EXTRAORDINARY CASES IN

EMERGENCY MEDICINE



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Mc Graw Hill Education

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This book is dedicated
to my wife, Marian*, my children,* Nicholas and Maria,
and is in loving memory of my parents, Donald and Lucille.

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Table of Contents

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Preface

Early in my professional life it became apparent that I would have the wonderful opportunity and honor to care for patients with a wide variety of illness and injuries. I started to collect medical images with the express intent of utilizing them to educate medical students, residents and fellow colleagues. The patient cases presented in this book pose unique diagnostic and therapeutic clinical challenges.

The practice of Emergency Medicine has changed dramatically over the course of my career. Medications, medical imaging, procedural equipment, and medical knowledge have significantly transformed the specialty of Emergency Medicine. The clinical management of the cases presented in this textbook represent what was the standard of care at the time the case occurred. The reader should realize that a given case might very well be managed considerably differently at the current time.

The cases presented in this book span a period over 36 years. I would like to sincerely thank the patients for allowing images related to their illness or injury to be obtained. Great care has been taken to present cases confidentially, and some specific case details have been excluded to prevent patient identification. Cases are not presented in chronologic order, so the given patient age does not correspond to any particular time period. The images have been screened for individual patient identification content, and the metadata associated with each digital image was removed.

There is a wide variation in the clinical, intellectual, and emotional aspects of the presented cases. All are presented with the express intent of education.

In caring for my patients, I adopted a personal philosophy early in my career summed up by the axiom *"There but for the grace of God go I."* I present these cases with that understanding and mindset.

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Acknowledgments

This book would not have been written without the help of many individuals.

My consulting editors. Dr. Jeffrey Ho, Dr. Matthew Prekker, and Dr. Gopal Punjabi readily volunteered to edit the manuscript and examine the images. As a result of their generosity, hard work, and attention to detail, this manuscript improved greatly from its first draft to its final form. I am indebted to them for their time, energy and expertise.

My colleagues. Dr. Joseph Clinton, Dr. David Plummer, and Dr. Stephen Smith have been colleagues of mine for more than three decades. Dr. Clinton inspired me to collect interesting medical images for use in the education of medical students, residents, and faculty physician colleagues. Dr. Plummer and Dr. Smith have provided innumerable remarkable image cases over the years that have been instrumental in our departmental teaching. Medical students, residents, and faculty physician colleagues have greatly benefited from their dedication to education. Likewise, to all of the emergency medicine physicians I have had the pleasure of working with through the years—thank you for being such outstanding colleagues.

Dr. William Locke. Dr. Locke provided me, at the time a complete stranger and a naive 19-year-old college student interested in a career in medicine, with an extended opportunity to shadow and observe his obstetrics and gynecology practice. My experience with Dr. Locke cemented my aspirations for a career in medicine.

Lastly, I would like to acknowledge every teacher and mentor I have had in my life. I am deeply and forever indebted to you.

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Legend Key

BA = black arrow

BDA = black dashed arrow

BAH = black arrowhead

WA = white arrow

WDA = white dashed arrow

WAH = white arrowhead

RA = red arrow

YA = yellow arrow

GA = green arrow

Blue arrow

CHAPTER 1 Airway

Case 1-1

Adult supraglottitis

Patient Presentation: A young adult presented with difficulty breathing. The patient became ill 24 hours prior to presentation with a fever and a progressively worsening sore throat.

Clinical Features: The patient was extremely anxious appearing, sitting upright, and drooling. The patient was in severe respiratory distress with marked inspiratory stridor and unable to phonate. Breath sounds were clear but diminished and difficult to hear secondary to transmitted upper airway noise.

Differential Dx:

- Supraglottitis
- Epiglottitis
- Foreign body
- Viral laryngotracheitis
- Retropharyngeal abscess
- Odontogenic infection
- Bacterial tracheitis
- Uvulitis
- Ludwig angina
- Angioedema
- Peritonsillar abscess

Emergency Care: This patient's severe respiratory distress with upper airway obstruction mandated immediate airway management with the working diagnosis of supraglottitis. Rapid sequence intubation was performed utilizing video laryngoscopy. Supraglottitis was visualized with a severely swollen epiglottis and arytenoids. A bougie device was inserted blindly into what was thought to be the glottic opening, and an endotracheal tube was placed over the bougie device into the trachea. The vocal cords of this patient were never visualized.

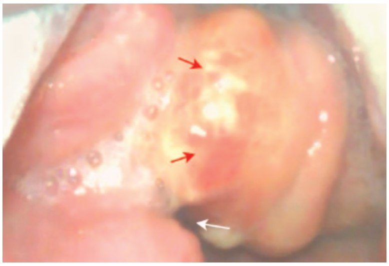

Figure 1-1. Laryngoscopic view. RA = severely swollen epiglottis, WA = pathway to glottis

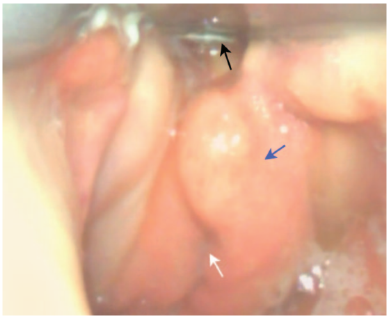

Figure 1-2. Laryngoscopic view. BA = laryngoscope, blue arrow = severely swollen arytenoids, WA = pathway to glottis

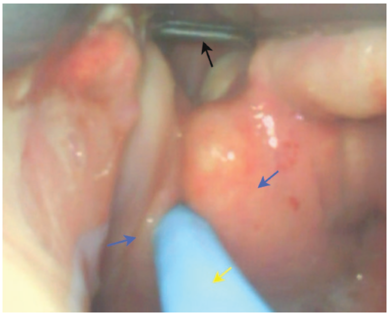

Figure 1-3. Laryngoscopic view. BA = laryngoscope, blue arrows = arytenoids, YA = bougie

Antibiotics and steroids were administered, and the patient was admitted to the intensive care unit.

Outcome: The patient made an uneventful recovery.

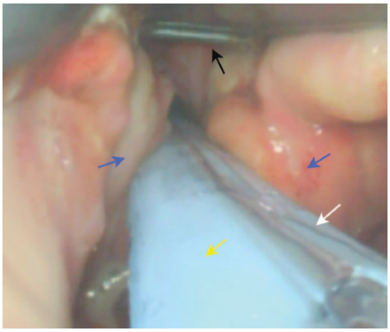

Figure 1-4. Laryngoscopic view. BA = laryngoscope, blue arrows = arytenoids, WA = endotracheal tube, YA = bougie

Key Learning Points:

- Airway management in adult supraglottitis is challenging.
- The bougie device is a simple yet invaluable tool in difficult airway management. As in this case, it can be blindly placed by slipping it under the epiglottis with the coudé tip of the bougie pointed anteriorly. The intubator can get tactile confirmation of tracheal bougie placement as the coudé tip rubs against the anterior tracheal rings. In addition, a firm endpoint encountered upon bougie advancement also indicates correct placement.
- Additional airway adjuncts should be available at the bedside in the management of adult supraglottitis, including the intubating laryngeal mask airway (ILMA), the King airway, as well as equipment for surgical airway management via cricothyrotomy.

