropriate. Cardiac enzymes and electrocardiograms should be obtained on an individual basis based on clinical scenario and this patient meets this criteria. Reduction in ultrafiltration will reverse a hypovolemic state, thus reducing myocardial demand ischemia (Choice C). Continuation or cessation of dialysis (Choice B) are both acceptable, but are dependent on clinical factors such a hemodynamic stability, physical findings, and degree of patient comfort.

4. C. Peritonitis is a common complication of peritoneal dialysis, and is the primary reason for cessation of peritoneal dialysis with transition to hemodialysis. Peritonitis in patients who undergo peritoneal dialysis has significant morbidity but are managed with empiric outpatient antibiotics in over 75% of cases. Current guidelines state that empiric gram negative and gram positive coverage with antibiotics are indicated. Outpatient antibiotics typically include intraperitoneal and oral administration, such as intraperitoneal ceftazolin and oral ciprofloxacin, but inpatient regimens can include intravenous, intraperitoneal, or oral modalities (Choice C). Monotherapy is also available in intravenous form with imipenem/cilastatin. Empiric antifungal coverage is not recommended due to emerging resistance to antifungals (Choice D) and a large review revealed that only 2% of peritoneal dialysis-associated peritonitis were from fungal elements.

Laparotomy would not be recommended even if the patient were hemodynamically unstable, unless there was another precipitating cause of peritonitis such as bowel perforation or hemorrhage (Choice A). Peritoneal dialysis catheter removal is not a first line treatment for microbial peritonitis. Indications for catheter removal are relapsing peritonitis, lack of antimicrobial response within five days of initiation, or tunnel or insertion sites that involve infection. Placement of a temporary dialysis catheter and initiation of hemodialysis is not indicated in this patient as he is hemodynamically normal without any gross electrolyte disturbance (Choice E).
5. A. If fungal elements are isolated on gram stain or culture, prompt removal of the dialysis catheter and administration of intraperitoneal or intravenous antifungals should be initiated. Intraperitoneal amphotericin B is generally not recommended as it causes additional pain to the patient and is known for developing significant intraperitoneal adhesions. Typically the peritoneal fluid has a grossly cloudy appearance and should be lavaged with normal saline until clear. The patient should undergo hemodialysis in the near future for a minimum of six weeks. Immediate hemodialysis is not necessary unless clinically indicated via signs of acidosis, electrolyte imbalance, uremia, or fluid overload. After the six week period, a new peritoneal catheter can be placed if the patient desires.

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A 65-year-old man presents to your clinic with complaints of increasing right lower extremity “heaviness” and swelling over the last 2 to 3 months. He states his symptoms worsen throughout the day and his shoes feel tight by the time he takes them off at night. He denies any skin changes, wounds, or recent trauma to the area. He also denies any fevers, chills, fatigue, weight loss, or weight gain. His past medical history is only significant for hypertension, obesity, and a recent history of melanoma of the right lower extremity for which he underwent resection of the lesion with regional lymph node dissection and has been recovering well. His social history and family history are unremarkable and he denies any recent travel.

He has never smoked and denies any alcohol use. He does not exercise regularly and takes an ACE inhibitor and a multivitamin daily. His vital signs are a temperature of 38°C, heart rate of 72 beats per minute, blood pressure of 135/74 mm Hg, respiratory rate of 14 breaths per minute, and oxygen saturation of 99% on room air. Physical examination demonstrates diffuse non-painful pitting edema over his right lower extremity that extends over the dorsum of his foot including his toes. There is no evidence of skin discoloration or open wounds. He has easily palpable pulses and good capillary refill. His right lower extremity measures 4 cm greater in circumference than his left lower extremity. There are no palpable masses in his groin. His other extremities are normal in appearance and the rest of his physical exam is unremarkable.

1. The patient is most likely suffering from which disease process?
   A. Chronic venous insufficiency
   B. Filariasis
   C. Nephrotic syndrome
   D. Lymphedema

2. The most common cause of secondary lymphedema worldwide is:
   A. Malignancy or a result of its treatment
   B. Lymphedema praecox
   C. Wuchereria bancrofti
   D. Lymphedema tarda

3. The best test for diagnosing this patient with suspected lymphedema is:
   A. Lymphangiography
   B. Computerized tomography (CT) scan
   C. Magnetic resonance imaging (MRI)
   D. Detailed history and physical exam
   E. Lymphoscintigraphy

4. The first line treatment of lymphedema consists of:
   A. Diuretics
   B. Lymphatic reconstruction or excision of diseased channels
   C. Compressive therapy
   D. Benzopyrones (Coumarin) and long-term antibiotics
5. You diagnose this patient with lymphedema and start him on the appropriate therapy. He returns to your clinic a few years later with a painful, purplish ulcerating macule on his right lower extremity. This presentation is most concerning for:

A. Lymphangitis  
B. Lymphangiosarcoma  
C. Hematoma  
D. T rombophlebitis

**ANSWERS**

1. D. This patient is most likely suffering from lymphedema. He is suffering from unilateral lower extremity edema, which excludes systemic etiologies of his edema, such as nephrotic syndrome, liver disease, and heart failure. Filariasis is the most common cause of secondary lymphedema worldwide, although this patient denies any travel history. Venous pathology, such as chronic venous insufficiency is by far the most common cause of unilateral lower extremity edema. Lower extremity edema caused by venous pathology typically presents with pitting edema that spares the feet. The prolonged venous disease the skin can become atrophic with hemosiderin pigmentation.

   This patient has a history of lower extremity melanoma with regional lymph node dissection, which is a risk factor for developing lymphedema. Other risk factors include increased body mass index, tumor location, post-operative infection or hematoma, and radiation therapy. Additional malignancies that have been associated with the development of lymphedema are sarcomas, gynecologic cancer, genitourinary cancer and head and neck cancer, but the most common malignancy to be associated with the development of lymphedema is breast cancer, with an incidence of 17% among survivors.

2. C. The most common cause of secondary lymphedema worldwide is Filariasis from infection by the nematode Wuchereria bancrofti. In developed nations, almost all cases of secondary lymphedema are caused by a sequela of malignancy or as a result of its treatment. Lymphedema praecox is the most common form of primary lymphedema and accounts for around 94% of cases. The onset is usually seen in children and teenagers and is predominantly seen in women with a ratio of 10:1 compared to men. Lymphedema tarda is an uncommon cause of primary lymphedema with an age of onset of 35 years old or greater and accounts for less than 10% of cases.

3. D. Diagnosis of lymphedema is relatively simple in the second and third stages of the disease. When lymphedema is in the first stage (i.e., pitting, mild, and relieved by elevation) diagnosis can be more difficult. In patients with suspected secondary forms of lymphedema, CT scan and MRI are useful in excluding an underlying malignant etiology. In most patients, the diagnosis of lymphedema can be made based on a thorough history and physical exam alone. Also, patients with previous known lymph node excision, such as the patient in the vignette, do not require additional studies for diagnosis of lymphedema (further imaging is only necessary as needed for follow-up for each underlying malignancy). In cases where the diagnosis of lymphedema is suspected but the etiology is unclear, lymphoscintigraphy is the diagnostic test of choice.

   Lymphoscintigraphy has a sensitivity around 70% to 90% and a specificity of nearly 100%. Lymphangiography provides the best detail of the lymphatic system, but due to complications such as lymphangitis, pulmonary embolism, allergic reaction to the contrast dye and further damage to the lymphatic vessels, it is reserved for patients being considered for lymphatic reconstruction.

4. C. There is no curative treatment for lymphedema. The goals of treatment are to minimize swelling and prevent infections to the affected limb. Patients are at increased risk of developing recurrent infections such as cellulitis, erysipelas and lymphangitis. A combination of physical therapies (CPT) is the primary approach to the management of lymphedema. CPT involves good skin care followed by manual lymphatic drainage through massage, bed rest with leg elevation, application of graded compression stockings and sequential pneumatic compression devices. When worn daily, compression stockings have shown long-term maintenance of reduced limb circumference, may protect against external trauma and the development of skin and subcutaneous tissue thickening.

   No drug therapy for the treatment of lymphedema has been shown to be effective. Diuretics can be
useful in an acute exacerbation secondary to infection or if seen with coexisting venous disease, but is not useful for long-term care of lymphedema. Coumarin is still under investigation as a potential treatment for lymphedema, but currently has no role in treatment in the United States.

Although patients with lymphedema are at increased risk of developing recurrent infections, prophylactic use of antibiotics has no role in treatment. Instead, patients should be prescribed antibiotics that they can keep with them and take at the first signs or symptoms of an infection.

Patients with lymphedema can be managed nonoperatively 95% of the time. Operative intervention may be considered for patients with Stage II or Stage III disease who have severe functional disability. Surgical intervention is made up of two categories: excisional or reconstructive. Long-term follow-up data for surgical care of lymphedema is not available currently, and is therefore not well accepted as a mainstay of treatment throughout the world.

5. B. T is clinical presentation is most concerning for lymphangiosarcoma. Lymphangiosarcoma is a rare malignant tumor that can occur in patients suffering from chronic lymphedema. T e tumor originates in vascular endothelial cells and manifests clinically as a reddish-blue or purple skin lesion with a macular shape, an ulcer, a poor healing eschar or a firm painful nodule.

Lymphangitis is usually caused by group A beta-hemolytic streptococcal or staphylococcal infections and presents in an area of cellulitis. It clinically presents with pain and multiple linear, long, red streaks toward the regional lymph nodes and can even manifest as a systemic response with fevers, chills, sepsis, or death. Treatment consists of warm compresses and intravenous antibiotics.

T rombophlebitis clinically presents with an erythematous palpable cord along a superficial vein. Causes of thrombophlebitis are from an indwelling catheter, venous stasis, intravenous drug use, or an occult hypercoagulable state. Treatment includes compression stockings and anti-inflammatory medications with surgery being reserved for clusters of varicosities or cases of supplicative septic thrombophlebitis.

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A 48-year-old female presents with a 10-month history of left, lower extremity swelling with worsening swelling and “crampy” pain over the last two days. She has a history of hypertension for which she takes hydrochlorothiazide. Her medical history is otherwise unremarkable. She has no family history of thrombophilia. On physical exam her distal pulses are easily palpable. She is noted to have multiple bilateral lower extremity varicosities as well as a brawny appearing, well-granulated ulcer over the left medial malleolus. The circumference of her left thigh is noted to be 5 cm greater than that of the right thigh and her left calf is 4 cm greater in circumference than that of the right calf. CT scan of the pelvis is consistent with May-Turner Syndrome.

1. Which of the following statements regarding May-Turner Syndrome (MTS) is true?
   A. MTS related thrombus accounts for 15% to 20% of all lower extremity deep venous thromboses (DVT).
   B. Compression of the right common iliac vein by the left common iliac artery is the most common cause of MTS.
   C. A common cause of MTS related mortality is acute pulmonary embolism.
   D. Duplex ultrasound is the best imaging modality with which to assess for iliac thrombus.
   E. In the setting of MTS associated thrombosis, anticoagulation alone is the most effective first line treatment.

2. Which of the following statements regarding chronic venous insufficiency (CVI) is true?
   A. Venous stasis ulcers are often located over the lateral malleolus.
   B. Ultrasound is of limited utility in the diagnosis of venous insufficiency.
   C. Distal extremity ulcerations associated with arterial disease are twice as common as venous stasis ulcers.
   D. The Trendelenberg test can be used to distinguish between superficial and deep venous system reflux.
   E. Calf muscle dysfunction plays no role in venous insufficiency.

3. Which of the following is true regarding the medical management of CVI?
   A. Systemic antibiotics are recommended as part of the routine treatment of venous stasis ulcers.
   B. Hydrocolloid dressings have not been shown to definitively improve ulcer wound healing over simple non-adherent dressings.
   C. In terms of venous ulcer healing, inelastic compression systems are more effective than multi-layer compression systems with an elastic component.
   D. Moderate exercise may limit venous ulcer wound healing.
   E. Intermittent pneumatic compression devices are considered first line treatment in the majority of patients.
4. Which of the following is true regarding the surgical management of CVI?
   A. The risk of greater saphenous nerve injury is increased with greater saphenous vein stripping distal to the knee.
   B. Radiofrequency ablation of the greater saphenous vein is not effective at preventing long term recurrence of venous reflux.
   C. Tumescent solution is not commonly used when performing endovenous laser ablation.
   D. With regard to endovenous laser ablation, longer laser wavelengths are better absorbed by hemoglobin and therefore exert less of an ablative effect on the vein wall.
   E. In the management of venous stasis ulcers, allograft placement in conjunction with compression has not been shown to improve wound healing.

5. Which of the following is true regarding varicose veins?
   A. Varicose veins are more prevalent in men than women.
   B. Liquid sclerotherapy is superior to foam in the treatment of varicose veins in the setting of greater saphenous vein reflux.
   C. Ischemic stroke has been reported as a complication of the use of foam sclerotherapy in the management of varicose veins.
   D. Varicose veins are never painful.
   E. The use of compression stockings has been definitively found to prevent the progression of uncomplicated varicose veins.

ANSWERS

1. C. Causes of mortality in the acute setting include pulmonary embolism and iliac vein rupture resulting in a retroperitoneal hemorrhage. Individuals with chronic MTS may develop chronic left lower extremity edema as well as venous stasis ulcers. MTS related thrombosis accounts for 2% to 3% of lower extremity DVTs and is most often seen in females 20 to 40 years old. Autopsy studies indicate that anatomic features consistent with MTS are found in 22% to 32% of individuals in the general population.

   MTS is most commonly the result of compression of the left common iliac vein by an overlying right common iliac artery, although anatomic variants involving compression of the inferior vena cava and right common iliac vein do exist. Over time chronic compression of the iliac vein leads to endothelial injury and thrombus formation. Acute MTS related thrombosis is often heralded by the sudden onset of left lower extremity pain and swelling and may be precipitated by pregnancy or recent abdominal surgery.

   Duplex ultrasound lacks the sensitivity to detect most cases of ileofemoral thrombus. The preferred imaging modalities in cases of MTS include CT with venous phase contrast or magnetic resonance (MR) venogram.

   Catheter directed thrombolyses as well as percutaneous mechanical thrombectomy with the addition of endovascular stent placement are the treatments of choice for the management of acute MTS associated thrombosis. Anticoagulation alone or with mechanical thrombectomy without stent placement results in re-thrombosis rates upwards of 70%. Endovascular stent placement is also considered the first line treatment of MTS without evidence of iliac thrombus.

2. D. The Trendelenberg test can be used to distinguish between superficial and deep venous system incompetence. To perform the test, the patient is placed in the supine position and the affected leg is elevated in order to empty the superficial venous system. Either manual compression or a tourniquet is applied proximally and the patient is moved to an upright position. Individuals with deep venous system insufficiency will have rapid filling of the superficial veins whereas patients with reflux that is limited to the superficial venous system will not have filling for greater than 20 seconds after changing position.

   Venous stasis ulcers are often located over the distal-medial aspect of the lower extremities, commonly in the vicinity of the medial malleolus. In contrast, ulcers associated with arterial disease tend to occur over the distal digits or over distal-lateral bony prominences. Both forms of ulceration can be painful. Venous stasis ulcers are typically shallow with irregular boarders and commonly have a granulated or fibrinous base.

   Evaluation with duplex ultrasonography is recommended for most patients with a new clinical diagnosis of venous insufficiency. Ultrasound is useful in the assessment of proximal venous compression, deep vein thrombosis, and for determining the direction of venous flow. By using a rapid cuff inflation-deflation
maneuver while the patient is upright, the extent of the reversal of venous flow in the superficial system can be determined. Reversal of flow for greater than 0.5 seconds in duration is consistent with incompetent superficial valves whereas reversal of flow for greater than one second is consistent with reflux originating in the deep venous system.

Venous stasis ulcers are present in around 1% of the population in westernized countries and account for around 80% of lower extremity ulcers.

Normal calf muscle function is thought to improve venous return via a pump-like action during ambulation and lower extremity exercise. Impaired calf muscle function has been shown to positively correlate with the severity of venous insufficiency as well as with the formation of stasis ulcers.

3. B. A meta-analysis of 42 randomized trials comparing the use of different dressing types in individuals with venous stasis ulcers demonstrated no significant difference in wound healing rates when using a hydrocolloid dressing versus a simpler, less expensive non-adherent dressing.

Bacterial colonization of stasis ulcers is common. A meta-analysis that reviewed 22 trials involving the use of topical antibiotics, antiseptics or systemic antibiotics found no clear evidence to support the routine use of systemic antibiotics in individuals with venous stasis ulcers. There was some data to suggest the usefulness of topical cadexomer iodine (not readily available in the United States); however, the authors concluded that more data was needed to determine the efficacy of alternative topical antibiotics/antiseptics such as povidone iodine and mupirocin. Systemic antibiotics are recommended in cases of ulcers with surrounding cellulitis.

A recent Cochrane review found that the use of compressive dressings promotes increased ulcer healing rates when compared to dressings without an element of compression (i.e., Unna boot). Single layer dressings were less effective than multi-layered dressings and multi-layered dressings utilizing an elastic component were found to be more effective than those without. Increased calf muscle function as the result of structured exercise is likely to improve venous return and thereby promote ulcer healing.

Intermittent pneumatic compression devices are not considered first line treatment for most individuals with chronic venous insufficiency as they are both expensive and require patient immobilization while in use.

4. A. The classic greater saphenous vein (GSV) stripping procedure involves stripping of the vein from the ankle to the groin with high ligation at the sapheno-femoral junction. The greater saphenous nerve, which is a sensory cutaneous branch of the femoral nerve, is at risk of injury as it emerges from the adductor canal (formed by the tendons of the gracilis and sartorius muscles) to run with the GSV just posterior-medial to the tibia. Injury to the nerve results in loss of cutaneous sensation over the medial leg and can be avoided by not stripping the GSV distal to the knee.

Radiofrequency ablation has been shown to result in long term GSV occlusion with occlusion rates upwards of 88% at four years in one large trial. Another recent study reports GSV and small saphenous vein occlusion rates of up to 94.6% and 94.5% respectively at 14 months after radiofrequency ablation.

Types of solution is used in both radiofrequency ablation as well as endovenous laser ablation to anesthetize the tissue surrounding the vein as well as to protect the area from thermal injury.

Shorter laser wavelengths are better absorbed by hemoglobin whereas longer wavelengths are better absorbed by water allowing them to have greater ablative effects on vein walls. Commonly used endovenous laser wavelengths are between 810 and 1470 nm.

A Cochrane review from 2013 found that allograft when used in conjunction with compression resulted in superior healing of longstanding stasis ulcers when compared to treatment with compression alone. Of note, the authors concluded that current data is insufficient to determine whether the use of autograft or xenograft results in increased rates of healing.

5. C. Although uncommon, ischemic strokes as well as transient ischemic attacks have been reported after foam sclerotherapy. Additional complications include DVT, anaphylactic reactions, and local tissue necrosis.

Varicose veins are approximately twice as common in women with a reported prevalence of 15% to 30.1% in men and 28% to 50.5% in women. Risk factors associated with the formation of varicose veins include prior pregnancy, standing occupations, prior episodes of thrombophlebitis, DVT, family history, and obesity.

Foam sclerotherapy, typically using 1% or 3% polidocanol in a gas to liquid ratio of 4:1, has been
found to be superior to liquid polidocanol in the treatment of varicose veins due to greater saphenous vein reflux. Lower extremity varicosities can be painful with standing. In addition to cosmetic complaints, patients frequently report feelings of heaviness, aching or itching sensations.

Despite numerous studies and randomized controlled trials, compression stockings have not been clearly shown to halt the progression or slow the recurrence of uncomplicated varicose veins.

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A 34-year-old female nurse, previously healthy, presented to the emergency department with a 2-day history of right shoulder pain that came on suddenly when she was lifting a heavy trash can. In addition, over the past 24 hours she reports persistent right arm swelling and bluish discoloration that is more severe with her arm in the dependent position.

1. Which of the following is true regarding the pathophysiology of the condition this patient most likely has?
   A. Scalene muscle fibrosis is the major causative factor.
   B. It is due to compression of the subclavian artery, most likely from a cervical rib.
   C. It is due to repeated compression of the subclavian vein in the costoclavicular space, resulting in intimal injury and thrombus formation in the axillary and subclavian veins.
   D. Hypercoaguable state leading to spontaneous subclavian vein thrombosis.

2. Which of the following is the most common order of anatomic structures in the thoracic outlet, moving from anteromedial to posterolateral?
   A. Subclavius muscle, subclavian artery, subclavian vein, phrenic nerve, anterior scalene muscle, brachial plexus, middle scalene muscle.
   B. Subclavius muscle, subclavian vein, phrenic nerve, anterior scalene muscle, subclavian artery, brachial plexus, middle scalene muscle.
   C. Anterior scalene, subclavian vein, subclavious muscle, subclavian artery, brachial plexus, middle scalene muscle, phrenic nerve.
   D. Anterior scalene, subclavian vein, subclavious muscle, brachial plexus, subclavian artery, middle scalene muscle, phrenic nerve.

3. Which of the following is true with regards to the diagnosis/workup of thoracic outlet syndrome?
   A. Electromyography and nerve conduction tests alone exhibit a strong degree of specificity in diagnosing.
   B. Scalene muscle injection are not helpful in diagnosing nTOS but serve as a useful temporizing measure prior to definitive surgery.
   C. Venography is considered the gold standard for the diagnosis of vTOS, but the diagnosis can be missed if the brachial veins are used for access.
   D. In vTOS, findings on dynamic ultrasound scan include presence of subclavian or axillary thrombus and decrease in venous velocity by 50% with abduction.

4. Regarding the management of Paget-Schroetter Syndrome, which of the following is true?
   A. Most patients can be managed with anticoagulation alone and experience low recurrence rates.
   B. It is best managed initially with angioplasty and stenting prior to definitive surgical decompression.
   C. Catheter-directed thrombolysis followed by first rib resection is the preferred management strategy.
   D. Primary patency rates exceed 90% if thrombolysis is performed within 6 weeks of symptom onset.
   E. None of the above.
5. Which of the following is the most common complication of a first rib resection?
   A. lymphatic leakage
   B. pneumothorax
   C. intercostal brachial cutaneous nerve injury
   D. long thoracic nerve injury
   E. subclavian vein injury

**Answers**

1. C. The thoracic outlet is defined as the anatomic area bound by the clavicle superiorly, first rib inferiorly, subclavius muscle anteriorly, and the middle scalene muscle posteriorly. It is through this region that the subclavian artery, vein, and brachial plexus pass as they exit the chest. The thoracic outlet syndrome (TOS) refers to the compression of one or more of the neurovascular structures as they exit this region, can be subdivided into 3 major classes depending upon the structure that is compressed (in order of decreasing incidence): neurogenic, venous, and arterial. Neurogenic TOS (nTOS) is by far the most common type, comprising greater than 90% of all cases, and is due to compression of the brachial plexus as it passes over the first rib between the anterior and middle scalene muscles (through the scalene triangle).

   - Scalen muscle fibrosis as the result of a traumatic event such as an MVC (classically whiplash injury) or engaging in repetitive upper extremity activity is a major causative factor, although occasionally an anomalous first rib or cervical rib can result in nTOS. The most common presenting symptom is arm paresthesias, present in approximately 90% of patients. Other classical symptoms are pain and weakness in the upper extremity, neck pain, and occipital headaches. Pain and paresthesias are most commonly noted in the C8-T1 (ulnar distribution). Arterial TOS (aTOS) is the least common variant with an incidence of approximately 1%. Patients typically present with ipsilateral hand and/or digit ischemia from distal embolization of a subclavian artery stenosis or aneurysmal dilation, almost always as a result of extrinsic compression from a cervical or anomalous first rib. The patient described above suffers from venous TOS (vTOS), also known as Paget-Schroetter Syndrome, which is thrombosis or severe narrowing of the subclavian and/or axillary vein from chronic extrinsic compression at the level of the costoclavicular space. It accounts for approximately 5% of all TOS cases. It is classically seen in young, healthy patients with a history of repetitive motion (swimmers, baseball pitchers, manual laborer, nurse) or those with an active lifestyle. Symptoms include arm swelling (unique to vTOS), cyanosis, pain/aching, and occasionally paresthesias in the fingers or hands (often secondary to hand swelling).

2. B. Moving from anteromedial to posterolateral, the subclavius muscle is the first anatomic structure, which attaches from the first rib to the inferior portion of the clavicle and can be a source of compression of the next structure, which is the subclavian vein. The phrenic nerve usually runs immediately posterior to the subclavian vein along the anterior scalene muscle. However, in approximately 5% to 7% of individuals it can run anterior to the subclavian vein, and can be a rare cause of subclavian vein compression.

   - The subclavian artery is separated from the vein via the anterior scalene muscle. Posterior and lateral to the artery are the brachial plexus and finally the middle scalene muscle.

3. D. The diagnosis of nTOS can be challenging and is made with a combination of physical examination maneuvers as well as adjuncts such as nerve conduction studies, EMG, and even anterior scalene muscle injections of local anesthetics or botox. There is a growing body of evidence to suggest that anterior scalene injections are reliable means to not only diagnose nTOS but also predict which patients will benefit from surgical decompression. In one study, 122 patients being evaluated for nTOS underwent anterior scalene block using electrophysiologic guidance. Of the patients who were ultimately diagnosed with a condition other than TOS, only 5% had a positive response to the block, compared to 92% of patients with confirmed TOS. In addition, of the patients who underwent surgical decompression for TOS, 94% of patients with a positive response to scalene muscle block preoperatively had successful surgery while only 50% of those with negative response preoperatively had good outcomes.

   - In addition to standard chest radiographs to detect the presence of a cervical or anomalous first rib, dynamic duplex ultrasonography is used to identify axillosubclavian thrombus as well as evaluate for venous compression by having the patient abduct the ipsilateral arm, which should result in a decrease in
venous velocity by 50%. Ultrasound is recommended by the American College of Radiology as the best first approach for direct evaluation of arm veins, although venography is still considered the gold standard for making the diagnosis of vTOS (Paget-Schroetter Syndrome). However, ultrasound-guided access to the deep system (true brachial veins) at the antecubital fossa or upper arm is needed to obtain optimal visualization and also perform intervention. If the cephalic vein is used for contrast injection, the diagnosis can be missed.

4. D. Because of poor long-term outcomes with anticoagulation alone, which has been associated with symptom recurrence in up to 70% of patients, the standard accepted treatment for Paget-Schroetter Syndrome is catheter-directed thrombolysis followed by first rib resection. However, success of thrombolysis decreases as the time between symptom onset and presentation increases. Although the exact time frame is up for debate, the best results have been achieved in patients who present within 10–14 days. Certainly after 6 weeks, long term patency results are quite low.

Angioplasty with or without venous stent is not recommended as treatment for Paget Schroetter Syndrome due to the rate of complications and restenosis or thrombosis. Stenting of the vein running through the non-decompressed costoclavicular junction has been shown to be complicated by stent fracture in some, deformation in nearly all, and rethrombosis rates as high as 40%.

5. B. All of the above have been reported as complications after first rib resection, with pneumothorax being the most common.

Entry into the pleural space with resultant pneumothorax and/or pleural effusion is a known hazard of first rib resection. At the completion of the procedure, it is generally recommended to instill irrigation into the field and perform a Valsalva maneuver in order to check for pneumothorax. If present, a small chest tube can be placed. In a large retrospective series of 770 patients who underwent supraclavicular first rib resection and scalenectomy, very few operative complications were noted. Although pneumothorax is a known complication of this procedure, no patients developed post operative pneumothorax because for the 20% of patients in whom the pleural space was inadvertently entered during the procedure, a closed suction drain was placed to seal the defect. Post operative causalgia requiring sympathectomy occurred in two patients. One patient experienced lymphatic leak.

In another series examining 334 surgeries for nTOS, 13 complications (3.9%) occurred. The most common was pneumothorax (n = 7), for which 6 required chest tubes and 1 patient required additional surgery. There were 5 instances of vascular injury (4 minor subclavian vein injuries and 1 transection of the internal mammary artery resulting in a 2 L blood loss). There was also one minor injury to the long thoracic nerve.

The intercostal brachial nerve is encountered during the transaxillary approach as it exits between the 1st and 2nd ribs, and should be preserved if possible. Damage to this nerve would result in loss of sensation over the medial aspect of the arm.

BIBLIOGRAPHY


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Ovarian Masses

Charles S. Dietrich III and Bradford P. Whitcomb

Disclaimer: The views expressed in this manuscript are those of the authors and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the United States Government.

A 52-year-old post-menopausal female presents to her primary physician with abdominal bloating and urinary frequency over the past several weeks. She denies abdominal or pelvic pain but confirms mild constipation with reported bowel movements every three days. She has had no vaginal or rectal bleeding. Her past medical and surgical history is significant for mild hypertension and a prior cesarean delivery. Her mother was diagnosed with breast cancer at age 45.

On examination, her vital signs are normal. Abdominal exam reveals normal bowel sounds and mild distention. No abdominal pain is elicited and there are no palpable abdominal masses. On pelvic exam, a nodular mass is noted in the left adnexal region with decreased mobility. Rectal exam is unremarkable. Laboratory assessment shows a normal CEA, but her CA125 level is elevated at 430 U/mL.

1. What is the best initial imaging study for a patient with a suspected ovarian mass?
   A. Abdominal X-rays
   B. Ultrasound
   C. Computerized tomography (CT) scan
   D. Magnetic resonance imaging (MRI)
   E. Positron emission tomography-computed tomography (PET-CT)

2. Which of the following confers the highest risk for lifetime development of ovarian cancer?
   A. BRCA1 mutation
   B. BRCA2 mutation
   C. Lynch syndrome
   D. Mother affected with ovarian cancer
   E. Mother and sister affected with ovarian cancer

3. For the above patient, what is the best management strategy?
   A. Observation
   B. Percutaneous core biopsy of the adnexal mass
   C. Surgical exploration with staging and cytoreduction
   D. Neoadjuvant chemotherapy
   E. Palliative care

4. Which of the following procedures should be included in the surgical staging of an apparent early ovarian malignancy?
   A. Pelvic washings
   B. Removal of the ovarian mass
   C. Omentectomy
   D. Pelvic and para-aortic lymph node sampling
   E. All of the above

5. Which of the following adjuvant treatment options is associated with the greatest overall survival?
   A. Intravenous cyclophosphamide and cisplatin
   B. Intravenous paclitaxel and carboplatin
   C. Intravenous paclitaxel, carboplatin, and bevacizumab
   D. Intraperitoneal and intravenous paclitaxel and cisplatin
   E. Intravenous cyclophosphamide and doxorubicin
ANSWERS

1. B. The best initial imaging study for evaluating an ovarian mass is the trans-vaginal ultrasound (TVS). Morphologic characteristics, volume of the mass, and assessment of vascular resistance through color Doppler assists in differentiating benign from malignant ovarian processes. The addition of abdominal ultrasound is important in delineating larger ovarian and uterine masses extending outside the pelvis. The sensitivity of TVS with color Doppler is approximately 92% to 99% for identification of malignant tumors of the ovary. Findings on ultrasound suggestive of a malignant process include complex masses with solid and cystic components, internal or external nodular excrescences, and surrounding pelvic ascites (Figure 93-1). Although there is no universal test or combination of tests that are recommended for ovarian cancer screening, there is data to support the use of the “morphology index” (based on tumor characteristics and volume) derived from TVS findings to better risk stratify the ovarian abnormality as benign versus malignant.

Plain film X-rays are not very useful in the evaluation of ovarian masses as they are typically composed of fluid and soft tissue; however, a plain film may reveal incidental calcifications, one of the hallmark findings in ovarian teratomas. CT performance differentiating the soft tissue structures within the ovary is also limited. Radiation exposure and IV contrast administration pose additional risk to the patient. CT is most useful if malignancy is suspected to evaluate for metastatic disease in the preoperative planning phase. PET-CT has poor sensitivity and specificity for adnexal masses and is expensive. Its utility is best served in a patient with a known ovarian malignancy that has a suspicion of recurrence. MRI is a rather specific modality when investigating the adnexa, and is usually reserved for indeterminate ultrasound findings.

2. A. Obtaining a thorough, and accurate, family history is mandatory in evaluating the patient with a suspicious adnexal mass. The average woman’s lifetime risk for developing ovarian cancer is 1.4%. However, in a meta-analysis published in 1998, the lifetime relative risk of developing ovarian cancer with one affected first degree relative was 3.1 (95% CI 2.6–3.7), conferring a 5% lifetime risk. If more than one relative was affected, the estimated relative risk increased to 11.7 (95% CI 5.3–25.9) (approximate 20% lifetime risk).

Overall, approximately 5% to 10% of women diagnosed with ovarian cancer have an inherited syndrome that increases risk. BRCA1 and 2 are tumor suppressor genes coding for a protein involved in the repair of double-stranded DNA breaks. Mutations in these genes are the most common deleterious familial mutations in ovarian cancer and confer the highest risk of penetrance compared to other risk factors. Patients with BRCA1 mutations have a lifetime ovarian cancer risk of approximately 40% to 53%, while BRCA2 penetrance is 20% to 30%. Hereditary Non-Polyposis Colorectal Cancer (HNPPCC), or Lynch Syndrome, represents a defect in the mismatch repair (MMR) genes. These patients carry a very high risk of developing colon and endometrial cancer, as well as additional risk for other extracolonic malignancies. Ovarian cancer risk varies based on the actual genetic defect: MLH1/MSH2—4–24%; MSH6—1–11%; PMS2—6%. Other familial syndromes, such as Li-Fraumeni (TP53 mutation) and Peutz-Jeghers (STK11 mutation) also carry increased risks of developing ovarian cancer.

3. C. The menopausal patient described has findings concerning for an ovarian malignancy based on her constitutional symptoms, the adnexal mass, and her elevated CA-125 level. In 2016, an estimated 22,280 new ovarian cancer cases will occur in the United States, and there will be an estimated 14,240 deaths (http://seer.cancer.gov/statfacts/html/ovary.html). Ovarian cancer is the fifth leading cause for cancer deaths among women. While symptoms occur in
women with ovarian malignancies, they are often vague and nonspecific. As such, almost 80% of patients are diagnosed with metastatic disease. Persistent symptoms that should prompt evaluation of the ovaries include pelvic pain, changes in bowel habits, bloating, and urinary frequency. The overall 5-year survival for all patients diagnosed with ovarian cancer is currently around 45%.

The American College of Obstetricians and Gynecologists (ACOG) and Society of Gynecologic Oncology (SGO) recommend referral of the menopausal patient with an adnexal mass to a gynecologic oncologist if any of the following is found: any elevation in the CA-125, associated ascites, the mass is fixed or nodular, evidence of metastatic disease is noted, or if familial risk is determined. In the pre-menopausal patient with an adnexal mass, referral should occur for CA-125 > 200 U/mL, ascites, evidence of metastatic disease, or hereditary risk. Observation has significant risk for delay in diagnosis and is not recommended. Percutaneous biopsy of the mass carries significant risk for peritoneal seeding or upstaging of the disease. Furthermore, it is not accurate, with sensitivity for malignancy detection ranging from 25% to 82%.