Further Reading:

Bizaki AJ, Numminen J, Vasama JP, Laranne J, Rautiainen M. Acute supraglottitis in adults in Finland: review and analysis of 308 cases. *Laryngoscope*. 2011;121(10):2107-2113.

Verbruggen K, Halewyck S, Deron P, Foulon I, Gordts F. Epiglottitis and related complications in adults. Case reports and review of the literature. *B-ENT*. 2012;8(2):143-148.

Westerhuis B, Bietz MG, Lindemann J. Acute epiglottitis in adults: an under-recognized and life-threatening condition. *S D Med*. 2013;66(8):309-311.

Case 1-2

Toy balloon in trachea

Patient Presentation: A 7-month-old infant was found by family members to have severe respiratory distress. The patient had been crawling on the floor a short time previously. There was no history of trauma and no significant prior medical history. After the family called 911, paramedics found the infant to be unresponsive in respiratory arrest, and they attempted bag-valve-mask ventilation.

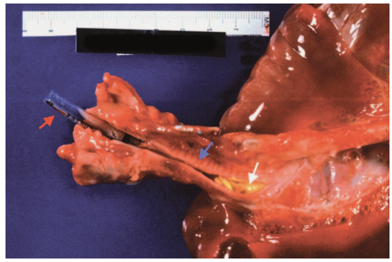

Figure 1-5. Autopsy photo. BA = trachea, RA = endotracheal tube, WA = toy balloon

Clinical Features: On arrival to the emergency department (ED), the patient was in respiratory and cardiac arrest. Cardiopulmonary resuscitation (CPR) was started. The initial cardiac rhythm was asystole, and the patient was being bag-valve-mask ventilated with difficulty due to high airway pressure.

Differential Dx:

- Foreign body
- Occult trauma
- Infection such as supraglottitis or bacterial tracheitis
- Sudden infant death syndrome
- Pneumothorax
- Anaphylaxis

Emergency Care: A careful inspection of the supraglottic space and vocal cords with a laryngoscope blade did not reveal any foreign body or anatomic abnormality. The infant was then endotracheally intubated but was extremely difficult to ventilate secondary to significant airway resistance. The patient was reintubated with similar high airway resistance encountered with no effective ventilation possible. An unsuccessful attempt to push the presumed foreign body from the distal trachea into a main stem bronchus using the endotracheal tube was made. High airway pressures persisted with an inability to ventilate. The last option attempted was transtracheal jet ventilation through the cricothyroid membrane, which did not clear the obstruction and resulted in subcutaneous emphysema of the neck.

Outcome: Resuscitation was unsuccessful, and the patient died. Subsequent autopsy with examination of the trachea revealed a yellow balloon straddling the carina, with the ends of the balloon in both left and right main bronchi preventing ventilation from the correctly placed endotracheal tube.

Key Learning Points:

- Foreign body aspiration is responsible for approximately 4,800 deaths per year in the United States in children under the age of 4 years, and it is the leading cause of unintentional injury mortality under the age of 1 year.

- This case occurred before the advent of an effective and easy-to-use tracheal foreign body extractor system. An endotracheal tube that has been shortened by cutting the distal end of the tube just proximal to the "Murphy eye" but distal to the balloon (so that there is only one open distal port) is placed into the trachea. A meconium aspirator is then attached to the proximal endotracheal tube, and high-flow wall suction is applied to the meconium aspirator. Trachea foreign bodies are suctioned up into, or against, the endotracheal tube. The endotracheal tube is then withdrawn while maintaining high-flow wall suction, thus removing the foreign body.

Further Reading:

Kei J, Mebust DP. Comparing the effectiveness of a novel suction set-up using an adult endotracheal tube connected to a meconium aspirator vs. a traditional Yankauer suction instrument. *J Emerg Med*. 2017;52(4):433-437.

National Safety Council. Injury Facts 2017. Available at: http://www.nsc.org/learn/safety-knowledge/Pages/injury-facts.aspx. Accessed May 9, 2018.

Case 1-3

Push pin in bronchus

Patient Presentation: A 10-year-old patient with autism presented after family members witnessed the child suddenly place a push pin into his mouth, followed by an immediate but brief coughing episode.

Clinical Features: The patient was asymptomatic on presentation to the ED.

Differential Dx:
- Aspiration or ingestion of the push pin

Emergency Care: A chest x-ray did not reveal a foreign body. The parents were certain the child had placed something in his mouth causing him to cough. As the parent's history was specific and compelling, the patient underwent flexible bronchoscopy under ketamine sedation in the ED. The tack was easily located in the proximal right mainstem bronchus. Attempts at removal using the flexible bronchoscope with an alligator forceps were unsuccessful as the sharp point of the tack was embedded in the bronchial mucosa.

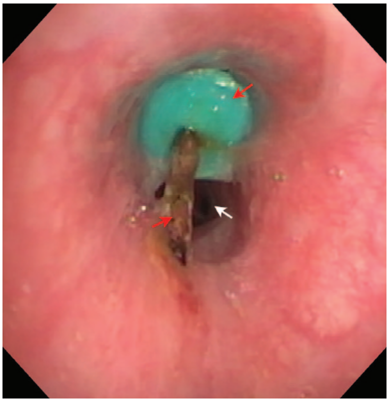

Figure 1-6. Fiberoptic bronchoscopic view. RA = push pin, WA = bronchus

Outcome: The patient was taken to the operating room where the tack was removed using a rigid bronchoscope.

Key Learning Points:
- Coughing is an indicator for aspiration of a foreign body.
- Listen carefully to the history provided by parents.

Further Reading:

Boyd M, Chatterjee A, Chiles C, Chin R Jr. Tracheobronchial foreign body aspiration in adults. *South Med J*. 2009;102(2):171-174.

Swanson KL, Edell ES. Tracheobronchial foreign bodies. *Chest Surg Clin N Am*. 2001;11(4):861-872.

Case 1-4

Aspirated tracheal plug

Patient Presentation: An obese patient status post tracheostomy for obstructive sleep apnea presented in severe respiratory distress. The patient had accidentally inhaled a trachea plug device used to occlude his tracheostomy while doing yoga. He was unable to provide any additional history secondary to distress.

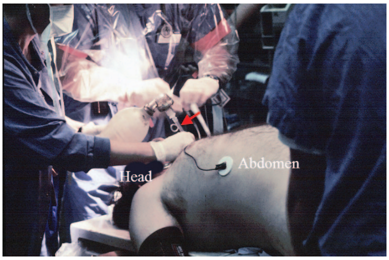

Figure 1-7. Patient intubated through the tracheostomy post foreign body removal. RA = endotracheal tube

Clinical Features: The patient was sitting upright, wide-eyed with extreme anxiety, and was using accessory respiratory muscles to compensate for his partial upper airway obstruction. He had significant inspiratory and expiratory stridor. Within a minute of ED arrival, he developed complete airway obstruction, with cessation of stridor, followed by loss of consciousness.

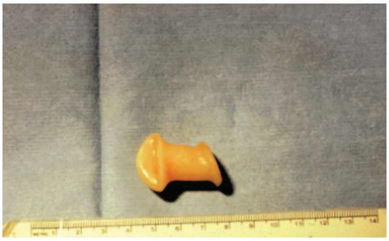

Figure 1-8. Tracheal plug that was accidentally aspirated through the tracheostomy

Differential Dx:

- The patient had an obstructing tracheal foreign body.
- The exact location and size relative to the trachea were unknown.