Neoadjuvant chemotherapy (chemotherapy given before surgical debulking of disease) is another option for patients who have had a confirmation of ovarian cancer by paracentesis or other biopsy. Patients with comorbid conditions making them poor surgical candidates or those with bulky upper abdominal or stage IV disease may benefit most from this approach. Recent trials have shown that neoadjuvant chemotherapy offers a significant improvement in optimal cytoreduction at interval surgery, diminished surgical morbidity, and similar progression free and overall survival rates in Stage IIIC and IV ovarian cancer. However, there is much debate internationally regarding this approach, and upfront surgery remains the most common strategy in the United States. Palliative care is an option once a pathologic diagnosis and accurate stage for prognosis has been determined, but it is usually reserved for patients with progressive disease or for those with significant comorbidities.

4. E. If an ovarian malignancy is confirmed on intraoperative assessment, accurate staging is paramount to determine the extent of the disease and appropriate adjuvant treatments. Upstaging of an apparent malignancy confined to the ovary ranges from 22% to 50% when formal staging procedures are performed. Formal staging usually includes the following: removal of the affected ovary; removal of the uterus and contralateral ovary (if fertility is not desired); careful evaluation of all peritoneal surfaces with biopsy of any suspicious areas; peritoneal washings for cytologic evaluation; infracolic omentectomy; random peritoneal sampling from the right hemidiaphragm, paracolic gutters, pelvic sidewalls, bladder, and posterior cul-de-sac; and removal of pelvic and para-aortic lymph nodes. Lymphadenectomy probably is the most important and technically challenging component of adequate staging. In a review by Powless et al., 13% of apparent early stage ovarian cancers were found to have positive nodes. While still recommended, several investigators have questioned the utility of omentectomy and random peritoneal biopsies when no gross disease is visible. In their reviews, upstaging based on omentectomy occurred in less than 4% of patients. Similarly, less than 5% of patients were found to have microscopic disease on random peritoneal biopsies.

The ACTION trial confirmed the importance of adequate staging. In this study, patients with Stage IA to IIA ovarian epithelial carcinoma were randomized after surgery to observation or adjuvant chemotherapy. Groups were further stratified into optimal versus non-optimal staging categories. In a recent long-term analysis, overall survival was improved in patients with optimal surgical staging, even among those receiving adjuvant chemotherapy [HR = 1.89, p = 0.05]. Considerable debate is ongoing regarding the route of surgical staging. Historically, laparotomy was felt to offer the best exposure for full evaluation of all peritoneal surfaces, and this approach is still standard today. However, as advances in minimally invasive surgery have occurred in the past decade, many investigators have concluded that operative outcomes with a laparoscopic approach could be compatible with those of laparotomy.

When an advanced ovarian malignancy is present, the extent of surgical cytoreduction directly correlates with overall survival. Cytoreduction is a concept that has until recently been unique to the management of ovarian malignancies. The theoretic benefits of cytoreduction include improved patient comfort, increased tumor perfusion, increased tumor growth fraction, and improved immunologic response. Removal of all individual tumor implants...
to less than one centimeter is currently considered an optimal cytoreduction. However, the definition of optimal cytoreduction is rapidly changing, and most gynecologic oncologists now consider reduction to microscopic disease to be the goal. In a review of several Gynecologic Oncology Groups (GOG) studies, patients with Stage IIIC disease had an overall survival of 71.9 months when cytoreduction to microscopic disease was achieved versus 42.4 months when disease was reduced to <1 cm. Achieving an optimal cytoreductive status often requires bowel resection and extensive upper abdominal procedures such as diaphragmatic stripping, splenectomy, and distal pancreatectomy.

5. With the exception of Stage IA grade 1 tumors, adjuvant chemotherapy is recommended for all epithelial ovarian cancers following surgical staging and tumor cytoreduction. Platinum based therapy has remained the cornerstone of therapy since the 1970s, with the current standard incorporating paclitaxel with carboplatin delivered intravenously every three weeks for six to eight cycles. With platinum based therapy, almost 75% of patients with advanced disease will achieve remission. Unfortunately, recurrences are likely, usually occurring within two years of primary therapy, and are rarely curable. Intense efforts are continually ongoing to discover novel treatment options.

Intraperitoneal (IP) chemotherapy has long interested gynecologic oncologists for its theoretic advantages. However, due to the challenges in delivery and increased toxicities, this route of administration was not favored until recently. In 2006, GOG 172 demonstrated one of the largest survival advantages for any ovarian cancer study ever published. In this trial, a 16 month overall survival advantage was found for an IP regimen (Day 1, intravenous paclitaxel; Day 2, intraperitoneal cisplatin; Day 8, intraperitoneal paclitaxel) when compared to intravenous paclitaxel and cisplatin delivered every three weeks. Toxicities were significantly increased in the IP group, with most patients only completing an average of 4 out of 6 planned cycles. However, quality of life assessments one year following completion of therapy were equivalent between the two groups. Following this publication, the NCI issued a rare clinical alert recommending that ovarian cancer patients be considered for IP treatment.

Only patients who achieve an optimal cytoreductive status are candidates for IP therapy, as chemotherapy penetration into tumor nodules exceeding one cm is diminished. IP ports can be easily placed at the time of a cytoreductive surgery, but this requires preoperative anticipation of findings and a lengthy discussion of adjuvant treatment options. The IP catheter can also be placed at a second operation which can typically be accomplished laparoscopically. A 9.6 French single lumen medport is positioned over a rib in the midclavicular line near the inferior costal margin. The catheter is then tunneled subcutaneously to the level of the umbilicus before entering the peritoneal cavity. Approximately 10 cm of catheter length should be contained intrabdominally. Port complications are the most likely reason for discontinuation of therapy and include infection, catheter occlusion, and intestinal erosion. Postoperative adhesions can also develop limiting circulation of chemotherapy.

Significant efforts are focusing on biologic targeted therapies in the treatment of ovarian cancer. Bevacizumab, a monoclonal antibody that prevents angiogenesis by inhibiting vascular endothelial growth factor (VEGF), has received considerable attention for its activity in a number of solid tumors. Several studies using bevacizumab in combination with cytotoxic chemotherapy have demonstrated a progression-free survival advantage in ovarian cancer; however, none have realized an overall survival advantage to date.

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Ectopic Pregnancy

Charles S. Dietrich III and Bradford P. Whitcomb

Disclaimer: The views expressed in this manuscript are those of the authors and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the United States Government.

A 24-year-old female presents to the emergency department with worsening right pelvic pain over the past 12 hours associated with vaginal spotting. She denies fevers and chills and has had no nausea or vomiting. Her bowel movements have been regular, and she denies any urinary symptoms. She is sexually active and not using contraception. Her last menstrual period was 7 weeks prior to presentation. Past medical and surgical history is remarkable only for a chlamydial infection two years ago.

Her vital signs show a temperature of 98.6°F with a heart rate of 101 and blood pressure of 95/55. Focused examination shows mild abdominal distention with right lower quadrant tenderness to deep palpation. No peritoneal signs are elicited. Her pelvic exam reveals a small amount of bleeding from a closed cervical os. There is no cervical motion tenderness, but exquisite tenderness with a slight fullness is appreciated in the right adnexal region.

Laboratory assessment is notable for a positive urine hCG test. Quantitative hCG returns at 2200 mIU/mL. Her white blood count is $6.5 \times 10^9$/L, hemoglobin 9.8 g/dL, hematocrit 29.2%, and platelets are $230 \times 10^9$/L. Chemistries are unremarkable.

1. What is the BEST initial imaging modality for this patient?
   A. Trans-vaginal ultrasound
   B. Trans-abdominal ultrasound
   C. Computerized tomography (CT) scan
   D. Magnetic resonance imaging (MRI)
   E. Abdominal X-rays

2. What single quantitative hCG level distinguishes between ectopic or intrauterine pregnancy (viable or nonviable) when no intrauterine fluid collection and normal adnexa are identified on ultrasonography?
   A. 500 mIU/mL
   B. 1000 mIU/mL
   C. 2000 mIU/mL
   D. 3000 mIU/mL
   E. There is no single hCG value that can reliably distinguish between ectopic or intrauterine pregnancy.

3. Which of the following is a contraindication to medically managing an ectopic pregnancy with methotrexate?
   A. Limited to no cardiac activity noted on ultrasonography
   B. Absence of pelvic pain
   C. hCG = 4500 mIU/mL
   D. Hemodynamically stable patient
   E. Unreliable follow-up

4. In a patient demonstrating hemodynamic instability, what is the best management option for an ectopic pregnancy in the distal fallopian tube?
   A. Expectant management
   B. Methotrexate
   C. Salpingostomy
D. Salpingectomy  
E. Salpingo-oophorectomy

5. Once an ectopic pregnancy has been diagnosed, what is the future risk for another ectopic pregnancy?
   A. 1%  
   B. 10%  
   C. 20%  
   D. 50%  
   E. 75%

ANSWERS

1. A. When a woman presents with pain and bleeding in early pregnancy, the differential diagnosis includes a viable intrauterine pregnancy, a nonviable intrauterine pregnancy, or an ectopic pregnancy. As ultrasound technology has improved, this modality, along with serum human chorionic gonadotropin (hCG) measurement, has become the cornerstone in the evaluation of early-pregnancy complications. Early pregnancy development follows a relatively predictable path as seen on trans-vaginal ultrasonography. A gestational sac is first seen around 5 weeks of gestational age when measured from the beginning of the last menstrual period. The yolk sac then appears at 5½ weeks. The embryo can usually be visualized adjacent to the yolk sac at approximately 6 weeks, and a visible heartbeat presents concurrently with the embryo in most cases. Any deviations from this expected pattern of development are worrisome for an abnormal gestation. Imaging studies with ionizing radiation should be avoided in early pregnancy if possible. Furthermore, modalities such as CT scan, abdominal X-rays, and MRI add little to the evaluation.

   Review of managed care databases suggests that ectopic pregnancies occur in 2.6% of all pregnancies. Risk factors include a history of a prior ectopic pregnancy, prior pelvic infections, previous surgeries, and smoking. Six percent of maternal deaths in early pregnancy are caused by ruptured ectopic pregnancies. However, improved diagnostic modalities which allow for earlier identification, have kept the maternal case-fatality rate low at 3.8 deaths per 10,000 ectopic pregnancies. While trans-abdominal ultrasonography can identify an intrauterine pregnancy, it lacks the capability to fully assess the adnexa. Findings on trans-vaginal ultrasound suggestive of an ectopic pregnancy include absence of an intrauterine pregnancy when expected based on hCG levels and/or gestational age, identification of an adnexal mass adjacent to the uterus and medial to the ovary, and heterogeneous pelvic fluid (Figures 94-1 and 94-2). The sensitivity of trans-vaginal ultrasound to detect ectopic pregnancy ranges from 0.73 to 0.93 in reported series.

2. E. Human chorionic gonadotropin measurement is the second diagnostic pillar in the evaluation of early-pregnancy complications. Unfortunately, isolated hCG levels can overlap the three most common possibilities in patients with first-trimester bleeding: viable intrauterine pregnancies, nonviable intrauterine pregnancies, and ectopic gestations. A single hCG value, therefore, cannot be used to reliably differentiate between these different possibilities despite intensive efforts to determine a discriminatory level. As ultrasound capabilities improved,
previous investigators reported a high accuracy in documenting an intrauterine gestation with hCG levels between 1000 to 2000 mIU/mL. However, recent studies have questioned these levels. Among women with a pregnancy of unknown location and hCG levels between 2000 to 3000 mIU/mL, 19 ectopic pregnancies and 38 nonviable intrauterine pregnancies will be found for each viable pregnancy, making the likelihood of a viable pregnancy approximately 2%. The lower reliability of an hCG discriminatory zone in the diagnosis of an intrauterine pregnancy may be due to the higher rate of multiple gestations seen in the obstetric population today. The levels of hCG in multiple gestations when compared to singleton pregnancies are higher for every stage of development.

In a patient with a pregnancy of unknown location, obtaining at least one follow-up hCG measurement is recommended before initiating treatment to avoid misdiagnosing a potential viable intrauterine pregnancy. Ninety-nine percent of symptomatic women with a viable pregnancy will demonstrate at least a 53% increase in hCG levels over a 48 hour interval. Serial evaluation should only be done if the patient is hemodynamically stable and can be reliably tracked.

3. C. Once an ectopic pregnancy has been confirmed, there are four main treatment options: expectant management, medical treatment with methotrexate, conservative surgery with salpingostomy, and salpingectomy. Categorizing the activity of the ectopic pregnancy into very less active, less active, and active can guide subsequent therapy. In general, less active ectopic pregnancies can be managed medically with high success rates. Active ectopic pregnancies usually require surgical intervention. Not surprisingly, the definition of activity has not been uniformly established. One author has proposed to define a less active ectopic pregnancy (one that can be treated with methotrexate) as one with a pretreatment hCG < 5000, with no cardiac activity in the embryo, in women with no symptoms, and in those who are hemodynamically stable.

Methotrexate is an antimetabolite that inhibits dihydrofolate reductase. Proliferating tissues, including trophoblastic cells, are readily affected. Its use in treating ectopic pregnancies was first reported in 1982 by Tanaka et al. While several regimens are effective, the most commonly used one today is a single-dose regimen using 50 mg/m² injected intramuscularly on Day 1. Serial hCG levels are trended and a 15% decrease is expected between Day 4 and 7. Additional doses can be administered for rising or plateaued values. Reliable follow-up is critical when treating patients with methotrexate, and success rates range from 63% to 96.7% in the literature. The wide range is due to the many definitions of success and variations in patient characteristics.

4. D. Active ectopic pregnancies by definition have either ruptured or have impending rupture. Patients can present with hemodynamic instability, hemoperitoneum, and associated severe pain. Surgical management is necessary for either patient stabilization or because of the high failure rate with a medical approach. The degree of hCG elevation usually is not helpful in these cases as management is dictated by the patients overall condition.

The vast majority of ectopic pregnancies are located in the distal fallopian tube, accounting for up to 97% of cases. Other ectopic implantation sites include the interstitial portion of the fallopian tube, cervix, ovary, abdomen, and previous cesarean scar. Heterotopic pregnancies (synchronous ectopic and intrauterine pregnancies) are increasing in incidence secondary to assisted reproductive technologies, occurring in 1% to 3% of this population.

Surgical options for managing an ectopic in the distal fallopian tube include conservative salpingostomy versus the more radical salpingectomy. Both procedures are feasible though a laparoscopic approach, although patient stability and surgeon experience will dictate the ultimate modality. During salpingostomy, a linear incision is made over the antimesenteric bulging portion of the tube. A suction irrigator is then used to hydrodissect and remove the ectopic mass. The tubal incision is not reaproximated with suture and left to close on its own. Salpingectomy includes complete removal of the fallopian tube with the contained products of conception.

The choice between conservative salpingostomy versus salpingectomy is usually made intraoperatively. Factors influencing management include the patient’s history (prior ectopic), patient preference, the appearance of the contralateral tube, and bleeding. In patients demonstrating hemodynamic instability, salpingectomy is usually preferred and has a 100% efficacy rate. Salpingostomy carries a failure rate of 6.6% to 17.5%, leading to persistent ectopic
tissue in the pelvis. In these cases, the hCG level fails to normalize, and subsequent treatment with methotrexate may be necessary.

5. B. The rate of recurrent ectopic pregnancy ranges from 6% to 10% regardless of the treatment modality selected. Patients often question their future fertility chances after having an ectopic pregnancy. The DEMETER trial compared medical management with conservative salpingostomy, and found no difference in the 2-year fertility rate (67% vs. 71%, p = 0.37). This trial also compared the 2-year fertility rate between salpingostomy and salpingectomy and demonstrated no difference (70% vs. 64%, p = 0.78).

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Crochet JR, Bastian LA, Chireau MV. Does this woman have an ectopic pregnancy? The rational clinical examination systematic review. JAMA. 2013;309(16):1722–9.


A 24-year-old gravida 0 caucasian female with no significant medical or surgical history presents to the emergency room with complaints of acute onset right lower quadrant pain increasing over the preceding 24 hours. She also endorses fevers, nausea, and vomiting.

Her vital signs show a temperature of 100.8°F, blood pressure 113/67 with respirations 18 and pulse 85. Pertinent positives on physical exam include tenderness in the right lower quadrant with voluntary guarding but no rebound and hypoactive bowel sounds. Pelvic exam reproduces exquisite right pelvic tenderness with a poorly defined pelvic mass. Laboratory evaluation includes a negative HCG, WBC 15,000, hemoglobin and hematocrit of 13 and 39 with platelet count of 350,000. She has normal renal and liver function tests. Imaging studies show an inflammatory mass in the right lower quadrant and pelvis.

1. Which of the following bacteria is the most common inciting organism in the development of acute pelvic inflammatory disease?
   A. Staphylococcus aureus
   B. Gonorrhea
   C. Escherichia Coli
   D. Peptostreptococcus sp.
   E. Bacteroides sp.

2. Which diagnostic radiologic study is the first-line imaging modality to evaluate for a gynecologic pathology in this patient?
   A. Computed tomography (CT) of the abdomen and pelvis with contrast
   B. Trans-abdominal ultrasound
   C. Trans-vaginal ultrasound

3. For the above patient, imaging documents a right adnexal cystic structure 8 cm in greatest diameter consistent with an abscess in the right adnexa. She is admitted for treatment. Which of the following is the LEAST appropriate initial treatment option for this patient?
   A. Operative laparoscopy with drainage of the abscess with intravenous cefotetan and doxycycline
   B. Intravenous cefotetan plus doxycycline
   C. Intramuscular ceftriaxone and IV ciprofloxacin
   D. Intravenous ampicillin/sulbactam
   E. CT–guided drainage with intravenous cefoxitin and clindamycin

4. Further treatment is dependent on the patient's response to therapy. Which of the following statements is correct?
   A. Sepsis is not commonly associated with a ruptured tubo-ovarian abscess but does not require surgical intervention.
   B. Bacteroides is the most frequent cause of Gram-negative sepsis associated with tubo-ovarian abscess.
   C. Antibiotics should be switched from parenteral to oral route of administration only after 72 hours of clinical improvement, resolution of nausea, vomiting, and severe pain.
   D. If this patient does not respond to intravenous antibiotics, a hysterectomy with bilateral salpingo-oophorectomy is required for cure of a
tubo-ovarian abscess (TOA) resulting from pelvic inflammatory disease.