Emergency Care: No foreign body was visualized at the tracheostomy site. There were two choices at this time: try to remove the foreign body or push the foreign body down into one main stem bronchus in order to open up a passageway to the other lung. The danger in pushing down the foreign body was the possibility of the foreign body being larger in diameter than the distal trachea and becoming wedged at the carina; therefore, retrieval was attempted. Several steps were taken simultaneously. Several people lifted the patient's legs, buttocks, and lower torso into the air and sideways in a suspended Trendelenberg and lateral decubitus position. Another person started to perform back blows. The emergency physician placed a pair of Magill forceps blindly into the tracheostomy site and began blind attempts to retrieve the foreign body. The Magill forceps was noted to go approximately 4 to 5 cm before the foreign body was tactilely encountered, grabbed, and removed. The patient was then intubated through his tracheotomy. The foreign body was approximately 3 cm in length and 1.5 cm in diameter.

Outcome: The patient was admitted to the hospital. He regained consciousness and had a normal neurologic examination with no subsequent pulmonary complications.

Key Learning Points:

- A pair of Magill forceps is an essential piece of equipment on the airway management cart.
- Tracheal foreign bodies present challenging clinical situations. The decision-making and therapeutic response needs to be individualized to each patient.
- Always consider the possibility that the tracheal foreign body, if inadvertently pushed down the trachea during endotracheal intubation, might become lodged in the distal trachea and result in complete airway obstruction. The diameter of the distal trachea in adults is 1.2 to 1.8 cm. The foreign body in this case might very well have become wedged in the distal trachea, increasing the likelihood of a poor outcome.

Further Reading:

Bowdler DA, Emery PJ. Tracheostomy tube fatigue. An unusual cause of inhaled foreign body. *J Laryngol Otol*. 1985;99(5):517-521.

Dogan K, Kaptanoglu M, Onen A, Saba T. Unusual sites of uncommon endobronchial foreign bodies. Reports of four cases. *Scand Cardiovasc J*. 1999;33(5):309-311.

Lawton MB, Abadee P. Aspiration of a tracheostomy plug. *Arch Phys Med Rehab*. 1987;68(5 pt 1):318.

Case 1-5

Airway angioedema

Patient Presentation: This patient presented with difficulty breathing. He noted that his tongue started to swell approximately 4 to 5 hours prior to ED presentation. He did not endorse any allergy history but was noted to be taking an angiotensin-converting enzyme (ACE) inhibitor.

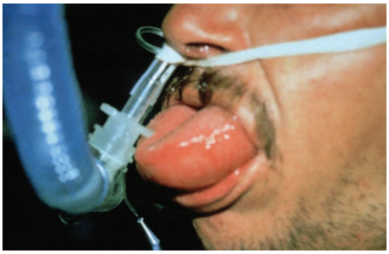

Figure 1-9. Tongue angioedema

Clinical Features: Significant tongue swelling was noted as a result of angioedema. He complained of difficulty with breathing and swallowing but did not have stridor. Breath sounds were normal without wheezing, no rash was present, and he was hemodynamically stable without hypoxia.

Differential Dx:

- The etiologies of angioedema can be categorized into three mechanisms:
  - Mast cell–mediated angioedema from true IgE-mediated allergic reactions
  - Bradykinin-mediated angioedema from ACE inhibitors or C1-inhibitor deficiency such as hereditary angioedema
  - Idiopathic mechanisms

Emergency Care: This patient had rapidly advancing angioedema of the tongue. Although he was not in respiratory distress, he complained about difficulty breathing. He was nasotracheally intubated with a fiberoptic laryngoscope under ketamine sedation.

Outcome: The patient was admitted to the intensive care unit and made an uneventful recovery.

Key Learning Points:

- The acute management of ACE inhibitor–associated angioedema includes maintaining upper airway patency, typically with endotracheal intubation. Deaths have been reported from massive tongue swelling due to ACE inhibitor–associated angioedema.
- Medical management of ACE inhibitor–associated angioedema includes discontinuing the drug and adding ACE inhibitors to the patient's allergy list. Antihistamines, glucocorticoids, and epinephrine, while lifesaving in allergic IgE-mediated histamine-induced angioedema, are thought to be ineffective or minimally effective in bradykinin-mediated angioedema.
- Icatibant is a synthetic bradykinin ß$_2$-receptor antagonist that may be useful in the management of life-threatening ACE inhibitor–induced angioedema.

Further Reading:

Bas M, Greve J, Stelter K, et al. Therapeutic efficacy of icatibant in angioedema induced by angiotensin-converting enzyme inhibitors: a case series. *Ann Emerg Med*. 2010;56(3):278-282.

Dean DE, Schultz DL, Powers RH. Asphyxia due to angiotensin converting enzyme (ACE) inhibitor mediated angioedema of the tongue during the treatment of hypertensive heart disease. *J Forensic Sci*. 2001;46(5):1239-1243.

Kieu MC, Bangiyev JN, Thottam PJ, Levy PD. Predictors of airway intervention in angiotensin-converting enzyme inhibitor-induced angioedema. *Otolaryngol Head Neck Surg*. 2015;153(4):544-550.

Sinert R, Levy P, Bernstein JA, et al. Randomized trial of icatibant for angiotensin-converting enzyme inhibitor-induced upper airway angioedema. *J Allergy Clin Immunol Pract*. 2017;5(5):1402-1409.

Case 1-6

Adult lye ingestion

Patient Presentation: This patient presented after ingesting lye in a suicide attempt.

Clinical Features: The patient was awake and in moderate painful distress. The patient had caustic burns to the lips and tongue.

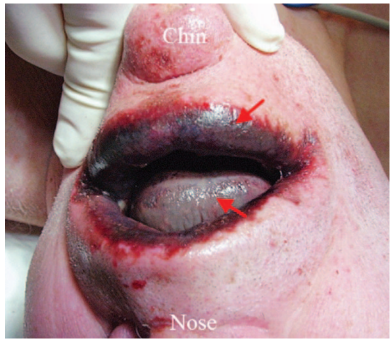

Figure 1-10. RA = caustic injury to the lips and tongue

Differential Dx:
- The presentation and clinical features were consistent with lye ingestion.

Emergency Care: The primary concern was for injury to the airway that might progress to upper airway obstruction. The patient underwent rapid sequence intubation. Caustic injury to the supraglottic structures, including the epiglottis, vallecula, and arytenoid cartilage, were visualized during laryngoscopy and intubation.

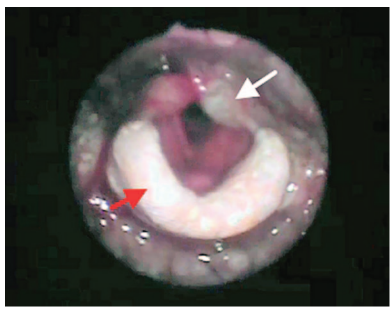

Figure 1-11. Laryngoscopic view. RA = caustic injury to the epiglottis, WA = caustic injury to arytenoid

Outcome: No outcome data are available for this patient.