E. The most common sequelae of TOA are infertility, ectopic pregnancy, and chronic pelvic pain.

ANSWERS

1. B. Pelvic inflammatory disease (PID) is a polymicrobial ascending infection that causes inflammation of the upper genital tract, including endometritis, salpingitis, pelvic peritonitis and in some cases leading to TOA formation. The general surgeon can be consulted in cases in which an infectious process involving the bowel such as diverticulitis or appendicitis, or an extirpative surgery is being considered with severe pelvic adhesive disease involving the bowel. The general surgeon’s expertise may be required in the surgical drainage of a TOA, or to assist in managing a patient suffering from life-threatening sepsis arising from a suspected TOA.

PID is diagnosed in more than 800,000 women annually in the United States. Ninety percent of these infections are treated as outpatients. The vast majority of cases are found in the reproductive age female less than 25 years of age. Many cases of PID, however, are asymptomatic and therefore elude diagnosis. PID typically originates with an infection of either Chlamydia trachomatis or Neisseria gonorrhoea in the lower urogenital tract. These pathogens ascend the genital tract causing cervicitis, endometritis and salpingitis. With the accompanying damage to the lower genital tract, bacterial organisms, generally found in the perianal region, can ascend through the cervix. As a result, PID transforms into a poly-microbial infection which may ultimately manifest as a TOA and sepsis. Occasionally, patients with chlamydia infection develop pericolicitis (Fitzhugh-Curtis Syndrome), an inflammation of the liver capsule and adjacent peritoneal surfaces.

Anaerobic and facultative aerobic bacteria, with or without N. gonorrhoea and C. trachomatis, have been isolated from the upper genital tract of women with PID. TOAs are caused by endothelial damage and associated edema within the fallopian tube. The intrinsic defense mechanisms of the upper genital tract become compromised leading to rapid bacterial growth. As the infection progresses, the ovary becomes involved with invasion of the ovarian epithelium. Classically peritonitis is characterized by fibrinoid exudate on the serosal surfaces of the uterus, tubes, and ovaries leading to agglutination. T is fibrinoid exudate can be seen laparoscopically on any intra-abdominal organ extending to the liver edge. Necrosis inside the complex inflammatory mass may lead to one or more polymicrobial abscess cavities. Interestingly, C. trachomatis has never been isolated from an abscess cavity.

Classic symptoms for PID include abdominal pain, abnormal discharge, inter-menstrual or postcoital bleeding, fever, urinary urgency, low back pain, nausea, and vomiting. Symptoms of TOA can be indistinguishable from acute salpingitis and appendicitis. TOAs generally manifest with symptoms to include abdominal and pelvic pain (> 90%), fever (50%), vaginal discharge (28%), nausea (26%), and abnormal vaginal bleeding (21%). Twenty percent of TOA cases, however, have normal white blood cell counts. There is no single complaint, physical exam finding or laboratory finding that is highly sensitive or specific for the diagnosis of PID, and the clinical diagnosis of PID has a positive predictive value of only 65% to 90%.

2. C. T e diagnosis of TOA requires the finding of an inflammatory mass on exam or imaging. Transvaginal ultrasound is considered the first-line imaging modality for gynecologic pathology, because it provides excellent imaging of the upper genital tract, is relatively inexpensive and does not expose the patient to radiation. CT scan of the abdomen/pelvis with contrast is preferred in cases where the diagnosis is uncertain, and in which there is a concern for a coexisting malignancy or gastrointestinal pathology such as appendicitis or diverticulitis. T e CT scan has increased sensitivity to detect a TOA (78% to 100% vs. 75% to 82%) and improved specificity (100% vs. 91%) as compared to ultrasound. MRI has limited utility in the evaluation of acute pelvic pain.

3. D. Treatment choice for TOA is dependent on many factors. At a minimum, all patients with TOA require admission and treatment with intravenous antibiotics. Multiple regimens are considered acceptable and should be implemented based on the resistance profile in the community. T e re are regimens that provide broad coverage for not only N. Gonorrhoea and C. trichomatis, but also for Mycoplasma genitalium, Gram positive, and Gram negative facultative aerobes, as well as anaerobic organisms (see Table 95-1).

T e cephalosporin-based regimens are preferred due to improved tolerability. Clindamycin,
metronidazole and cefoxitin have been shown to have superior abscess wall penetration and activity within the cavity in animal models. Amnioglycosides have reduced activity in acidic, anaerobic environments such as those found in abscesses. Adding ampicillin to gentamicin and clindamycin nearly doubles cure rates for TOA from 47% to 87.5%. Due to the high rates of resistance of E. Coli, ampicillin-sulbactam is no longer recommended as a single agent for the treatment of community acquired intra-abdominal infections. The resistance of community acquired N. Gonorrhoeae to fluoroquinolones has also eliminated this class of antibiotics as a first or second line treatment option for PID or TOA. Antibiotic therapy can be switched from a parenteral to an oral route of administration after 24 to 48 hours of clinical improvement including resolution of nausea and vomiting, fevers, and severe pain. Patients should complete a 14 day course with oral antibiotics. These regimens include doxycycline (100 mg BID) combined with metronidazole (500 mg BID). Other regimens include amoxicillin/clavulante (875 to 2000 mg BID) or trimethoprim/sulfamethaxazole (800/160 mg BID) and metronidazole (500 mg BID). Drainage is not necessary as a first line treatment unless there is concern for sepsis, which would indicate a ruptured abscess.

4. E. When clinical response is not achieved within 48 hours after initiation of antibiotics, surgical management or drainage should be strongly considered. When drainage of a TOA is indicated, options include a percutaneous approach by interventional radiology, or a surgical approach via either a laparoscopic or open procedure. Unilateral salpingo-oophorectomy may also be necessary depending on the clinical scenario. Pelvic abscesses have been drained using ultrasound or CT guidance with a transabdominal, transgluteal, transrectal, or transvaginal approaches depending on the location of the abscess with success rates of 77.8 to 100%.

The decision for surgical management of a TOA with either drainage or excision depends on the status of the patient and the size of the abscess. When rupture is suspected based on presentation with acute abdomen or septic shock, prompt surgical intervention is required because of the high morbidity and risk of mortality associated with a ruptured TOA. E. Coli is the most common isolate in women with ruptured TOAs and a frequent cause of Gram-negative sepsis. Large case series have shown that antimicrobial therapy alone is usually effective in 70% of all TOAs and, in a few of these studies, abscess size has been shown to be predictive of treatment success with antibiotics alone. Reed et al. showed that 35% of abscesses 7 to 9 cm in size required surgery compared to almost 60% of abscess > 9 cm. DeWitt et al. showed that abscesses > 8 cm more often required drainage or surgery. It is reasonable to observe the effect of IV antibiotic therapy without immediate surgery in women who are not developing signs of sepsis and whose abscess is 8 cm or less in diameter.

When clinical response is not achieved with antibiotic therapy, surgical management should be considered. Hysterectomy with bilateral-salpingo-oophorectomy is generally not necessary but can be considered if patient has extensive disease and has

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### Table 95-1 INPATIENT PARENTERAL ANTIBIOTIC REGIMENS FOR TREATMENT OF SEVERE PELVIC INFLAMMATORY DISEASE AND TUBO-OVARIAN ABSCESS

<table>
<thead>
<tr>
<th>Recommended Regimen:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clindamycin 900 mg intravenously every 8 hours PLUS</td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone 1 g intravenously every 12 hours</td>
<td></td>
</tr>
<tr>
<td>Substitute gentamicin for ceftriaxone in patients with Beta-lactam allergy; gentamicin loading dose 2 mg/kg intravenously or intramuscularly followed by maintenance dose (1.5 mg/kg) every 8 hours. Single daily dosing may be substituted.</td>
<td></td>
</tr>
<tr>
<td>Alternative Regimens:</td>
<td></td>
</tr>
<tr>
<td>Cefoxitin 2 g intravenously every 6 hours OR</td>
<td></td>
</tr>
<tr>
<td>Cefotetan 2 g intravenously every 12 hours PLUS</td>
<td></td>
</tr>
<tr>
<td>Doxycycline 100 mg intravenously or orally&lt;sup&gt;a&lt;/sup&gt; every 12 hours OR</td>
<td></td>
</tr>
<tr>
<td>Ampicillin/sulbactam 3 g intravenously every 6 hours PLUS</td>
<td></td>
</tr>
<tr>
<td>Doxycycline 100 mg orally or intravenously&lt;sup&gt;a&lt;/sup&gt; every 12 hours</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>May be initiated when patient is able to tolerate oral therapy to avoid phlebitis associated with parenteral doxycycline.

completed child-bearing. A post-menopausal patient with a TOA should be consented for total abdominal hysterectomy with bilateral salpingo-oophorectomy due to the strong association with either gynecologic or intestinal malignancy. Hysterectomy with bilateral salpingo-oophorectomy has the least risk of recurrence but also the highest surgical morbidity. The long-term sequelae of PID are infertility or ectopic pregnancy due to tubal scarring and chronic pelvic pain attributed to pelvic adhesive disease.

BIBLIOGRAPHY


A 26-year-old gravida 0 female with history of chronic low grade right pelvic pain presents to the emergency room with onset of acute right lower quadrant pain over the course of the preceding 12 hours. The gynecology team has taken patient to the operating room to address her pain with the preliminary diagnosis of ruptured ovarian cyst. On diagnostic evaluation, they find severe endometriosis with a large right sided endometrioma involving the appendix. The ovary with endometrioma is fixed to the right pelvic side wall and posterior uterus. Endometriosis has completely obliterated the posterior cul-de-sac with thick adhesions between the recto-sigmoid colon and the uterus. The gynecology service has requested assistance from the general surgery service to extricate the ovary and perform appendectomy.

1. Which of the following is the LEAST common symptom for endometriosis?
   A. Dyschezia
   B. Dyspareunia
   C. Infertility
   D. Dysmenorrhea
   E. Hematochezia

2. The most common site of intestinal endometriosis is:
   A. Rectum and sigmoid
   B. Appendix
   C. Cecum
   D. Small bowel

3. Which of the following statements is true concerning the laparoscopic evaluation of endometriosis?
   A. Endometriosis presents with a uniform type of lesion.
   B. The number and size of the lesions directly correlates with patient symptoms.
   C. Endometriosis is commonly found outside of the pelvis.
   D. Deep endometriotic lesions can become retroperitonealized and be difficult to appreciate laparoscopically.
   E. Endometriosis is not associated with infertility.

4. An oophorectomy plus appendectomy is performed in the above patient. If this patient has persistent pain post operatively consistent with endometriosis, which therapy would be least appropriate?
   A. GnRH (gonadotropin releasing hormone) agonist therapy
   B. Oral contraceptive therapy
   C. Medroxy-progesterone acetate intramuscular injection therapy
   D. Left oophorectomy
   E. Non-steroidal anti-inflammatory therapy

5. If endometriosis involves the recto-vaginal septum or bowel, which of the following statements is correct?
   A. Colonoscopy or rigid proctoscopy are of high yield in diagnosing bowel endometriosis.
   B. Transvaginal ultrasound has a < 50% sensitivity and specificity in diagnosing recto-vaginal endometriosis.
C. Gross endometriotic lesions along the appendix and small bowel are common.
D. Excision of recto-vaginal endometriosis improves fertility.
E. Pain outcomes with bowel resection of endometriosis are similar to those with rectal nodule excision without bowel resection.

ANSWERS

1. E. The differential diagnosis for acute as well as chronic pelvic pain is broad involving the gynecological, urologic, gastrointestinal, musculoskeletal, and neurologic systems. Most commonly the general surgeon is consulted in cases of acute pelvic pain in cases in which a gastrointestinal diagnosis such as appendicitis, diverticulitis, or hernia is entertained. However, as in the above scenario, the general surgeon may also be consulted to assist in the treatment of chronic pelvic pain with endometriosis generally due to severe adhesive disease involving the bowel. Endometriosis affects 6% to 10% of reproductive-aged women. The most common presentations include dysmenorrhea (79%), generalized pelvic pain (69%), and dyspareunia (45%). Bowel symptoms such as constipation, diarrhea, dyschezia, and tenesmus are present in up to 36% of patients with severe endometriosis. Hematochezia originating from endometriosis is rare.

2. A. Endometriosis is defined as hormonally responsive endometrial tissue found outside of the uterus. It is found most commonly on the ovary, uterine serosa, in the posterior cul-de-sac along the uterosacral ligaments, and in the ovarian fossae, but can be found throughout the peritoneal cavity. Cases of lesions in the thorax presenting as catamenial pneumothorax and in central nervous system have also been reported. Rectovaginal or intestinal involvement is estimated to be present in 5% to 12% of women with endometriosis. Intestinal endometriosis involves the rectum and sigmoid colon in 76% of cases, the appendix in 18% and the cecum in 5%. Small bowel is rarely involved.

3. D. Laparoscopy is considered the “gold standard” for the diagnosis of endometriosis with visual identification of endometriotic lesions. There histologic subtypes of endometriotic lesions are found in the peritoneal cavity: superficial lesions, deep infiltrative lesions (DIE), and endometriomas. Endometriotic lesions are highly variable in size, texture, and color. Endometriosis can present as fibrotic scar tissue, hemorrhagic or clear vesicles, flat yellow-brown lesions or the classic raised reddish-blue islands which are typically found on the peritoneal lining of the pelvis. Although visual inspection by an experienced surgeon can have sensitivity of 94% to 97% and specificity of 77% to 85%, histopathologic confirmation remains the standard for diagnosis. Interestingly, neither the severity nor location of disease correlates directly with the severity of symptoms. Superficial lesions can cause pain symptoms however are rarely associated with adhesions. In contrast, deep infiltrative endometriosis lesions invade into neighboring tissue leading to significant pelvic adhesive disease which can involve bowel and bladder such as depicted in the above scenario. In rare cases this invasion is transmural leading to endometriosis in the lumen of the bladder or bowel with associated cyclic hematuria, dysuria, hematochezia, or dyschezia. Endometriotic lesions, particularly DIE, can become reperitonealized making it difficult to appreciate the extent of the lesions when observing them laparoscopically.

Endometriomas are accumulations of ectopic endometrial tissue on the ovary and have characteristic ultrasound findings. Although endometriosis is associated with infertility, the impact of endometriomas on reproductive function is uncertain. Multiple large, prospective studies demonstrate that asymptomatic endometriomas do not negatively impact the live birth rates associated with assisted reproductive technologies. However, according to most studies, excision of endometriomas may result in a deleterious impact on surrogate markers of ovarian reserve. Thus, endometrioma excision may be associated with a worse prognosis for future reproductive interventions compared to medical management or observation. However, this distinction, is probably only critical with female patients older than 35 years of age.

4. D. Endometriosis can be treated both medically and surgically. A patient’s desire for future fertility and the magnitude of her symptoms will help determine the primary mode of therapy. Medical therapy is either analgesic or hormonal. All forms of hormonal birth control have been shown to be effective in suppressing endometriosis-associated pain. These include oral contraceptive pills, patches, rings, injectable or implantable progestins, or the levonorgestrel
intrauterine device. These modalities prevent the cyclic stimulation of the endometriosis tissue by either inhibiting ovulation or by local endocrine effect. Second line therapy involves gonadotropin releasing hormone agonist (GnRH) which eliminates the pulsatile GnRH signals of the hypothalamus on the pituitary. T is process suppresses gonadotropin secretion from the pituitary which in turn markedly decreases production of gonadal steroids by the ovary. A potential complication of long term unopposed therapy with a GnRH agonists is a reduction in bone mineral density.

T e goal of surgery is to extirpate as much of the endometriosis as possible while reestablishing normal pelvic anatomy. T e risks and benefits of aggressive surgical treatment for endometriosis need to be carefully weighed. T e definitive surgery for endometriosis involves the complete removal of all endometriosis lesions as well as the uterus and ovaries. In a patient with severe, symptomatic endometriosis who has completed child-bearing, a hysterectomy with bilateral oophorectomy should be considered. T e treatment for the patient with future fertility desires have to be individualized. T e most recent large scale review in the Cochrane database does not demonstrate that endometriosis cysts have a deleterious effect on pregnancy or live birth rates. T us, surgical treatment of an endometrioma should be reserved for those patients who are symptomatic or have findings concerning for cancer.

Recommended treatment involves either excision of the cyst wall or unilateral oophorectomy, both of which generally improve symptoms and lower risk of symptomatic recurrence as compared to simple drainage and electrocoagulation. Most patients with symptomatic endometriosis, who wish to maintain their ovaries, benefit from post-operative hormonal suppression in the treatment of chronic pelvic pain.

5. E. T e general surgeon will most likely be involved in endometriosis surgery with bowel involvement as depicted in the above scenario. Colonoscopy is of low value in diagnosing rectovaginal endometriosis as endometriotic lesions may invade through the serosa into the muscularis, but rarely into the bowel lumen. Based on a meta-analysis by Hudelist involving 1100 patients, trans-vaginal ultrasound has a sensitivity of 91% and a specificity of 98% for rectovaginal endometriosis. Magnetic resonance imaging (MRI) and barium enema may also be used preoperatively with reasonable accuracy in making diagnosis. Gross endometriotic lesions along the appendix are rare but if found should prompt appendectomy. Decision on the type of surgery for deeply invasive recto-vaginal endometriosis should be decided on a case-by-case basis. Bowel resection has been reported in numerous trials with improvement of 70% of pain symptoms however all report complications. Pain outcomes from rectal nodule excision without segmental bowel resection seem to be similar with less associated post-operative complications.

BIBLIOGRAPHY


A 53-year-old female presents to the emergency room with the acute onset of left leg pain while walking her dog. The patient did not fall at the time of presentation nor is there a history of recent trauma. The pain starts in the left buttock and radiates down the left leg to the posterior calf and foot. The patient also describes some numbness in the left calf and mild plantar-flexion weakness. She gives a past medical history of well-controlled hypertension and does not smoke cigarettes. After the emergency room physician provides some pain relief in the form of narcotics, a consult to the surgical team is made.

1. When a physician is evaluating a patient with signs and symptoms of sciatica, what would be picked up in the history and physical that would alert the physician of a more emergent disease process?
   A. Acute onset of urinary or bladder and bowel incontinence with saddle anesthesia
   B. Steroid use
   C. Immunosuppression
   D. IV drug use
   E. All of the above

2. After the history and physical are completed, what should the initial imaging be in the emergency room with the radicular pain and mild numbness and no history of trauma as described in the question stem?
   A. Magnetic resonance imaging (MRI) of the lumbar spine without gadolinium in the emergency room
   B. Computerized tomography scan (CT) without contrast of the lumbar spine
   C. CT myelogram of the lumbar spine
   D. No imaging in the acute setting in the absence of signs of cancer, fracture, or cauda equina syndrome
   E. Plain PA and lateral X-ray of the lumbar spine

3. The patient is seen in clinic 2 weeks after the initial presentation to the emergency room. She continues to have severe pain in the left leg with a positive straight leg raise and a decreased ankle jerk. An MRI has been completed, which shows a disc herniation at L5-S1 impinging on the left S1 nerve root. What is the typical next step in management of the patient’s sciatica?
   A. Inform the patient of the risks and benefits of surgery and schedule her for a discectomy at L5-S1.
   B. Inform her that 85% of patients improve without surgery within the first 6 weeks and give her more time to recover.
   C. Recommend activity modification with bed rest for 1 to 2 weeks.
   D. Prescribe oral steroids to reduce the inflammation around the nerve root.
   E. Recommend antidepressant therapy as there is a psychological component to sciatica that should be treated.

4. Which of the following facts concerning the anatomy and prevalence of lumbar herniated discs is true?
   A. L4-5 and L5-S1 account for about 50% of herniated lumbar discs.
B. The nerve root involved in a typical lateral recess herniated disc between L4-L5 is the nerve root that exits at the higher level (L4).
C. The nerve root involved in an extreme lateral herniated disc between L4-L5 is the nerve root that exits at the lower level (L5).
D. Cauda equina syndrome from a herniated lumbar disc accounts for only 1% to 2% of lumbar disc surgeries.
E. Herniated lumbar discs in the pediatric age group are quite common but infrequently require surgery.

5. The patient undergoes an uneventful microdiscectomy for her L5-S1 herniated disc. After surgery her strength is noted to be intact in bilateral lower extremities throughout all muscle groups. The night of surgery the patient complains of severe back pain, new weakness in her left plantar-flexion and urinary retention. What is the most likely cause of these new symptoms?
A. Reherniation of a disc fragment at the operative level
B. Inflammation of the nerve root from surgery
C. Spinal epidural hematoma
D. Damage of the nerve root from retraction at the time of surgery
E. Unintended durotomy causing arachnoiditis

ANSWERS

1. E. This is an extremely important question in evaluating a patient with back pain and radiculopathy. The physician must know the “red flag” symptoms that would alert him/her as to a more severe process. All of the answers in this section provide a clue to those syndromes. Answer A, acute onset of urinary or bladder and bowel incontinence with saddle anesthesia, refers to cauda equina syndrome (CES). Though there is controversy as to whether the patient should go to surgery within 24 or 48 hours, it remains a surgically urgent case. Answer B, steroid use, could put a patient at risk for both an infectious or a minor traumatic process. Answer C, immunosuppression, puts the patient at risk for an infectious process such as osteomyelitis or epidural abscess. Finally, answer D, IV drug use, would also put the patient at high risk for epidural abscess or osteomyelitis.

2. D. This is a difficult answer to arrive at for surgeons. In most cases, patients come to the clinic with a diagnosis and imaging already included with them. When the patient first comes to the ER on symptom onset, the correct answer is **No imaging in the first month of symptoms**. T is remains true only in the absence of the “red flag” symptoms discussed as these red flags aid the physician in ruling out cancer, infection, spinal fracture, and cauda equina syndrome. Some red flags that should tip off a surgeon to a possible malignancy are a history of cancer (the most predictive), age over 50, unexplained weight loss, and a failure to improve after 1 month. Possible malignancies include primary tumors such as osteoblastoma, osteosarcoma, and lymphoproliferative tumors and metastatic bone disease from lung, thyroid, prostate, kidney and colon cancer among others. If pain persists, MRI is generally the imaging modality of choice performed without gadolinium. In patients with a contraindication for an MRI (pacemakers, etc.), a CT myelogram can provide adequate visualization.

3. B. The patient in the question stem is only 2 weeks out from onset of pain. Barring a neurologic deficit or signs of cauda equina syndrome, patients are given time to recover from the herniation. Over 85% of herniated disc patients will improve without surgical intervention in approximately 6 weeks. Bed rest is an option for 2 to 3 days maximum in patients with radicular complaints, as more time can be harmful for recovery. Additionally, antidepressants are more indicated for chronic back pain and oral steroids have not been shown to improve symptoms.

4. D. This question addresses the prevalence and anatomy of herniated discs in the lumbar spine. L4-5 and L5-S1 account for over 90% of herniated lumbar discs. When examining the lumbar spine, the nerve root that exits between L4 and L5 is the L4 root. Most discs herniate into the lateral recess, which is medial to the exiting nerve root. In this way, the disc impinges on the nerve root “on deck” (see Figure 97-1). T is is an image of a L5-S1 disc herniation. T e vertical arrow indicates the disc herniation in the lateral recess compressing the S1 nerve root. T e horizontal arrow indicates the L5 nerve root in the neuroforamen.
An L4-5 disc herniation in the lateral recess would cause pain in an L5 distribution. An extreme lateral disc at L4-5, on the other hand, would impinge on the exiting nerve root, L4. It is important to realize...
that cauda equina syndrome is uncommon accounting for only 1% to 2% of all herniated disc surgeries. Also, herniated lumbar discs in the pediatric age group are quite rare as stated.

5. **C.** When performing or providing care for a patient who underwent a discectomy, it is extremely important to perform thorough neurologic tests. Complications associated with a discectomy can include a reherniation of the disc (up to 4% over 10 years), temporary worsening of motor function (1% to 8% of patients), and unintended durotomy (0% to 14% of cases). All of these may be a cause of temporary worsening neurologic function. Any new neurologic deficit in a patient following surgery should be assumed to be a spinal epidural hematoma until proven otherwise. Work-up should include an immediate MRI and return to the operating room. Long-term complications of microdiscectomy are uncommon and are often related to reherniation or instability in the spinal segment. These complications can present with recurrence of the patient’s leg pain, pain in the back or buttocks, and weakness/numbness in the distribution of the compressed nerve root.

### BIBLIOGRAPHY


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Orthopedic Surgery
Matthew J. Martin
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Calcaneus Fractures

Justin T. Fowler and Justin Robbins

A 27-year-old professional painter sustained a fall from a fifteen foot scaffold while on the job. By his report, he landed on both feet in a standing position and had immediate severe foot and leg pain and was unable to ambulate. His primary survey is unremarkable and his secondary survey is normal except for the examination of his right foot. He presents to the emergency department with a swollen and deformed right foot and complains of severe pain at rest and with any palpation or manipulation of the foot. Radiographs of the right foot reveal a comminuted, intra-articular calcaneus fracture.

1. Plain radiographs of the patient’s right foot are shown (Figure 98-1). What other associated injury is classically described from this type of mechanism (fall from height landing on both feet) and associated with the presence of this injury?
   A. Closed head injury
   B. Hollow viscous injury
   C. Pelvic fracture
   D. Lumbar spine fracture
   E. Concomitant foot fractures

2. Anteroposterior, lateral, and oblique radiographs are performed and reveal a displaced calcaneus fracture. What other imaging modality should be ordered to further delineate the injury?
   A. Non-contrast magnetic resonance imaging (MRI)
   B. Weight-bearing foot films
   C. Non-contrast computerized tomography (CT) scan with reconstructions
   D. Triple phase bone scan
   E. None of the above. Adequate information is provided by the radiographs.

Figure 98-1 Lateral foot radiograph revealing a displaced, intra-articular calcaneus fracture with depression of the posterior facet. Radiographs courtesy of MAJ Justin Fowler MD.
3. Several hours have gone by while awaiting further work up and disposition of the patient and you notice that the skin overlying the Achilles tendon is becoming dark and appears to be tented by the fracture. What is the next most appropriate course of action?
   A. Emergent reduction in the emergency room
   B. Emergent orthopaedic consultation
   C. Placement of a well-padded splint and strict elevation
   D. CT angiography of the lower extremity
   E. Emergent compartment pressure check of the foot

4. What is the preferred treatment for a displaced, intra-articular fracture of this bone in a young, active patient?
   A. Well-padded splint with conversion to a short leg cast
   B. Closed reduction and casting
   C. Percutaneous screw fixation
   D. Emergent open reduction internal fixation
   E. Delayed open reduction internal fixation

5. Which of the following is predictive of a better outcome after open reduction and internal fixation of a displaced, intra-articular fracture of this type?
   A. Female gender
   B. Significant articular impaction
   C. Workers compensation
   D. Age > 50
   E. Heavy laborer

**ANSWERS**

1. **D.** The patient has a calcaneus fracture. The associated injuries, specifically lumbar spine injuries, have been historically reported in up to 50% of patients. The most common mechanism of injury for calcaneus fractures has been a fall from a height with the patient initially striking the ground with their feet in a standing or semi-standing position. This results in the calcaneus fracture, but also the transmission of impact forces up the spine, with the lumbar region bearing most of the burden. As motor vehicle collisions have become an increasingly prevalent mechanism, newer data has suggested that roughly 10% of patients with calcaneus fracture will have a concomitant lumbar spine injury and approximately 25% have other additional lower extremity injuries. The other injuries listed can occur with any significant trauma mechanism, but are all less commonly associated with calcaneus and other fractures of the foot. Any patient with this type of mechanism should be suspected of having a lumbar spine fracture until proven otherwise, and the optimal diagnostic study is a dedicated CT scan of the lumbar spine.

2. **C.** Initial diagnosis of a calcaneus fracture can be readily made with conventional plain X-rays of the foot (Figure 98-1). The simplest broad classification of calcaneus fractures is based on whether there is articular involvement, with 75% of fractures being intra-articular, and approximately 25% being extra-articular. Although the initial diagnosis can often be made with standard X-rays, a high-quality CT of the hindfoot is the definitive imaging modality of choice for diagnosis, classification, and operative planning. The CT scan should be performed with 2 to 3 mm interval slices in the sagittal, axial, and 30 degree semi-coronal planes (Figure 98-2). This imaging modality allows for accurate characterization of the fracture pattern and facilitates planning for the patient’s definitive treatment. A CT scan is useful in assessing the amount and location of joint impaction, lateral wall blowout, involvement of calcaneocuboid joint, and the number of primary fracture lines in the posterior facet. An MRI has little additional utility compared to a high-quality CT scan for diagnosing, characterizing, or directing treatment plans for calcaneus fractures. Similarly, additional X-rays including weight-bearing films will not provide sufficient...
anatomic details, and will also likely be poorly tolerated by the patient with a calcaneus fracture.

3. B. Displaced avulsion fractures of the posterior tuberosity with impending skin necrosis require immediate reduction to prevent full thickness skin loss over the posterior ankle and Achilles tendon. Emergent orthopaedic surgical consultation should be obtained as closed reduction typically is not adequate to remove tension from the skin. It is typically treated as an orthopaedic emergency and usually requires surgical reduction and stabilization in the operating room in an acute fashion. The ankle can be splinted in plantar-flexion in an attempt to take pressure off the overlying skin while awaiting surgical consultation. Placement of a splint will not provide any benefit, and in fact could produce additional pressure necrosis on the area if not fitted well or if there is additional swelling after the splint is placed. CT angiography is only useful if there is a suspicion of a concomitant vascular injury in the fractured extremity, and has no role for evaluation of foot fractures with a normal vascular exam. Emergent compartment pressures are indicated if there is suspicion of a compartment syndrome, but in this scenario the primary problem is the displaced fracture and not an elevated compartment pressure.

4. E. Intra-articular displacement of the calcaneus has been shown to lead to subtalar arthrosis, subfibular impingement, difficulty with shoe wear, hindfoot stiffness, and limited function. If the articular surface is amenable to reconstruction in a young, healthy patient, then surgical fixation should be attempted. The status of the soft tissue envelope dictates the timing of surgical intervention. Traditionally, delayed fixation through an extensile lateral approach has been the mainstay treatment for these fractures. These patients will typically have a significant amount of swelling, bruising, and soft tissue edema of the foot which can result in poor wound healing if surgery is performed during the acute phase. Open reduction and internal fixation is typically delayed to allow this soft tissue swelling to subside and mitigate the risk of surgical site complications, poor wound healing, soft tissue loss, and hardware infections.

5. A. A prospective, randomized, controlled trial of non-operatively treated versus operatively treated calcaneus fractures from four Canadian trauma centers revealed that certain patient demographics were predictive of better versus worse outcomes after treatment of displaced intra-articular calcaneus fractures. Women treated with operative fixation had significantly higher quality of life scores than women who were managed non-operatively. The study also showed that heavy laborers, workers compensation cases, older age, higher degree of articular comminution, and smoking are all predictors of worse outcomes after operative fixation. The exact reason for this gender disparity remains unknown, but these factors should be taken into consideration when planning a management strategy and in counseling the patient regarding the risks versus benefits of operative versus non-operative management.

BIBLIOGRAPHY


A 24-year-old male presents as an acute trauma after injury in a motorcycle crash. On initial presentation he is a GCS 11 (E3V3M5). Because of severe pain and labored breathing, he is intubated and sedated. During your secondary survey, you note the patient has significant edema, swelling, and abrasions about the right shoulder girdle.

1. What serious, and potentially devastating, diagnosis is characterized by lateral displacement of the scapula?
   A. Pneumothorax
   B. Multiple rib fractures
   C. Scapulothoracic dissociation
   D. Shoulder dislocation
   E. Sternoclavicular dislocation

2. What study can you evaluate or obtain to further investigate and diagnose the suspected injury in Question 1?
   A. Ventilation–perfusion (V–Q) scan
   B. External rotation anterior-posterior (AP) shoulder X-ray
   C. Axillary X-ray
   D. Internal rotation AP shoulder X-ray
   E. Chest X-ray

3. While reviewing a chest CT obtained as part of the initial workup, you note a displaced right scapular fracture. What additional injuries are most commonly associated with scapular fractures?
   A. Pulmonary injury
   B. Head Injury
   C. Femur fracture
   D. Arterial injury
   E. Brachial plexus injury

4. Upon further clinical evaluation you note that the patient has a prominence along the anterior aspect of his shoulder and a sulcus adjacent to the posterior acromion. He is still not following commands, but examination with gentle range of motion demonstrates limitations in internal rotation and abduction. What is your next step in management?
   A. Attempt a closed reduction.
   B. Obtain a chest CT.
   C. Schedule an outpatient magnetic resonance image (MRI).
   D. Obtain orthogonal X-rays.
   E. Diagnosis should be made based on physical exam.

5. What is the most common neurovascular injury associated with an anterior shoulder dislocation?
   A. Musculocutaneous nerve
   B. Axillary nerve
   C. Axillary vein
   D. Subclavian artery
   E. Radial nerve

ANSWERS

1. C. Scapulothoracic dissociation results from complete disruption of the scapulothoracic articulation with associated lateral translation of the scapula
without associated partial or complete amputation of the soft tissue, with the overlying skin typically intact. Scapulothoracic dissociation typically results from a high energy, traction force, to the upper extremity. Motorcycle accidents are the most commonly described mechanism in the literature. Considered analogous to a closed forequarter amputation, it is associated with a myriad of concomitant injuries including: dislocation of the acromioclavicular and sternoclavicular joints, clavicle fracture, vascular injury to the subclavian and axillary vessels, brachial plexus injuries, and complete or partial disruption of the surrounding musculature.

The clinician must maintain a high index of suspicion as patients are often obtunded, sedated, or intubated during initial evaluation, preventing a complete neurological examination. Additionally, because these injuries are associated with a high energy mechanism and severe and potentially life threatening concomitant injuries, scapulothoracic dissociation can be missed or overlooked, without appropriate and complete evaluation. Typically these patients will have significant swelling and edema of the entire shoulder girdle from neck to axilla from underlying hematoma. Evaluation and comparison of pulses of the upper extremity should be promptly performed, and if absent or uneven, further studies including arterial pressure indexes, and if abnormal (< 0.9), arteriogram should be obtained.

With the low incidence of injury, outcomes studies are limited. However, previous studies have suggested a mortality rate of roughly 20% (3 of 15 patients), though the true rate is likely higher as a result of death from associated injuries in these patients. Associated neurovascular injury is extremely common, with neurologic injury in 94% of patients and vascular injury in 88%. In addition to a mortality rate between 10% to 20%, outcomes are universally poor with 52% rate of flail extremity and early amputation rate of 21%. Early recognition of scapulothoracic injury, and likely associated neurovascular injury, is paramount as diagnosis guides treatment and effects long term outcomes.

2. E. The diagnosis of scapulothoracic dissociation can be made based on a non-rotated chest X-ray. Lateral displacement of the scapula is pathognomonic. Comparison of the scapular position can be made with the contralateral side, and differences and asymmetry noted. The amount of scapular lateralization, or scapular-index, can be measured. The distance from the sternal notch or midline of the spine to the glenoid or medial border of the scapula can be measured and compared with the contralateral side. The injured side measurement is divided by the non-injured side measurement. The normal scapular-index is about 1.09, and in one of the largest series, the ratio in patients with a scapulothoracic dissociation averaged 1.29.