Key Learning Points:
- The emergency physician's single most important consideration in managing caustic ingestion injury is airway management. Patients who demonstrate upper airway injury, as in this case, should be endotracheally intubated for airway protection because significant and worsening edema formation is likely.
- Medical and surgical management of severe caustic injuries is complex.

Further Reading:

Rollin M, Jaulim A, Vaz F, et al. Caustic ingestion injury of the upper aerodigestive tract in adults. *Ann R Coll Surg Engl*. 2015;97(4):304-307. ISSN: 1478-7083.

Struck MF, Beilicke A, Hoffmeister A, et al. Acute emergency care and airway management of caustic ingestion in adults: single center observational study. *Scand J Trauma Resusc Emerg Med*. 2016;24(1):45.

Case 1-7

Pediatric lye ingestion

Patient Presentation: A 3-year-old presented with an accidental ingestion of lye with a pH of 14.

Clinical Features: The patient was awake, alert, and in moderate painful distress. He was sitting upright and drooling. There was significant pale edema of his lateral and posterior oropharyngeal walls with uvula hydrops.

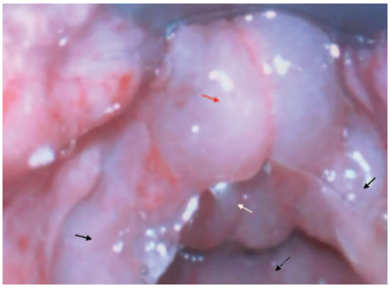

Figure 1-12. Laryngoscopic view during intubation. BA = edematous lateral pharyngeal walls, BDA = edematous posterior pharyngeal wall, RA = edematous epiglottis, WA = air bubble exiting the glottis

Differential Dx:

- Caustic ingestion with airway compromise
- Upper gastrointestinal injury

Emergency Care: The patient underwent rapid sequence intubation using succinylcholine and ketamine. Laryngoscopy revealed markedly altered upper airway anatomy. The epiglottis, lateral pharyngeal walls, and posterior pharyngeal wall were severely edematous. There was a small air bubble exiting posterior to the epiglottis. The air bubble was used as a guide in identifying the glottic opening and placement of a bougie. An endotracheal tube was then slid over the bougie to complete the procedure.

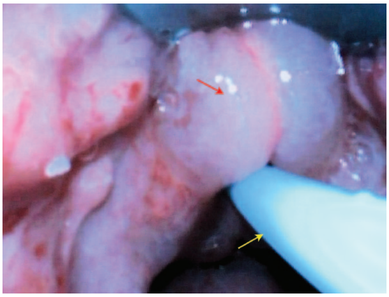

Figure 1-13. Laryngoscopic view. RA = edematous epiglottis, YA = bougie placed posterior to epiglottis into the glottic opening

Outcome: Bronchoscopy and endoscopy revealed minimal tracheal, esophageal, and stomach injury. He was treated with IV steroids, remained intubated for a total of 6 days, and made a full recovery.

Key Learning Points:

- The emergency physician's single most important consideration in managing caustic ingestion injury is timely airway management. Patients who demonstrate upper airway injury, as noted in this patient, should be intubated for airway protection in the event of worsening edema.
- Early intubation is important as expanding edema may preclude the ability to intubate the trachea other than via a surgical airway.
- Pediatric ingestion of caustic substances can result in severe injury to the esophagus.
- Medical and surgical management of pediatric severe injuries from ingestion of caustic substances is complex.

Further Reading:

Gandhi RP, Cooper A, Barlow BA. Successful management of esophageal strictures without resection or replacement. *J Pediatr Surg*. 1989;24(8):745-749.

Kane TD, Nwomeh BC, Nadler EP. Thoracoscopic-assisted esophagectomy and laparoscopic gastric pull-up for lye injury. *JSLS*. 2007;11(4):474-480.

Lamireau T, Rebouissoux L, Denis D, Lancelin F, Vergnes P, Fayon M. Accidental caustic ingestion in children: is endoscopy always mandatory? *J Pediatr Gastroenterol Nutr*. 2001;33(1):81-84.

Othersen HB Jr, Parker EF, Chandler J, Smith CD, Tagge EP. Save the child's esophagus, Part II: colic patch repair. *J Pediatr Surg*. 1997;32(2):328-333.

Shepherd RL, Raffensperger JG, Goldstein R. Pediatric esophageal perforation. *J Thorac Cardiovasc Surg*. 1977;74(2):261-267.

Tucker JA, Reilly BK, Tucker ST, Reilly JS. Pediatric otolaryngology in the United States: Chevalier Jackson's legacy for the 21st century. *Otolaryngol Head Neck Surg*. 2012;146(1):5-7.

Case 1-8

Peanut allergy

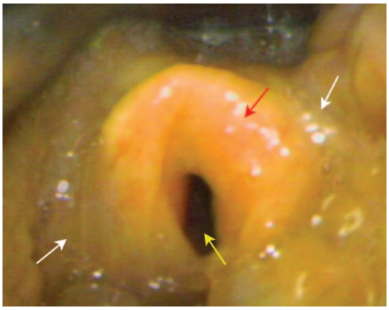

Figure 1-14. Laryngoscopic view. Supraglottic angioedema. RA = epiglottis, WA = vallecula and piriform sinuses, YA = opening to the glottis

Patient Presentation: A young patient with a peanut allergy presented with moderate to severe respiratory distress. The patient had been well until accidentally ingesting peanuts.

Clinical Features: The patient presented awake and alert but moderately ill appearing and very anxious. He was sitting upright and not controlling his secretions with continuous drooling. His voice was altered. The tongue was normal, but there was angioedema of the posterior oropharynx and uvula. There was no rash, breath sounds were normal, and the patient was hemodynamically stable.

Differential Dx:
- The clear history accompanying his presentation pointed toward angioedema secondary to an IgE-mediated allergic reaction to peanuts.
- The patient had not been ill and was not febrile, making an infectious process unlikely.
- The sudden onset made foreign body aspiration a possibility.

Emergency Care: The patient underwent flexible laryngoscopy under light sedation for both diagnostic and therapeutic aim. The supraglottic structures were markedly abnormal with a swollen edematous epiglottis and significant supraglottic angioedema of the vallecula and piriform sinuses. The glottic opening was significantly narrowed. Once the severe edema was visualized, the patient was endotracheally intubated over the fiberoptic laryngoscope. The patient was treated with IV steroids and antihistamines while in the ED.

Outcome: The patient was admitted to the intensive care unit where he made an uneventful recovery.

Key Learning Points:
- It is important to load the fiberoptic laryngoscope with an endotracheal tube in any patient suspected of having significant upper airway abnormalities *before* the first diagnostic insertion of the scope.
- All patients who present with significant allergic reactions should be sent home with multiple epinephrine self-injection kits.
- Peanut, tree nut, and seed allergies are among the most common causes of food-induced anaphylaxis.

Further Reading:

Husain Z, Schwartz RA. Food allergy update: more than a peanut of a problem. *Int J Dermatol*. 2013;52(3):286-294.

Moellman JJ, Bernstein JA, Lindsell C, et al. A consensus parameter for the evaluation and management of angioedema in the emergency department. *Acad Emerg Med*. 2014;21(4):469-484.

Patel BY, Volcheck GW. Food allergy: common causes, diagnosis, and treatment. *Mayo Clin Proc*. 2015;90(10):1411-1419.