3. A. In a review of 58 scapula fractures as a result of blunt trauma, Tompson et al. found a high rate of concomitant injury to the ipsilateral lung, chest wall, and chest contents. Fifty-three percent of patients had a pulmonary contusion, 53% rib fractures, 26.8% clavicle fractures. Neurovascular injury was not uncommon, with an incidence of brachial plexus injury of 12.5% and a 10.7% incidence of subclavian, brachial, or axillary artery injury.

Baldwin et al. controlled for injury severity score in order to determine if commonly associated injuries with scapula fractures were simply a result of an increased injury severity score. They showed the following injuries had increased frequency in patients with a scapula fracture compared to those without: rib fractures, pneumothorax, lung injury, ipsilateral extremity injury, and spine injury.

A scapula fracture, with a high energy blunt mechanism of injury, should alert the clinician to the possibility of additional injury to the ipsilateral lung, chest wall, shoulder girdle, and surrounding neurovascular structures.

4. D. Based on the clinical exam findings present, the patient has a suspected shoulder dislocation. Anterior shoulder dislocations are by far the most common, accounting for approximately 98% of all glenohumeral dislocations. The typical mechanism for an anterior dislocation is with the arm in an abducted and externally rotated position. Posterior dislocations are relatively rare, and result from axial load to an adducted, flexed and internally shoulder, and can also be associated with electrical shocks or seizures.

An acutely dislocated shoulder is typically very painful. The patient with an anterior dislocation will typically hold the arm in slight abduction and range of motion will be limited secondary to pain.

Radiographs are an essential part of the initial assessment, ensuring appropriate diagnosis including the direction of dislocation, presence of
associated fractures, and potential blocks to reduction. The standard shoulder trauma series must include orthogonal X-rays including a true AP, axillary lateral and scapular Y view. Obtaining only a single view of the shoulder can lead to missed injury and inaccurate diagnosis. CT can help aid in diagnosis if appropriate imaging cannot be obtained.

After appropriate diagnosis is made, a reduction can be performed. There are several classic methods for relocation including the Kocher, traction-counter traction, Stimson and Milch to name a few. Newer studies and techniques focus on limiting premedication. Recent meta-analysis have shown equivalent effectiveness using an intra-articular lidocaine injection instead of intravenous analgesia and sedation for manual acute closed reduction of anterior shoulder dislocation with decreased risk of post procedure complications.

5. B. The axillary nerve (C5,C6) is a direct continuation of the posterior cord of the brachial plexus. Because it is tethered, anterior and posterior, to the glenohumeral joint with limited excursion, it is susceptible to injury from shoulder dislocation. In a study of 105 patients with acute primary anterior shoulder dislocations, 21% of patients (22/107) were found to have a nerve injury, the most common (n = 13) involving injury to the axillary nerve. The authors of this study note that the incidence of nerve injury may have been underestimated as it was diagnosed by clinical examination alone, not with electrophysiologic testing.

In a prospective study of 101 consecutive patients with anterior shoulder dislocation or humeral neck fracture, de Laat et al. found electrophysiologic evidence of nerve injury in 45% of patients. The axillary nerve was most commonly injured (37%) followed by the suprascapular nerve (29%) and the musculocutaneous nerve (22%).

Initial diagnosis of a nerve injury can be difficult to pain. Detailed initial exam and assessment, additional follow up for repeat examination, or electrophysiologic testing, can help detect injury early, and potentially prevent long term poor functional outcome.

BIBLIOGRAPHY


While on your pediatric rotation, you are called to a trauma code in the emergency room. The patient is a 6-year-old female who was restrained in the back seat of a car when it lost control and went over an embankment. When you arrive, the child is conscious and breathing spontaneously. Initial vitals are stable and she is following commands. The child is in significant pain, but is able to communicate to you that her right elbow and left leg hurt.

1. With regards to pediatric trauma surgery patients, compared to adult trauma patients, the former has:
   A. Small head:body ratio
   B. Larger total blood volume
   C. Decreased capacity for plastic deformation
   D. Increased baseline metabolic rate combined with a larger physiologic reserve
   E. Smaller surface area to body volume

2. After your initial assessment you begin to order labs and imaging. In consideration of cervical spine evaluation, you make the following decision:
   A. Cervical spine radiographs are not indicated but lumbar spine radiographs are, because lumbar spine injuries are more common in children.
   B. Cervical spine radiographs are indicated because she may have lost consciousness.
   C. Cervical spine radiographs are not indicated because children are unlikely to sustain injury to the cervical spine as a result of their unique osseous anatomy.
   D. Cervical spine radiographs are indicated as a result of the mechanism of injury and potential distracting injuries of her left leg and right elbow.
   E. Cervical spine radiographs are not indicated, but a magnetic resonance imaging (MRI) of her cervical and thoracolumbar spine is.

3. Upon further evaluation of her right elbow, you notice an obvious deformity. What is your initial step in management of this potential injury?
   A. Obtain labs to rule out infection.
   B. Obtain a computerized tomography (CT) scan to evaluate potential fracture.
   C. Perform a careful neurovascular examination.
   D. Perform a closed reduction, then obtain X-rays.
   E. Provide sedation to allow evaluation of stability and range of motion.

4. Radiographs of the left femur demonstrate a displaced midshaft fracture. How would the workup of this femur fracture differ, if at all, if the child was a non-ambulatory 11 month old, injured as a result of a fall?
   A. Obtain labs to rule out infection.
   B. Obtain a CT scan to further evaluate the fracture.
   C. Obtain inlet and outlet pelvic X-rays.
   D. The child would need to be evaluated for possible child abuse.
   E. The workup would be unchanged.
ANSWERS

1. D. There are many important differences in the anatomy, physiology, mechanism, and characteristics of injuries that make pediatric trauma unique. The proportions of a child's body are different from those of an adult, predisposing to certain injuries. Children have a large head to body ratio; the younger the child the more disproportionate the ratio. Their relatively larger heads predispose them to head, neck, and upper cervical spine injuries.

   Pediatric bone growth and development is incomplete, with bone more deformable and able to fracture with (relatively) less force. These characteristics can lead to internal organ damage without apparent injury or fracture of the thoracic rib cage. Additionally, the immature cage leaves the spleen and liver exposed and vulnerable to injury.

   Children have a smaller total blood volume (80 mL/kg) than adults. As a result, equivalent or small-volume blood loss can have more significant physiologic consequences, with hypovolemia developing more rapidly. Additionally, because of a higher baseline metabolic rate and increased physiologic reserve, the apparent hemodynamic response to trauma may be minimal. Additionally, children have a more minimal metabolic response to trauma, and hypotension is often a late sign of shock in these patients. They are also more prone to hypothermia because of an increased ratio of body surface area to volume.

2. D. The pediatric spine, especially in children under 8 years old, has many important anatomic and biomechanical differences that predispose it to cervical injury. As previously stated, children have a larger head to neck ratio. Additionally, in early childhood, the fulcrum of flexion is at the C2-C3 level, compared to C5-C6 by age 11. It is too, predisposes to upper cervical spine injury. Pediatric cervical spine trauma may present as fracture, fracture with subluxation, subluxation alone (without fracture), or spinal cord injury without radiographic abnormality (SCIWORA). The incidence of SCIWORA and isolated soft tissue injury alone are more common in children < 9 years old. As a result of these, and other, complicating factors, the assessment and clearance of pediatric patients with potential spine injuries is challenging. Incomplete and inaccurate assessment can result in missed cervical spine injuries while prolonged can be associated with significant morbidity.

   Lee et al. developed a multidisciplinary approach to pediatric cervical spine injury evaluation and clearance. The authors use the presence of any of the following as a reason for immobilization and radiographic evaluation: child is unconscious or inconsolable, mechanism of injury suggestive of possible cervical spine injury (motor vehicle crash, fall from height, pedestrian struck, etc.), neck pain or focal neck tenderness, presence of a distracting injury, abnormal neurologic exam findings or history of transient neurologic symptoms that suggest c-spine injury, physical signs of neck trauma, significant trauma to head and or face, or an unreliable exam secondary to substance abuse. In short, in the multiply injured patient, a cervical spine is presumed present and must be ruled out by physical exam and radiographic evaluation.

3. C. Pediatric elbow injuries present a challenge to the treating physician because diagnosis, physical examination, radiographic evaluation and interpretation, and surgical treatment can all be difficult. Additionally, complications, both acute and chronic, are not uncommon. Unfortunately, while fractures around the elbow can be difficult, they are also quite common. Elbow injuries in children occur more commonly than in adults, and account for approximately 30% of all extremity fractures in patients age 0 to 7 years. Injuries to the upper extremity account for 65% of all fractures and dislocations in children, with fractures of the distal end and forearm being most common, followed by fractures and dislocations of the elbow. Of all pediatric elbow fractures, supracondylar fractures are the most common.

   While physical examination in the uncooperative child with a swollen elbow can be challenging, it is absolutely essential, and should be the first step in treatment. The two most important aspects of the exam are the neurovascular assessment and the presence of any soft tissue injury. Examination and documentation of neurovascular status must be completed prior to any reduction, and follow and reduction maneuver, to assess for any interval change. For supracondylar distal humerus fractures specifically, neurologic injury is relatively common, ranging from 10% to 18%.

   Supracondylar humerus fractures requiring fixation were previously thought to be a surgical emergency. However, there has been a shift in thinking that those fractures without vascular compromise,
severe soft tissue swelling, pressure on the skin can wait (i.e., wait until morning) until an OR team familiar with this operation is available. Again, this decision hinges and underlines the importance of accurate and complete physical examination. However, these patients must be splinted and admitted for observation with continued neurovascular checks until surgery can safely be performed.

4. D. Pediatric diaphyseal femur fracture rates continue to increase, accounting for 1.4% to 1.7% of all pediatric fractures. They are the most common reason for hospitalization in a pediatric patient with orthopedic injury. Treatment of these fractures is largely dependent on patient age: infants, 6 months to 5 years, 5 to 11 year olds, and patients age 11 to skeletal maturity. Treatment in our example would likely be treated operatively with flexible intramedullary nails.

The treating physician of a child < 36 months old with a femur fracture has to consider, and rule out, non-accidental trauma as the cause of injury, according to the Academy of Orthopedic Surgeons clinical guidelines. The recommendation is based on Level II studies which reported that 14% of femur fractures were the result of child abuse in children aged 0 to 1 year, and 12% in patients aged 0 to 3 years. Treatment should include a complete history and physical, direct communication with the child’s pediatrician or physician, and if available, consultation with a child abuse team. Additionally, a selective skeletal survey should be ordered if felt appropriate by the treating physician.

The true incidence of child abuse and related fractures is likely underestimated as a result of underreporting. The consequences of missing a case of abuse can result in serious complications including continued abuse or death.

BIBLIOGRAPHY


Knee Injuries

Jeremy McCallum and Douglas Rowles

SCENARIO 1
A 27-year-old healthy male is transported to the emergency department after a motor vehicle crash. He was a restrained driver in a head on collision with another car and was reportedly traveling about 55 mph. His vehicle’s airbag deployed. The responding medics report he was responsive at the scene and complained of isolated right knee pain with numbness and tingling to his right lower extremity below the knee.

A head to toe assessment by the on call trauma team in the emergency department confirms injury is localized to the right lower extremity. Physical examination reveals significant soft tissue swelling around the right knee with deformity but soft and supple leg muscular compartments, a 2 cm bleeding laceration along the anterolateral aspect of the knee, and diffuse numbness of the right foot and lateral leg. Both the dorsalis pedis and posterior tibial pulses are palpable but noticeably weaker compared to his contralateral extremity. His motor examination reveals significant weakness with foot and great toe dorsiflexion but the exam is limited due to pain.

1. After applying a saline-soaked dressing and ace wrap to the wound, initial management in the emergency department should include which of the following?
   A. A computerized tomography (CT) scan of his head, abdomen, pelvis, and CT angiography of the right lower extremity.
   B. Immediate right leg compartment pressure testing.
   C. Immediate portable X-Rays of his right hip, knee, and lower extremity.
   D. Admit for observation, antibiotics, and serial examinations.
   E. Transport to the OR for irrigation, exploration, debridement of the open wound, and other procedures as indicated.

2. X-ray assessment of the knee and leg reveals a posteromedial knee dislocation without obvious fractures. X-rays of the hip, femur, and below the knee are normal. Regarding the neurovascular status of the right lower extremity, which of the following should be the next step in management?
   A. Immediate transport to the OR for open reduction and vascular repair.
   B. Obtain immediate vascular studies including an angiography.
   C. Conscious sedation followed by closed reduction and reassessment of distal pulses and neurologic exam.
   D. Operative washout of the wound and knee joint reduction followed by ice, elevation, and observation of neurovascular status.
   E. Immediate referral to orthopedic surgery.

3. Regarding vascular injury associated with knee dislocations, which of the following statements is true?
   A. The incidence of injury to the popliteal artery is low (< 2%).
   B. Vascular repair can be delayed up to 24 hours, after which amputation rates dramatically increase.
C. Physical exam alone is sufficient in detecting all vascular injuries after knee dislocation.
D. After reduction and return of pulses, serial examinations at least every 4 to 6 hours for a minimum of 48 hours is necessary to monitor for late-developing complications.
E. Normal pulses rule out an arterial or venous injury.

4. Assuming injury to the popliteal artery is confirmed preoperatively, which statement regarding surgical management is correct?
A. Vascular repair should be completed followed by splinting prior to orthopedic consultation.
B. Orthopedic referral for immediate ligament repair or reconstruction is indicated prior to vascular repair.
C. Vascular repair and management of the open wound should be completed followed by bracing and outpatient rehabilitation of the ligamentous knee injury.
D. Vascular repair and management of the open wound should be completed. Reconstructive knee surgery is typically not needed due to post-traumatic stiffness.
E. Vascular repair and orthopedic surgical management should occur simultaneously.

5. Regarding neurovascular injuries associated with knee dislocations, which of the following statements is correct?
A. The incidence of neurovascular compromise increases proportionately with increasing energy of injury.
B. Delayed recognition of an associated vascular injury significantly increases the chance of poor functional outcomes or limb loss.
C. Neurovascular injury is unlikely in low energy injuries.
D. The most common neurologic injury associated with knee dislocation is tibial nerve injury.
E. All of the above statements are correct.

SCENARIO 2
A 62-year-old female is transported to the emergency department due to injuries incurred as a restrained front seat passenger in a roll-over motor vehicle accident. She has a past medical history significant for type 2 diabetes, hypertension, hyperlipidemia, and hypothyroidism. During the trauma assessment, she is noted to have a pneumothorax, multiple facial contusions, and a closed injury to her right knee. Focused examination of the knee reveals severe soft tissue swelling, mild blistering of the skin over the anterior portion of her knee but no open wounds and significant diffuse pain with active and passive motion. Her distal neurovascular exam is intact. X-rays of the knee reveal a displaced tibial plateau fracture.

1. Management of her knee injury should include which of the following?
A. Urgent surgical treatment with open reduction and internal fixation.
B. Urgent definitive surgical treatment with external fixation.
C. Long leg casting until bony union.
D. Splint versus external fixation until soft tissue swelling resolves followed by open reduction and internal fixation.
E. Splint versus knee immobilizer until soft tissue swelling resolves followed by use of a bone stimulator, functional bracing, and physical therapy.

2. Which of the following may be a concomitant knee injury to a tibial plateau fracture?
A. Meniscus tear
B. Ligament tear
C. Osteochondral or chondral injury to the articular surface
D. Knee capsule tear
E. All of the above

3. Which of the following factors most strongly predicts an increased risk of leg compartment syndrome in this patient?
A. Severity of soft tissue swelling
B. Integrity of the knee joint capsule
C. Time since injury
D. Amount of displacement of the tibial fracture
E. Tourniquet time during surgery

SCENARIO 3
A 19-year-old male patient presents to the emergency department after sustaining a left knee injury earlier that day playing basketball. He reports a similar injury to this knee a year previously, after which he has had frequent episodes of his knee giving way. Physical examination reveals an effusion and soft tissue swelling about the knee. He has pain but is able to fully flex and extend the knee. X-ray examination of the knee is normal but
an magnetic resonance imaging (MRI) scan obtained the next day reveals a complete tear of the anterior cruciate ligament.

1. Which of the following physical examination tests is most reliable at diagnosing an anterior cruciate ligament (ACL) tear?
   A. Anterior drawer test
   B. Lachman test
   C. Pivot shift test
   D. McMurray test
   E. Apley compression test

2. What is the most likely associated knee injury with an acute ACL tear?
   A. Medial collateral ligament tear
   B. Medial meniscus tear
   C. Lateral meniscus tear
   D. Medial patellofemoral ligament tear
   E. Medial joint impaction fracture (bone contusion)

3. Initial management of this patient should include all of the following except?
   A. A course of anti-inflammatory medications (NSAIDS).
   B. Referral to orthopedic surgery for reconstructive knee surgery.
   C. Referral to physical therapy.
   D. Knee immobilization in a brace until swelling is resolved.
   E. Referral for a well-fitted ACL brace.

4. Which of the following is NOT an acceptable alternative as a graft option for ACL reconstruction in this patient?
   A. Autologous Ipsilateral Patellar Tendon Graft.
   B. Autologous Quadrupled Hamstring Tendon Graft.
   C. Contralateral Patellar Tendon Graft.
   D. Allograft (Donor) Tendon Graft.
   E. All of the above are acceptable graft options.