Case 1-9

Pediatric smoke inhalation

Patient Presentation: Two pediatric patients involved in the same house fire presented complaining of throat pain and cough, but they denied any difficulty breathing. They denied any other injuries or burns.

Clinical Features: The patients were awake, alert, and in no respiratory distress. They were intermittently coughing with the production of carbonaceous sputum. Their voices sounded hoarse, but they were controlling secretions and had no stridor. Breath sounds were normal. No other injuries were apparent.

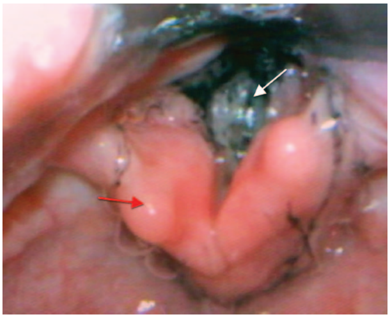

Figure 1-15. Laryngoscopic view. RA = edematous arytenoids, WA = black soot on vocal cords

Differential Dx:

- Inhalation injury to the upper airway and lungs

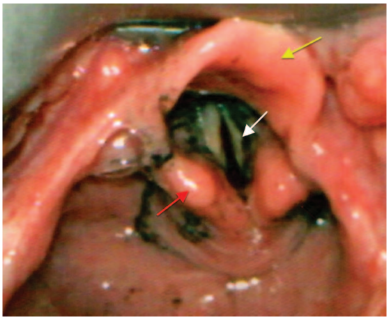

Figure 1-16. Laryngoscopic view. RA = edematous arytenoids, WA = black soot on vocal cords, YA = epiglottis

Emergency Care: These patients were in no respiratory distress but demonstrated evidence for significant inhalation injury with a cough producing carbonaceous sputum, an altered voice, and throat pain. Both patients underwent fiberoptic laryngoscopy under light sedation that revealed evidence for significant upper airway inhalation injury. Rapid sequence intubation was performed in both patients; laryngoscopy revealed swollen and inflamed arytenoids and a swollen and inflamed epiglottis, with black soot covering the vocal cords.

Outcome: These patients were admitted to the pediatric intensive care unit and made uneventful recoveries.

Key Learning Points:

- Signs and symptoms of inhalation injury are an indication for early airway management. Swelling and edema can rapidly progress, making subsequent intubation extremely difficult.
- The clinician should have a low threshold to examine the upper airway with a fiberoptic scope.
- Load an endotracheal tube on to the fiberoptic laryngoscope *before* the first look at the upper airway in order to be prepared to intubate.

Further Reading:

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Case 1-10

Airway foreign bodies: fishbone and toothpick (two patients)

Patient Presentation: Two patients presented with a foreign body sensation in their throat. The first patient stated he had a fishbone stuck in his throat from dinner the previous night. The second patient stated he accidentally swallowed a toothpick. Neither patient complained of difficulty breathing, but both endorsed mild pain with swallowing. Neither patient had an episode of coughing associated with this event.

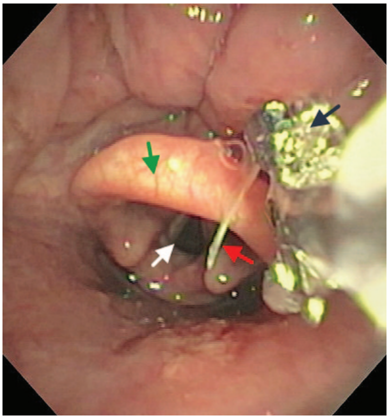

Figure 1-17. Laryngoscopic view. BA = Magill forceps, GA = epiglottis, RA = fishbone, WA = vocal cords

Clinical Features: Both patients were alert, afebrile, and well appearing with no respiratory distress. Neither had stridor, trismus, drooling, or difficulty controlling their secretions.

Differential Dx:

- Foreign body impaction in the mucosa of the oropharynx, vallecula, piriform sinuses, glottis, or esophageal inlet.
- One could also consider mucosal injury from a foreign body that has already passed into the digestive tract.

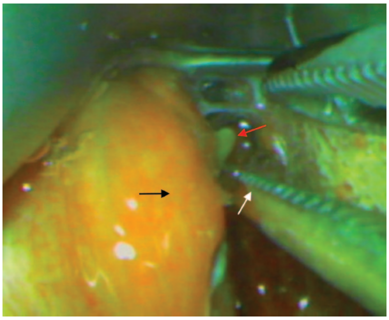

Figure 1-18. Laryngoscopic view. BA = left tonsil, RA = tooth pick, WA = Magill forceps

Emergency Care: The treatment was identical for these two patients. Nebulized lidocaine (50 mg) was administered. A benzocaine 14.0%, butamben 2.0%, and tetracaine hydrochloride 2.0% mixture was sprayed on the posterior pharyngeal wall. Lidocaine cream 4% was generously spread over the entire tongue with a tongue depressor, and the patient was encouraged to swallow as needed. The patients were placed supine, and a video laryngoscope was slowly introduced. The fishbone was stuck in the vallecula, anterior to the epiglottis and anterolateral to the vocal cords. A pair of Magill forceps was used to grab and remove the fishbone. The head of the toothpick was located posterior and inferior to the left tonsil and was grasped and removed with the Magill forceps.

Outcome: Both patients had relief of their foreign body sensation and were discharged home.

Key Learning Points:

- The key to successful foreign body removal from the posterior oropharynx or supraglottic area in an awake patient is adequate topical anesthesia.
- It is important to carefully look in the vallecula and piriform sinuses as foreign bodies can be missed in these locations.
- If no foreign body is located, either the foreign body has already passed into the gastrointestinal tract, or the physician was unable to visualize it. Additional diagnostic imaging can be performed, including computed tomography (CT) or magnetic resonance imaging (MRI) scans, depending on the nature of the foreign body.
- Complications of fishbone ingestion include migration in the paraglottic space, perforation of the common carotid artery, perforation of a Meckel diverticulum, appendicitis, small bowel perforation, and embedding in the tongue.

Further Reading:

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Koay CB, Herdman RC. Nasendoscopy guided removal of fish bones from the base of tongue and the vallecula. *J Laryngol Otol*. 1995;109(6):534-535.

Sakaida H, Chiyonobu K, Ishinaga H, Takeuchi K. Use of a rigid curved laryngoscope for removal of a fish bone in the hypopharynx. *Case Rep Otolaryngol*. 2016;2016:9689521.

Case 1-11

Airway obstruction from food

Patient Presentation: A nursing home resident presented after a choking episode that started while eating and subsequent loss of consciousness en route to the hospital.

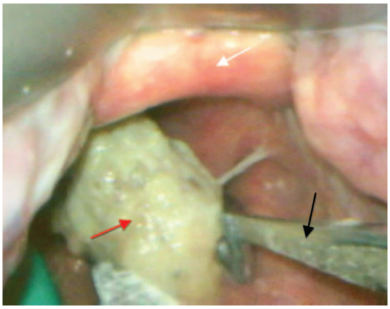

Figure 1-19. Laryngoscopic view. BA = Magill forceps, RA = obstructing food (sausage), WA = epiglottis

Clinical Features: This elderly patient presented with a markedly decreased level of consciousness in severe respiratory distress. Agonal respiratory effort was present. Bag-valve-mask ventilation was ineffective.

Differential Dx:

- An upper airway foreign body was most likely given the history and presentation.
- Other possibilities included angioedema from allergic reaction, laryngospasm, and an infectious etiology such as epiglottitis.

Emergency Care: IV succinylcholine and etomidate were immediately administered, and video laryngoscopy was performed. A large piece of sausage was sitting on top of the vocal cords. It had a ball valve motion associated with the patient's agonal respiratory attempts, being sucked into the glottis opening with inspiration, and pushing off the glottis during expiration. The foreign body was removed with Magill forceps from its position just posterior to the epiglottis.

Outcome: This patient was lost to follow-up.

Key Learning Points:

- A pair of Magill forceps is a lifesaving piece of equipment for the emergency medicine physician. It needs to be immediately available.

Further Reading:

Eggler D. The Heimlich maneuver: mandatory for nursing home employees. *Geriatr Nurs*. 1987;8(1):26-27.

Kikutani T, Tamura F, Tohara T, Takahashi N, Yaegaki K. Tooth loss as risk factor for foreign-body asphyxiation in nursing-home patients. *Arch Gerontol Geriatr*. 2012;54(3):e431-e435.

Case 1-12

Laryngeal fracture

Patient Presentation: A 44-year-old involved in a high-speed motor vehicle crash presented complaining of chest pain, shortness of breath, and anterior neck pain.

Clinical Features: The patient was awake, alert, and complaining of anterior neck pain. Oxygen saturation was 86%. The patient had an altered voice without stridor. There was swelling and palpable subcutaneous emphysema of the anterior neck. The patient was in mild respiratory distress but had clear breath sounds. He had no neurologic symptoms or signs.

Figure 1-20. Marked anterior neck swelling

Differential Dx:

- The presence of swelling and subcutaneous emphysema indicate injury to the tracheobronchial tree and/or esophagus.

Emergency Care: The patient was double prepped for a surgical airway and orotracheal intubation. He underwent rapid sequence intubation with succinylcholine and etomidate. Laryngoscopy revealed a normal epiglottis but markedly abnormal glottic anatomy. The arytenoids and vocal cords were not visualized. A bougie was carefully inserted into the likely glottic opening with no resistance encountered, and an endotracheal tube was then advanced over the bougie to establish a secure airway. An axial image from a neck CT scan obtained after airway management demonstrates subcutaneous emphysema and fracture of the thyroid cartilage.

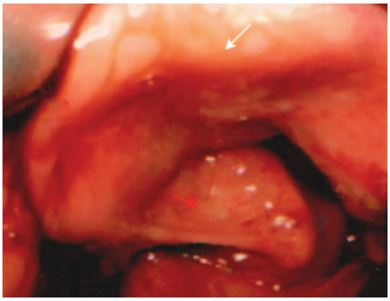

Figure 1-21. Laryngoscopic view. RA = abnormal glottis anatomy, WA = epiglottis

Outcome: The patient had an open reduction and internal fixation of his laryngeal fractures after a tracheostomy was performed. The patient was discharged with a left vocal cord paralysis.

Key Learning Points:

- Signs of laryngeal fracture include neck swelling, subcutaneous emphysema, altered voice, and laryngeal pain.

- Endotracheal intubation using rapid sequence intubation and direct laryngoscopy is an acceptable approach for emergent intubation, but a "double prep" should be performed, ie, the neck prepped and equipment at hand with the physician(s) ready to perform a surgical airway in the event of failure of the initial approach.
- In the setting of traumatic airway injury, it is preferable to use a bougie on the initial attempt instead of an endotracheal tube (with or without stylet) to access the trachea. The bougie has a smaller diameter than the endotracheal tube and is more likely to get past any obstructions from the laryngeal fractures.

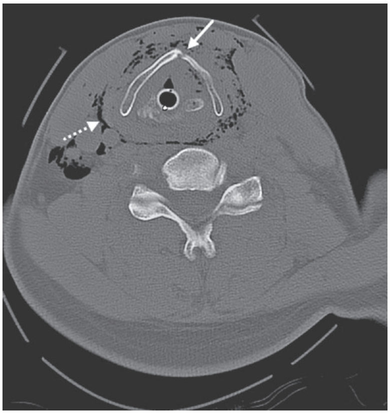

Figure 1-22. Noncontrast neck CT scan. WA = fractured larynx, WDA = subcutaneous air

- It is also preferable to utilize a video laryngoscope with as little manipulation of the upper airway as possible. The bougie and/or endotracheal tube should be gently placed. If an obstruction is encountered, additional force should not be applied; instead, a surgical airway is indicated.

Further Reading:

Kadish H, Schunk J, Woodward GA. Blunt pediatric laryngotracheal trauma: case reports and review of the literature. *Am J Emerg Med*. 1994;12(2):207-211.

Kim JP, Cho SJ, Son HY, Park JJ, Woo SH. Analysis of clinical feature and management of laryngeal fracture: recent 22 case review. *Yonsei Med J*. 2012;53(5):992-998.

Case 1-13

Difficult airway from a cervical spine fracture

Patient Presentation: An elderly patient presented for evaluation after a fall.

Clinical Features: The patient was unresponsive on arrival to an outside hospital. Rapid sequence intubation was performed with extreme difficulty secondary to nonvisualization of the glottis. Post intubation the patient was being adequately ventilated, and a sagittal image from a cervical spine CT scan demonstrated an extension-type cervical spine fracture. The endotracheal tube and balloon were above the glottis, with the tip of the endotracheal tube wedged into soft tissue. The cervical spine was immobilized, and the patient was transferred to our facility without further manipulation of the endotracheal tube.

Figure 1-23. Cervical spine CT scan. WA = cervical spine fracture, WAH = endotracheal tube, WDA = soft tissue lodged into opening of endotracheal tube

Differential Dx:

- The severe cervical spine injury with prevertebral swelling as the etiology for the inability to intubate the trachea.

Emergency Care: Upon arrival to our facility, the patient was being adequately ventilated through the malpositioned endotracheal tube. Fiberoptic laryngoscopy through the endotracheal tube showed the end of the endotracheal tube abutting soft tissue. This correlated with the tube's position on the cervical spine CT scan. Several unsuccessful attempts were made to pass the fiberoptic scope past this obstruction. A controlled cricothyrotomy was performed securing the airway.

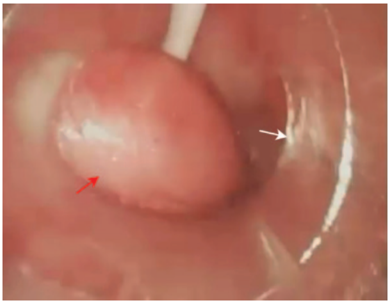

Figure 1-24. Fiberoptic view through the endotracheal tube. RA = soft tissue wedged into endotracheal tube opening, WA = end of endotracheal tube

Outcome: The patient died as a result of this severe cervical spine injury.

Key Learning Points:

- Patients with severe cervical spine injuries can develop significant neck swelling, leading to compression or deviation of the upper airway. This can result in the inability to visualize normal upper airway and glottic anatomy.

Further Reading:

Cleiman P, Nemeth J, Vetere P. A significant cervical spine fracture: think of the airway. *J Emerg Med*. 2012;42(2):e23-e25.