5. Which of the following is the most likely complication of ACL reconstructive surgery?
   A. Stiffness
   B. Intra-articular infection
   C. Deep venous thrombosis (DVT)
   D. Iatrogenic neurovascular injury
   E. Graft failure

ANSWERS TO SCENARIO 1

1. C. After evaluation and stabilization of the patient radiographs should be obtained to confirm the diagnosis. Radiographs should not unnecessarily delay the reduction of the knee. Given up to 50% of knee dislocations can undergo a spontaneous reduction prior to radiographs, normal radiographs do not rule out a knee dislocation. Rim fractures, joint asymmetry, avulsion fractures, and mild subluxation of the tibiofemoral joint may be the only radiographic finding. An MRI of the knee can be obtained on an elective basis once the patient is acutely stabilized and is the diagnostic imaging modality of choice. The question stem states this is an isolated injury making option A incorrect. Compartment syndrome in a knee dislocation is not uncommon and may be secondary to the initial trauma, hemorrhage, or reperfusion of an ischemic limb.

   Answer B, a low threshold to measure compartment pressures is appropriate; however, obtaining radiographs and attempting reduction of the knee are the more appropriate answer. The patient needs further workup before D or E would be applicable.

2. C. Once a knee dislocation is identified, emergent closed reduction with sedation should be attempted. The reduction maneuver depends on the direction of dislocation and generally involves gentle traction-countertraction. The reduction should be performed as atraumatically as possible with sedation (if needed to avoid further damage). Occasionally the injuries cannot be reduced in a closed fashion. In a posterolateral dislocation, the medial femoral condyle buttonholes through the joint capsule and/or the medial collateral ligament, causing a puckering of the skin and preventing a closed reduction. If closed reduction fails, the patient is indicated for emergent surgical reduction. Answers A, B, and D are incorrect because a closed reduction has not been attempted. After reduction, the injured knee is frequently unstable and should be placed into a long leg splint (above the knee splint) in approximately 20 degrees of flexion to prevent posterior subluxation of the tibia. A circumferential splint/cast should be avoided to help prevent compartment syndrome. Post-reduction radiographs should be obtained to confirm adequate reduction. After reduction the vascular assessment should be repeated. Answer E, referral to an orthopedic surgeon, is recommended for a knee dislocation however reduction should not be needlessly delayed while waiting for a consultation.
3. D. Vascular injuries associated with fractures/dislocations are relatively uncommon, but there is a strong association with posterior knee dislocations and popliteal artery/vein injuries. Answer A, the rate of popliteal artery injury, has been reported to range from 14% to 65%. Multiple algorithms have been published for assessment of the vascular status of the lower extremity in the incidence of suspected knee dislocation. Initially, a physical exam should be performed assessing both posterior tibial and dorsalis pedis pulses in comparison to the contralateral extremity. Answer C/E, normal pulses, do not “rule out” a vascular injury. In the presence of “hard signs” of ischemia (cool, pulseless, obviously dysvascular extremity) vascular surgery consultation should be obtained immediately. However, when a patient presents with “soft signs” of ischemia (asymmetric pulses and/or warmth), further assessment is warranted. Measurement of the ankle-brachial index (ABI) can augment the physical exam. An ABI > /= 0.9 is reassuring that there is no clinically significant vascular injury. However, choice D is correct because delayed thrombus is a continued risk, making reassessment every 4 to 6 hours important. If the ABI is abnormal, further studies are indicated. Either an arterial ultrasound, which is technician dependent and may not always be available, or CT angiography versus conventional angiography should be completed. Emergent vascular repair is indicated if a significant injury is identified, with the (B) amputation rate as high as 86% in cases where vascular repair was delayed greater than 8 hours.

4. E. If a vascular injury is identified both vascular and orthopedic surgery should be urgently consulted. The key to this question is that both teams will need to work simultaneously in stabilizing and restoring blood flow to the lower extremity. Answers A and C are incorrect because vascular repair without stabilizing the leg will likely fail. Answer B is incorrect because restoring vascular flow to the leg is the first priority and should be done within 8 hours and answer D is incorrect because reconstructive knee surgery will be needed to protect the vascular repair and regain functional range of motion in the short term as well as to prevent long term knee instability.

5. B. Multiple series have demonstrated that suboptimal functional outcomes and even amputation can result when there is delayed recognition of an associated injury to the popliteal vessels, and all knee dislocations should be assumed to have a vascular injury until it has been ruled out. Several studies have also demonstrated an increased incidence of these injuries among obese patients versus non-obese. Answers A and C are incorrect because in a review of low energy dislocations, 41% were found to have a vascular injury. T is is comparable to the vascular injury rates of cohorts with combined (low and high energy and high energy injuries). T e most commonly injured nerve in a knee dislocation is the peroneal nerve, not the (D) tibial nerve. Neurologic injury occurs in 16% to 40% of knee dislocations. Less than 50% of patients with peroneal nerve injuries have nerve recovery.

**ANSWERS TO SCENARIO 2**

1. D. Displaced tibial plateau fractures greater than 0.5 to 1 cm are managed with operative reduction and fixation (answers C and E). Protected mobilization can be used for fractures that are non- to minimally displaced with a stable ligamentous exam. High energy injuries can lead to severe injury to the overlying soft tissue as demonstrated by swelling and fracture blisters. Bicondylar fractures, fracture-dislocations, and shaft dissociated fractures have worse soft tissue injury. Definitive surgical reduction and treatment should be delayed in high energy injuries until the soft tissue envelope allows (answer A). In high energy trauma, it may take 8 to 21 days for the swelling to subside and skin conditions to improve. Interval treatment can range from a well applied splint to temporary spanning external fixation. T e goal is to maintain length and alignment until definitive fixation can be preformed and post-reduction radiographs should be obtained. Traction radiographs and/or post reduction CT scan can be helpful in evaluation and planning of treatment. Even with staged management of these fractures, infection rates still range from 8.4% to 18%.

2. E. Regarding answers A and B, meniscal tears occur in up to 50% of plateau fractures. Ligamentous injuries occur in approximately 30% to 77% of fractures. Answers C and D are incorrect because capsular tears and chondral injury can both be present as part of the injury pattern. Second fractures, reverse Segond fractures, anteromedial tibial margin fractures, and semimembranosus tendon insertion site fractures are all evidence of associated injuries.
3. The rate of compartment syndrome in tibial plateau fractures is 10% to 15%. Presenting symptoms include pain out of proportion to injury, swelling, pain on passive stretching, pallor, absence of pulses, hyperesthesia, and motor weakness. Physical exam can be unreliable (answer A) and if suspected, leg muscular compartmental pressures should be assessed. The amount of displacement (correct answer D) as well as a higher Shatzker and/or OA/OA classification are associated with increased risk of compartment syndrome. Repeat examination of the leg for compartment syndrome should be continued at regular intervals because it can occur 24 hours or more after injury (answer C).

**ANSWERS TO SCENARIO 3**

1. B. The Lachman test is the most sensitive physical exam maneuver to test for ACL laxity. The knee is placed in 20 to 30 degrees of flexion, the femur is stabilized, and an anteriorly directed force is applied to the tibia. The examiner should estimate the distance of translation as well as whether there is an endpoint or not. The pivot shift test and anterior drawer test are other physical examination maneuvers testing the anterior cruciate ligament, however, they are not as reliable as the Lachman exam. The McMurray test and Apley compression test are a physical exams evaluating the meniscus not the ACL.

2. C. Meniscal tears are the most common associated injury seen with an ACL tear. They occur in 65% to 75% of patients. Lateral meniscal tears are more common in acute ACL injuries. Answer B is incorrect because medial meniscus tears are more frequently seen in chronic injuries but less prevalent in acute injuries. Bone bruises or trabecular microfractures occur in just over half the patient with an ACL injury, however, these are typically located along the lateral femoral condyle and the posterolateral proximal tibia. These are a result of the subluxation and spontaneous reduction of the knee joint that occurs during an injury that leads to knee ligament disruption. Approximately 33% of patients with an ACL tear will have at least one additional ligament injured. Regarding choice A, the medial collateral ligament is injured in about 7% of patient with an ACL injury.

3. D. Answers A and C are incorrect because the treatment for a suspected ACL tear includes pain control, MRI, and physical therapy for mobilization. Answer D is correct because prolonged immobilization should be avoided as it may lead to arthrofibrosis. Regarding choice E, the use of an ACL brace continues to be controversial and has become an individualized and optional part of the treatment plan. Patients should be referred to an orthopedic surgeon for counseling of treatment options. The ideal candidate for surgical reconstruction is the patient with an acute ACL deficiency and an active lifestyle as well as one with a chronic injury and functional instability with normal daily activities.

4. E. Graft selection depends upon patient factors and surgeon preference. Multiple options of grafts are available for ACL reconstruction. Both autograft and allograft are utilized. Autograft options include quadrupled hamstring tendons, bone-patellar tendon-bone, and
quadriiceps tendon. Allograft options are varied and include bone-patellar tendon-bone, achilles tendon, hamstring tendons, anterior tibialis tendon, and posterior tibialis tendons. Generally speaking, the results of ACL reconstruction with any of these graft options are acceptable, although there are specific clinical scenarios that can lend themselves to certain choices. A lengthy discussion with the patient, outlining the positives and negatives of the graft choices is frequently needed.

5. A. Stiffness following ACL reconstruction or arthrofibrosis is the most common complication after surgical reconstruction. It is likely related to inflammation affecting the synovial lining leading to thickening of the capsule and loss of the normal space within the joint. Proper surgical technique and rehabilitation can help reduced the risk of joint stiffness. Loss of extension is reported to be as high as 59% in some populations and other complications are rare. Graft failure occurs and varies with different populations and different graft types. It ranges from 2% to 5%. The rate of deep venous thrombosis is approximately 1% to 1.5%, iatrogenic neurovascular injury incidence is about 1%, and postoperative intra-articular infection has been reported as low as 0.3% in a large cohort.

BIBLIOGRAPHY


Urology
Joseph R. Sterbis
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A 35-year-old man presents to the emergency department with one hour of severe right-sided flank pain. He is nauseated and vomited when the pain began. He has no medical history and is not on any medications. He has voided and his urinalysis shows 55 RBC per HPF and no WBC's.

1. What is the single best test to diagnose a kidney or ureteral stone?
   A. KUB
   B. Renal ultrasound
   C. IVP (intravenous pyelogram)
   D. Non-contrast computerized tomography (CT) scan of the abdomen and pelvis
   E. CT scan of the abdomen and pelvis with and without IV contrast

2. Which of these factors would mandate immediate decompression of the urinary tract with either a ureteral stent or a percutaneous nephrostomy tube?
   A. Acute kidney injury
   B. Sepsis presumed from the obstructed kidney
   C. Uncontrollable pain
   D. A, B, and C
   E. A and B

3. What is the most effective analgesia for kidney stone colic in the emergency department?
   A. NSAID's
   B. Tylenol
   C. NSAID's and IV opiates
   D. IV opiates
   E. Tylenol and IV opiates

4. Which factors are predictive of ureteral stone passage?
   A. Stone size
   B. Stone location
   C. Presence or absence of hydronephrosis
   D. A and B
   E. A, B, and C

5. Which medical condition(s) would you want to rule out in a recurrent calcium oxalate stone former?
   A. Hyperparathyroidism
   B. Gout
   C. Cushing's Syndrome
   D. A and B
   E. A, B, and C

ANSWERS

1. D. A non-contrast CT (NCCT) of the abdomen in pelvis is the single most accurate imaging test for a renal or ureteral stone. The sensitivity and specificity of NCCT are both in the high 90% range. Other imaging modalities, such as renal ultrasound and kidney, ureter, and bladder (KUB) X-ray, can be used to monitor a known stone, or are helpful if radiation must be limited (pregnancy), but have a lower sensitivity and specificity than a NCCT.

   Renal ultrasound is most helpful if the patient has hydronephrosis; however, 20% to 25% of patients with a ureteral stone will not have hydronephrosis. Likewise, 20% to 30% of ureteral calculi will not appear on a KUB. As a result, a NCCT is the optimal
test to assess unilateral flank pain in the emergency department. A low dose protocol can be performed in patients with a relatively low BMI, in an effort to reduce radiation exposure.

2. D. Uncontrollable pain, sepsis from the renal unit that is obstructed by a stone, and acute kidney injury are the main reasons to perform immediate decompression of a renal unit. The choice of a stent or a percutaneous nephrostomy tube is based on local experience, available personnel, the patient’s condition, and the chance of successful placement of either type of device.

3. C. The combination of NSAID’s and IV opiates has been shown to be superior to either agent alone in the management of renal colic in the emergency department.

Tylenol has not been widely studied in the management of renal colic, and the pain is usually substantial, thus this would be a less desirable analgesic. In addition, many patients with renal colic are vomiting, and require parenteral analgesia and rapid analgesia at that.

4. D. The combination of stone location and stone size allows estimation of ureteral stone passage rates. In general, the smaller a ureteral stone is the higher the chance of passage. Likewise, the more distal a ureteral stone is the higher the chance of passage. Smaller distal stones are more likely to pass than larger proximal stones. The presence or absence of hydronephrosis has no bearing on whether or not a stone will pass.

5. A. Hyperparathyroidism can cause urinary stones; however, only 1% to 2% of kidney stone formers have hyperparathyroidism. Surgical management of the parathyroid disease is often curative of future stone formation. An elevated blood calcium level, or even a high normal blood calcium level, as well as recurrent episodes of kidney stones should alert you to this as a diagnostic possibility. A serum parathyroid hormone (PTH) level, as well as serum calcium and vitamin D level should be obtained on these patients.

**BIBLIOGRAPHY**


A 64-year-old Caucasian male coal miner with a prior 20 pack per year smoking history, diabetes mellitus, hypertension, and hyperlipidemia presents for evaluation of urinary frequency. A urinalysis demonstrates 2 WBC/high powered field, 10 RBC/high powered field, and is negative for all other components. No red blood cell casts or dysmorphic red blood cells are present on urine microscopy.

1. Microscopic hematuria is defined as which of the following?
   A. Positive urine dipstick test  
   B. 1 cell/high powered field  
   C. 3 cells/high powered field  
   D. 5 cells/high powered field

2. Which of the following represents the complete work-up of microscopic hematuria?
   A. Cystoscopy, urine cytology  
   B. Renal ultrasound and bladder barbotage  
   C. Computerized tomography (CT) intravenous pyelogram  
   D. Cystoscopy, CT intravenous pyelogram  
   E. Urine cytology, urine culture

3. Cystoscopy revealed a large bladder tumor. A transurethral biopsy of his tumor reveals muscle invasive, high-grade bladder cancer. The patient then undergoes a radical cystectomy and ileal conduit. Which of the following electrolyte abnormalities is expected after urinary diversion with ileum?
   A. Hypokalemic, hyperchloremic metabolic acidosis  
   B. Hypokalemic, hyperchloremic metabolic alkalosis  
   C. Hyperkalemic, hypochloremic metabolic acidosis  
   D. Hypokalemic, hypernatremic metabolic alkalosis  
   E. None of the above

4. The patient returns to clinic 18 months after surgery with recurrent gross asymptomatic hematuria. Which of the following sites is the likely location for cancer recurrence?
   A. Ileal conduit  
   B. Kidney  
   C. Psoas muscle  
   D. Left renal pelvis  
   E. Thyroid

ANSWERS

1. C. Asymptomatic microscopic hematuria (AMH) is defined as three or greater red blood cells per high-powered field on a clean catch midstream urinary specimen in the absence of any other benign cause. A positive dipstick does not define AMH and microscopic examination of the urinary specimen is mandatory for diagnosis. The likelihood of a urologic malignancy in the presence of microscopic hematuria is approximately 10%.

2. D. The complete work-up for hematuria includes cystoscopy and CT intravenous pyelogram. With this evaluation strategy, the cause for hematuria is identified in 80% of cases. Patients with persistent hematuria after a negative initial evaluation warrant repeat evaluation at 48 to 72 months. If the patient cannot
obtain a CT intravenous pyelogram, then alternative acceptable imaging studies include intravenous pyelogram, retrograde pyelography, or magnetic resonance urography.

3. A. Hypokalemic, hyperchloremic metabolic acidosis is the electrolyte abnormality present when ileum as a urinary conduit. Hypochloremic acidosis occurs when ammonium chloride is absorbed from the urine into the blood stream. Hypokalemic, hyperchloremic metabolic alkalosis occurs when the stomach is used for urinary diversion and hydrochloric acid and potassium are lost in gastric secretions. Hyperkalemic, hypochloremic, hyponatremic metabolic acidosis are electrolyte derangements seen when jejunum is used for urinary diversion. The jejunum secretes sodium and chloride, while potassium and hydrogen are absorbed.

4. D. The patient has developed an upper urinary tract tumor. According to SEER data, the relative risk for upper urinary tract tumors for white men and women was listed as 64.2% and 75.4% at or before 2 years; 44.3% and 40.5% at 2 to 5 years; 50.8% and 42.1% at 5 to 10 years; and 43.2% and 22.2% at more than 10 years, respectively. Upper tract surveillance after a bladder tumor is necessary and is more likely to occur with high-grade bladder cancer. It can be performed with CT urography.

BIBLIOGRAPHY


A 39-yr-old Caucasian male with a history of poorly controlled hypertension, asthma, and hyperlipidemia obtains a CT of his abdomen and pelvis to evaluate for vague right-sided abdominal pain and is found to have a right renal mass, measuring $8 \times 6 \times 7$ cm in size. A complete work-up reveals renal cell carcinoma with a single lung metastasis. His glomerular filtration rate (GFR) was calculated to be 30 mL/min.

1. Decreased GFR (<60 mL/min) has been associated with which of the following?
   A. Increased risk of death
   B. Decreased cardiovascular health
   C. Increased risk of hospitalization
   D. A and B only
   E. All of the above

2. Which of the following is true of cytoreductive nephrectomy?
   A. In rare cases it can lead to further metastasis of the tumor.
   B. It can improve T-cell function against the primary tumor.
   C. It can negatively impact the response to systemic cytokine therapy.
   D. It has no impact on survival.
   E. It cannot be performed in the setting of metastatic disease.