Iizuka S, Morita S, Otsuka H, et al. Sudden asphyxia caused by retropharyngeal hematoma after blunt thyrocervical artery injury. *J Emerg Med*. 2012;43(3):451-456.

Matthews S, Shenvi CL. Airway obstruction and neurogenic shock due to severe cervical spine injury. *Am J Emerg Med*. 2017:35(1):196.e1-196.e2.

Case 1-14

Severe cervical spine injury and difficult airway

Patient Presentation: A 62-year-old man was involved in a motor vehicle crash.

Clinical Features: The patient presented on a backboard; he was awake and alert but quite agitated and combative. He complained of severe neck and upper back pain. He was initially hemodynamically stable.

Differential Dx:

- Multiple traumatic injuries

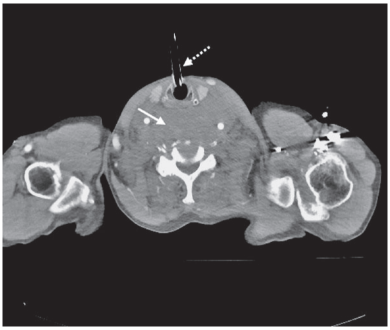

Figure 1-25. Contrast-enhanced neck CT scan. WA = large hematoma, WDA = cricothyrotomy tube

Figure 1-26. Cervical spine CT scan. WA = fracture with ligamentous injury

Emergency Care: IV fentanyl and droperidol did not control his pain or agitation. Early in his evaluation, he sat upright, screaming about his neck. He was laid back down and noted to be apneic and quickly became hypoxic. Bag-valve-mask ventilation was effective with improved oxygen saturations. The initial attempt at rapid sequence, orotracheal intubation was unsuccessful as the epiglottis was the only anatomic structure visualized in the bloody oropharynx. The emergency physician attempted to slip the bougie under the epiglottis but was met with firm resistance. Bag-valve-mask ventilation was restarted; however, severe airflow resistance was encountered, and the patient was now unable to be ventilated in this manner. An ILMA was quickly placed but was again ineffective. At this point, a cricothyrotomy was initiated. External examination of the neck prior to the cricothyrotomy incision revealed severe swelling and a very tense neck to palpation. The cricothyrotomy was accomplished readily, and the patient was effectively ventilated.

Outcome: An axial image from a contrast-enhanced neck CT scan revealed severe prevertebral swelling from a hematoma and the endotracheal tube placed into the cricothyroid membrane. A cervical spine fracture dislocation with significant displacement of C5 on C6 was the etiology for the neck hematoma and difficult airway. He underwent open reduction and internal fixation of his cervical spine injury with halo placement. He had a prolonged hospital and rehabilitation course but was discharged from the hospital neurologically intact with minimal physical and cognitive deficits.

Key Learning Points:

- Severe prevertebral hematoma from a cervical spine injury can result in a difficult airway.
- It is imperative that the emergency physician always be thinking one step ahead in the airway algorithm and be prepared with backup techniques. In the case presented, prompt recognition of the "can't intubate, can't ventilate" situation leads to an early and successful surgical airway.

Further Reading:

Alherabi AZ. Retropharyngeal hematoma. *Saudi Med J*. 2008;29(10):1501-1503.

Darby JM, Halenda G, Chou C, Quinlan JJ, Alarcon LH, Simmons RL. Emergency surgical airways following activation of a difficult airway management team in hospitalized critically ill patients: a case series. *J Intensive Care Med*. 2016. Available at: http://journals.sagepub.com/doi/10.1177/0885066616680594. Accessed May 10, 2018.

Gotlib T. Retropharyngeal hematoma secondary to neck trauma—case report. [in Polish]. *Otolaryngol Pol.* 2008;62(6):800-802.

Heard AB, Green RJ, Eakins P. The formulation and introduction of a 'can't intubate, can't ventilate' algorithm into clinical practice. *Anaesthesia*. 2009;64(6):601-608.

Hubert V, Duwat A, Deransy R, Mahjoub Y, Dupont H. Effect of simulation training on compliance with difficult airway management algorithms, technical ability, and skills retention for emergency cricothyrotomy. *Anesthesiology*. 2014;120(4):999-1008.

Jain U, McCunn M, Smith CE, Pittet JF. Management of the traumatized airway. *Anesthesiology*. 2016;124(1):199-206.

Kuhn JE, Graziano GP. Airway compromise as a result of retropharyngeal hematoma following cervical spine injury. *J Spinal Disord*. 1991;4(3):264-269.

Lown N. Can't intubate, can't ventilate: 'mask–LMA–knife.' *Br J Anaesth*. 2015;115(1):147-148.

Morishima K, Kurita S, Yamama Y, Nakatani K. Two patients with CICV (cannot intubate cannot ventilate) rescued by cricothyrotomy [in Japanese]. *Masui*. 2013;62(12):1406-1409.

Natt BS, Malo J, Hypes CD, Sakles JC, Mosier JM. Strategies to improve first attempt success at intubation in critically ill patients. *Br J Anaesth*. 2016;117(suppl 1): i60-i68.

Park JH, Jeong E-K, Kang D-H, Jeon SR. Surgical treatment of a life-threatening large retropharyngeal hematoma after minor trauma: two case reports and a literature review. *J Korean Neurosurg Soc*. 2015;58(3):304-307.

Sabato SC, Long E. An institutional approach to the management of the 'Can't Intubate, Can't Oxygenate' emergency in children. *Paediatr Anaesth*. 2016;26(8):784-793.

Case 1-15

Swallowed keys

Patient Presentation: A 41-year-old patient presented to the ED for evaluation of altered mental status. The patient had no prior psychiatric history. Paramedics reported the patient had been acting oddly for 20 days and had attempted to swallow both lipstick and quarter coins at the scene. The paramedics gave IM haloperidol 5 mg and midazolam 5 mg to control agitation. In the ED, the patient remained agitated and combative. During the ED arrival process, the patient grabbed a set of keys from a nursing counter and swallowed them.

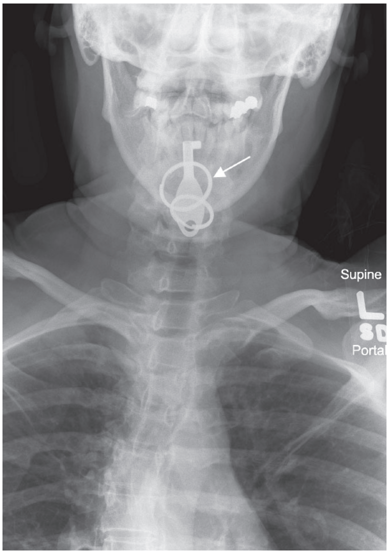

Figure 1-27. Chest x-ray. WA = keys in hypopharynx

Clinical Features: After ingesting the keys, the patient began to drool and could not control her secretions. She appeared to be in distress with gagging. There was no coughing or stridor present. The keys were not visible on simple oropharyngeal examination.

Differential Dx:

- Given the symptoms and signs, the keys could be lodged in several anatomic spaces, including the vallecula, piriform sinus, hypopharynx, glottis, trachea, esophageal inlet, or esophagus.