3. Which of the following is true of pulmonary metastatectomy in this setting?
   A. Resection of limited metastatic disease has been reported to be associated with long disease-free intervals and overall survival.
   B. Pulmonary metastases are not amenable to surgical resection.
   C. Metastatectomy has been proven in randomized control trials to improve disease-free survival.
   D. Metastatectomy is contraindicated if there is more than 1 pulmonary lesion.
   E. Metastatectomy will not improve his length of survival.

4. The patient’s family history is significant for von Hippel-Lindau disease (VHL). He is tested for VHL and is found to have VHL type 2B. He also reports having intermittent headaches, occasional palpitations, diaphoresis, which he attributed to his poorly controlled hypertension. What is the likely source of his prior symptoms?
   A. Retinal hemangioblastoma
   B. Cerebellar hemangioma
   C. Pancreatic cysts
   D. Pheochromocytoma
   E. Epididymal cystadenoma

5. Of the following, which is the most reliable method to distinguish renal cell carcinoma from an upper tract urothelial tumor?
   A. Retrograde urography
   B. CT urography
   C. Non-contrast renal CT
   D. Urine cytology
   E. Intravenous pyelography
ANSWERS

1. E. An independent, graded association has been documented between a reduced estimated GFR (starting at a GFR < 60 mL/min) and the risk of death, cardiovascular events, and hospitalization. All of the above are correct.

2. B. Cytoreductive nephrectomy preceding systemic therapy is performed in the setting of advanced metastatic disease and has been shown to lead to spontaneous regression of the tumor. It is also believed that T-cell function is inhibited by large primary tumors. Overall survival has been shown to improve when surgery is combined with cytokine therapy.

3. A. Resection of limited metastatic disease has been reported to be associated with long disease-free intervals and overall survival. Isolated pulmonary metastases are lesions that are most commonly amenable to resection with curative intent. The overall survival of patients undergoing complete resection of limited metastatic disease was reported with median 5-year survival rates of 35% to 50%. No prospective randomized trials have been performed to demonstrate the favorable outcome attributed to resection of solitary metastatic disease. The current studies may reflect patient selection bias, inherent differences in tumor biology, and natural history or other confounding factors. The presence of additional pulmonary lesions is not a definitive contraindication to metastatectomy.

4. D. Pheochromocytoma occurs in 10% to 17% of patients with VHL. VHL type 2 differs from type 1 in that affected family members are at high risk to develop pheochromocytomas. VHL type 2 is further divided into types 2A, 2B, and 2C. Individuals in families with VHL type 2A develop pheochromocytomas but have a low risk for renal cell carcinoma (RCC). Those with VHL type 2B develop pheochromocytomas and have a high risk for RCC. Those with VHL type 2C develop pheochromocytomas but have a low risk for renal cell carcinoma.

5. B. Upper tract urothelial carcinoma (UT-UC) is a relatively uncommon form of cancer arising from the urothelial lining of the renal pelvis and calyces. UT-UC of the renal pelvis is an aggressive tumor, which may invade the renal parenchyma and mimic primary RCC. Advanced RCC can also invade the pelvicalyceal system. Distinguishing these primary lesions from each other can be difficult, and correct diagnosis is needed to determine appropriate surgery and medical treatment.

CT urography is easier to perform than intravenous pyelography and has a higher degree of accuracy in detecting renal parenchymal lesions. The sensitivity for detecting upper tract malignant disease has been reported to approach 100% with CT urography. CT urography also has a specificity of 60% and a negative predictive value of 100%. Retrograde urography has an accuracy of 75% in diagnosis of an upper tract malignant neoplasm. Ureteroscopy is reserved for situations when the diagnosis is unclear after conventional radiographic studies and for patients in whom the treatment plan may be changed on the basis of the ureteroscopic findings, for example those who may be amenable to endoscopic resection. Accuracy estimates of the sensitivity of cytology range from about 20% for grade 1 tumors to 45% and 75% for grade 2 and grade 3 tumors. Non-contrast CT does not allow for distinction between parenchymal and urothelial lesions.

BIBLIOGRAPHY


A 22-year-old Caucasian male presents to general surgery clinic for evaluation and treatment of a left inguinal hernia. During the physical examination, the hernia is identified, but a 3 cm left testicular mass is also noted. It is painless and firm. The patient has not noted it previously.

1. The initial radiographic assessment should consist of what test?
   A. Scrotal magnetic resonance imaging (MRI)
   B. Pelvic and Scrotal computerized tomography (CT)
   C. Testicular ultrasound
   D. Any of the above

2. Imaging has confirmed a testicular mass concerning for malignancy. Pending urologic evaluation, a serum β-hCG, Alpha-Fetoprotein (AFP), and lactate dehydrogenase (LDH) tests are ordered, all of which are significantly elevated above normal limits. Radical orchiectomy will be performed via which incision and will demonstrate which most likely pathology?
   A. Scrotal incision; Seminoma
   B. Scrotal incision; Non-seminoma
   C. Inguinal incision; Seminoma
   D. Inguinal incision; Non-seminoma

3. What is the primary landing zone for retroperitoneal metastases in a left-sided testicular germ cell tumor?
   A. Para-aortic lymph nodes
   B. Interaortocaval lymph nodes
   C. Para-aortic lymph nodes
   D. Inguinal nodes

4. Following the orchiectomy and staging imaging, which demonstrated a retroperitoneal mass, the patient was treated with three cycles of BEP (Bleomycin, Etoposide, and Cisplatin). This history should prompt what concerns for subsequent operative procedures?
   A. Bleomycin-induced pulmonary fibrosis should prompt the anesthesia provider to limit FiO₂ and be judicious in crystalloid and colloid administration.
   B. Etoposide-induced pulmonary fibrosis should prompt the anesthesia provider to limit FiO₂ and be judicious in crystalloid and colloid administration.
   C. Cisplatin-induced pulmonary fibrosis should prompt the anesthesia provider to limit FiO₂ and be judicious in crystalloid and colloid administration.
   D. A and B
   E. B and C

5. Following his course of chemotherapy, the patient has a residual retroperitoneal mass, prompting his urologist to perform a retroperitoneal lymph node dissection. The patient should be counseled regarding what potentially permanent genitourinary side effect as a result of this particular procedure?
   A. Urinary retention
   B. Detrusor overactivity
   C. Reduced penile sensation
   D. Erectile dysfunction
   E. Retrograde ejaculation
ANSWERS

1. C. The imaging study of choice in testicular cancer is a scrotal ultrasound. Classically, testicular cancer will present as a painless testis mass, confirmed with a corresponding hypoechoic lesion on ultrasound. The patient should have an accompanying Posterior-Anterior (PA) and lateral chest radiograph. Once a malignant diagnosis is confirmed, a CT of the abdomen and pelvis with IV and oral contrast will complete the radiographic staging by assessing for retroperitoneal metastases.

2. D. Testicular cancer is managed with a radical orchiectomy, which consists of a high ligation of the spermatic cord at the level of the internal inguinal ring performed via an inguinal incision. A long permanent suture is placed on the proximal end of the spermatic cord before it is tucked into the internal ring so that it may be later identified during a retroperitoneal lymph node dissection. The inguinal incision allows for complete excision of the cord, along with potential microscopic metastases, as well as avoiding contamination of the scrotal lymphatics, reducing rates of local recurrence. One meta-analysis demonstrated a local recurrence rate of 2.9% for those with scrotal violation vs. 0.4% with inguinal incisions. Care should also be taken to avoid violation of the tunica vaginalis in order to reduce the risk of local tumor recurrence. The presence of an elevated AFP indicates that the patient will be treated as though he has a non-seminomatous germ cell tumor as pure seminoma will never produce AFP. Seminoma will express hCG in approximately 15% of patients. Choriocarcinoma and embryonal carcinoma, non-seminomatous subtypes, can also produce hCG. Serum LDH is nonspecific, but it can correlate with disease volume.

3. C. Left-sided tumors predominantly metastasize to the para-aortic lymph nodes, while right-sided tumors will generally metastasize to the para-caval and interaortocaval lymph nodes. In either case, metastasis can occur to the opposite side, but such crossing metastases are more common with right-sided tumors. Generally, testis cancer metastasizes in an organized, progressive manner, beginning with the retroperitoneal lymph nodes. One exception is choriocarcinoma, which can spread in a hematogenous manner.

4. A. Bleomycin exposure can generate pulmonary interstitial fibrosis. Patients treated with bleomycin have experienced a potentially fatal respiratory distress syndrome following general anesthesia. Historically, it has been recommended to reduce FiO2 at the time of surgery, however, a retrospective study demonstrated that the most significant factor predicting postoperative morbidity was overall perioperative fluid balance. In this study, fluid balance was defined as the combination of colloid and crystalloid received in surgery, subtracting the urine, blood, and nasogastric fluids lost in the same timeframe.

In addition to fluid resuscitation and oxygenation concerns, one should consider obtaining preoperative pulmonary function tests prior to major surgical procedures. The same study cited above also demonstrated that low preoperative forced vital capacity also correlated with postoperative oxygenation problems. Any preoperative assessment of a testicular cancer patient should determine his exposure to bleomycin, with appropriate precautions taken if necessary.

5. E. Retrograde ejaculation is a well-known side effect from retroperitoneal lymph node dissection (RPLND). The post-ganglionic sympathetic nerves responsible for ejaculation (T12-L3) are disrupted during a RPLND. This side effect may be avoided by performing a template RPLND in low stage disease or by performing a bilateral nerve-sparing RPLND. In the former, the predictable metastatic pattern of testicular germ cell tumors allow either the right or left sympathetic nerves to be spared, thus preserving ejaculation. Alternatively, a unilateral nodal dissection can be performed, with care taken to preserve the individual nerves along with the hypogastric plexus anterior to the aorta, just below the origin of the inferior mesenteric artery. With appropriate nerve sparing, ejaculation can be preserved in nearly all patients.

An additional complication of RPLND is that of chyloous ascites, due to lymphatic leakage. This can be prevented by meticulous attention to lymphostasis.

BIBLIOGRAPHY


A 30-year-old male is brought to the emergency room following a gunshot wound to the left lower quadrant. He undergoes an exploratory laparotomy at which time a colonic injury is identified, requiring resection of the injured segment and a diverting colostomy. During further assessment, a left ureteral transection is noted in the mid-ureter.

1. The patient is acidotic, hypothermic, and hemodynamically abnormal. He has no other apparent injuries. The treatment of choice in this setting is which of the following?
   A. Transureteroureterostomy
   B. Ureteroureterostomy
   C. Boari flap
   D. Ligation of the ureteral stumps with permanent suture
   E. Psoas hitch with ureteral reimplant

2. His preoperative computerized tomography (CT) scan demonstrated a 5 mm left lower pole renal calculus. Which of the following treatment options is contraindicated?
   A. Transureteroureterostomy
   B. Ureteroureterostomy
   C. Boari flap
   D. Ligation of the ureteral stumps with permanent suture
   E. Psoas hitch with ureteral reimplant

3. Which of the following considerations is true when performing an ureteroureterostomy?
   A. A tension-free anastomosis is not required.
   B. Spatulating opposing ends of the ureteral segments can be done selectively.
   C. Complete the anastomosis with fine, permanent suture is required.
   D. Placement of a double-J ureteral stent across the anastomosis is recommended.
   E. In the setting of a gunshot wound, a ureteroureterostomy cannot be done.

4. Which of the following is true regarding ureteroneocystostomy?
   A. The reimplant should be placed on the base of the bladder.
   B. A refluxing reimplant has a higher risk of stricture.
   C. This is the treatment of choice for distal ureteral injuries.
   D. Stay sutures should not be placed in the ureter to avoid tissue handling.
   E. If a psoas hitch is required, the ipsilateral bladder pedicle may need to be ligated to achieve sufficient mobilization of the bladder.

5. Which of the following is true about ureteral injury due to external trauma from gunshot wounds?
   A. Ureteral injuries associated with external trauma will always present with hematuria.
   B. The diagnosis is usually made by a CT cystogram.
   C. High velocity gunshot wounds (> 350 m/second) can create a surrounding energy wave 30 to 40 times the missile diameter.
   D. Injury from missiles and bullets can be located only along the path of tissue penetration.
ANSWERS

1. D. If recognized at the time of surgery, surgical division of the ureter and/or partial ureteral excision should be managed based on the location and length of injury. Options for repair include ipsilateral ureteroureterostomy, ureteral reimplantation with or without a psoas hitch, trans ureteroureterostomy. In occasions when the patient is unstable, the ureter can be ligated with sutures, a nephrostomy tube is placed, and reconstruction can occur within the next 48 to 72 hours. If the patient is hemodynamically unstable, then damage control is recommended and delayed ureteral repair can be performed.

2. A. Transureteroureterostomy places the contralateral renal unit at risk and is contraindicated in patients with a prior history of urinary stone disease. Both upper tracts are at risk if there is any problem with one side. The other reconstructive surgeries can be implemented in the setting of known stone disease.

3. C. The use of permanent sutures within the urinary tract is a nidus for stone formation. The proximal and distal ends of the ureters should be spatulated and sewn together in a tension-free fashion with absorbable monofilament suture. A stent should be placed across the watertight anastomosis. Contusions or damaged areas of the ureter need to be debrided until the edges bleed prior to performing ureteral anastomoses.

4. D. Short defects involving the distal ureter should be repaired with ureteroneocystostomy. Non-refluxing ureteral implants have a higher risk of stricture than refluxing ureteral implants. Refluxing anastomoses show no increase in complications related to urine reflux. The principles of repair include spatulation, lack of tension, stenting, postoperative drainage, and a watertight anastomosis with fine non-reactive absorbable suture. The contralateral bladder pedicle can be ligated when performing a psoas hitch using in order to provide enough mobilization to perform a ureteroneocystostomy. Stay suture can improve tissue handling and preserve the blood supply to the ureter. Re-implanted ureters are usually placed at the dome of the bladder.

5. C. The missile or bullet can tumble during penetration and cause damage to the surrounding tissues at a significant distance from its path. Hematuria is not always present after ureteral injury. Triphasic CT can be used to evaluate tissue trauma and for ureteral injury. CT cystogram will usually identify a bladder injury. High velocity bullets or missiles can create an energy wave that penetrates and injures distant tissues. Damage to the ureters can present 3 to 5 days after injury as increased drainage from the surgically placed drains. T is fluid can be sent to pathology for a creatinine level.

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A 58-yr-old male is diagnosed in urology clinic with clinical T2a Gleason 3 + 4 = 7 prostate cancer. His serum PSA is 4.2. He has a history of hypertension and no prior surgical history. He has no prior history of radiation or chemotherapy administration.

1. Which treatment options should NOT be recommended to the patient?
   A. Radical prostatectomy with bilateral pelvic lymph node dissection
   B. External beam radiation therapy
   C. Brachytherapy seed implants
   D. Active surveillance

2. The patient elects for a radical prostatectomy with bilateral pelvic lymph node dissection. During the pelvic lymph node dissection, the left obturator nerve is accidentally divided with metzenbaum scissors. It is recognized immediately. How do you address this complication?
   A. Because the division was done sharply, leave the two ends free following completion of the lymphadenectomy.
   B. Reapproximate the two ends with fine, permanent suture.
   C. Perform a nerve graft, approximating the two ends.
   D. All of the above
   E. A or C

3. During the apical prostatic dissection, a small 1 cm full thickness rectal injury is incurred. Which of the following is the best course of action at this time?
   A. Omental flap coverage following primary repair
   B. Resection of the injured rectum, followed by primary anastomosis
   C. Resection of the injured rectum, primary anastomosis and diverting ileostomy
   D. Diverting colostomy after resection even in a patient without prior radiation therapy
   E. Double layer, air-tight closure of the rectal injury

4. Four months later, the patient is scheduled for a laparoscopic cholecystectomy. The operating room nurse has difficulty placing a foley catheter. What is the most likely source for this difficulty?
   A. Anastomotic contracture at the bladder neck
   B. Prostate cancer recurrence at the bladder neck
   C. Urethral stricture
   D. Rectourethral fistula

5. The patient experiences a disease recurrence and is initiated on androgen deprivation therapy (ADT). Which of the following is true regarding this treatment?
   A. The patient is at reduced risk for cardiac morbidity.
   B. The patient is at increased risk for loss of lean muscle.
   C. The patient is at reduced risk for osteoporosis.
   D. The patient is at increased risk for loss of body fat.

ANSWERS
1. D. Active surveillance is appropriate for men with low risk prostate cancer, defined as having
organ-confined pathology, < 0.2 mL, a Gleason sum less than or equal to 6, and no Gleason grade 4 or 5 in the biopsy specimen.

2. B. If the obturator nerve is accidentally divided, it should be reanastomosed with fine, non-absorbable sutures. The patient can make a full functional recovery.

3. D. Rectal injury is a serious intraoperative complication. If a rectal injury occurs, the prostatectomy should be completed. Small injuries that are less than 50% of the circumference of the rectum can be treated without resection. The rectum can be closed primarily, and a piece of omentum should be placed between the rectal closure and the vesicourethral anastomosis to reduce the incidence of rectourethral fistula. The rectal defect should be closed in two layers and the wound copiously irrigated with antibiotic solution. If the patient has had radiation therapy prior to surgery, a diverting colostomy should be performed.

4. A. Two to five percent of patients develop a bladder neck contracture approximately 6 to 12 weeks after an open prostatectomy. The initial management includes dilation with urethral sounds or a direct vision incision of the bladder neck.

5. B. General complications of androgen ablation include osteoporosis, hot flashes, and decline in cognitive function, increased cardiovascular morbidity and mortality, and changes in body habitus. Bone mineral density can decrease, and the longer the patient remains on ADT, the greater the risk of fracture. ADT has been linked to cognitive decline in men with prostate cancer. Men treated with ADT have demonstrated a loss of muscle mass and increase in percentage of body fat. ADT can adversely affect body habitus, glucose metabolism, lipid profiles, and increase cardiovascular morbidity and mortality.

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