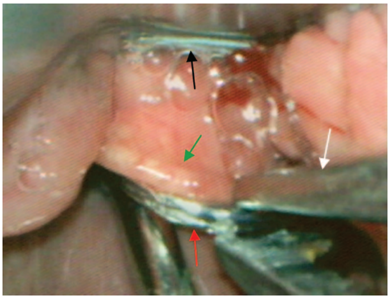

Figure 1-28. Laryngoscopic view. BA = laryngoscope in vallecula, GA = epiglottis, RA = key ring, WA = Magill forceps

Emergency Care: The patient was immediately taken to the ED stabilization room. The patient was sedated with 100 mg of IV ketamine. A portable chest radiograph demonstrated the position of the keys in the hypopharynx or esophageal inlet superior to the trachea. Lidocaine 80 mg was nebulized to anesthetize the upper airway. Using a video laryngoscope placed in the vallecula, the key ring was identified posterior to the epiglottis and in the esophageal inlet. A pair of Magill forceps was used to grasp and remove the key ring.

Outcome: The patient tolerated the sedation and foreign body removal well and was admitted to the psychiatric service.

Key Learning Points:

- Expect the unexpected from agitated and combative patients.
- Low-dose ketamine, when administered by slow IV push to a patient with a normal respiratory effort, generally leaves intact respiratory efforts and allows for safe procedural sedation.
- Hypersalivation is an uncommon side effect of ketamine. Atropine or glycopyrrolate can be utilized if hypersalivation is significant or complicates the procedure.
- Upper airway manipulation, including awake endotracheal intubation or foreign body removal, is aided by any combination of nebulized lidocaine, topical lidocaine cream applied to the tongue, and intranasal lidocaine jelly.

Further Reading:

Higgins GL 3rd, Burton JH, Carter WP, Floor AE. Comparison of extraction devices for the removal of supraglottic foreign bodies. *Prehosp Emerg Care.* 2003;7(3):316-321.

Je SM, Kim MJ, Chung SP, Chung HS. Comparison of GlideScope versus Macintosh laryngoscope for the removal of a hypopharyngeal foreign body: a randomized cross-over cadaver study. *Resuscitation.* 2012;83(10):1277-1280.

Nadir A, Sahin E, Nadir I, Karadayi S, Kaptanoglu M. Esophageal foreign bodies: 177 cases. *Dis Esophagus.* 2011:24(1):6-9.

Strayer RJ, Nelson LS. Adverse events associated with ketamine for procedural sedation in adults. *Am J Emerg Med.* 2008;26(9):985-1028.

Case 1-16

Penetrating tracheal injury

Patient Presentation: A 19-year-old man presented to the ED stabilization room with multiple stab wounds.

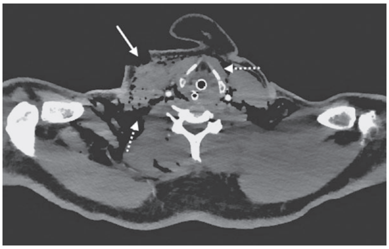

Figure 1-29. Contrast-enhanced neck CT scan. WA = knife entry point, WDA = extensive subcutaneous emphysema

Clinical Features: The patient presented sitting up with severe active hemorrhage from his mouth and head. He was unable to speak with a markedly decreased in level of consciousness consistent with a Glasgow Coma Score of 6. The paramedics were applying pressure on a neck wound, and additional stab wounds to the head and shoulder were noted. Significant subcutaneous neck emphysema was palpable. The heart rate was 150 beats/min.

Differential Dx:
- Vascular injury to the carotid artery and jugular vein
- Injury to airway structures
- Esophageal injury
- Penetrating brain injury
- Cervical spine injury
- Brachial plexus injury

Emergency Care: The patient underwent immediate and uncomplicated rapid sequence intubation with succinylcholine. A bleeding scalp artery was quickly tied off. The massive transfusion protocol was initiated, and tranexamic acid was administered. The patient was taken directly to the operating room.

Outcome: In the operating room, a near complete transection of the trachea was discovered. The endotracheal tube balloon eventrated out through the tracheal defect, but the distal tube remained in the trachea. The tracheal injury was primarily repaired. Complete esophageal and thyroid gland transections were discovered and also repaired primarily. After operative repair of his trachea and esophagus, a contrast-enhanced neck CT scan was obtained that demonstrated extensive subcutaneous emphysema and the stab wound entry site. The patient made a complete recovery.

Key Learning Points:
- Despite the viscerally stimulating (for the physicians) exsanguinating hemorrhage on presentation, management of the airway was, and should be, the initial and primary concern.
- The patient and the intubating physician were fortunate to have the endotracheal tube pass beyond the tracheal injury with the tip of the tube remaining within the trachea. In the event the endotracheal tube could not be passed distal to the injury, a surgical airway would have been the next step.

Further Reading:

Baumgartner FJ, Ayre B, Theuer C. Danger of false intubation after traumatic tracheal transection. *Ann Thorac Surg*. 1997;63(1):227-228.

Valerio P, Ivan M, Francisco R, et al. Survival after traumatic complete laryngotracheal transection. *Am J Emerg Med*. 2008;26(7):837.e3-e4.

Vivero RJ, Saint-Hilaire R, Bhatia RG, Leibowitz JM. Cricotracheal separation after gunshot to the neck: report of a survivor with recovery of bilateral vocal fold function. *J Emerg Med*. 2014;46(2):e27-e30.

Case 1-17

Facial gunshot wound with aspiration of the bullet

Patient Presentation: A 28-year-old suffered a gunshot wound to the face.

Clinical Features: The patient was awake and alert in moderate distress. He had an open mandibular wound and was missing several mandibular teeth. He was leaning forward and bleeding from his mouth. There was no stridor.

Differential Dx:

- Penetrating facial trauma with multiple diagnostic possibilities, the most concerning of which is airway injury

Emergency Care: The patient underwent successful rapid sequence intubation using etomidate and succinylcholine. A head, face, and neck CT scan demonstrated the mandibular fracture, bullet fragments in the posterior oropharynx, and the endotracheal tube displaced to the right due to an adjacent hematoma. A chest radiograph demonstrated bullet fragments within the thorax. A thorough search for additional bullet wounds did not identify an entry point for the thoracic bullet fragment. A bronchoscopy performed by the emergency physician located the bullet fragment within the bronchus intermedius. The fragment had been aspirated into his respiratory tract from the facial gunshot wound.

Outcome: The patient was taken to the operating room where he underwent open reduction and internal fixation of his open mandibular fracture as well as bronchoscopic removal of the bullet fragment. The patient made a full recovery.

Key Learning Points:

- Careful physical examination to determine the number of entry and exit wounds, bullet paths, and number of

Figure 1-30. Facial CT scan. WA = mandible fracture, WAH = displaced endotracheal tube, WDA = bullet fragments

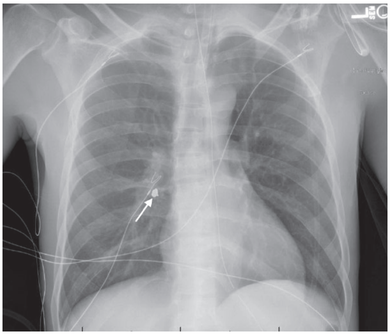

Figure 1-31. Chest x-ray. WA = aspirated bullet fragment

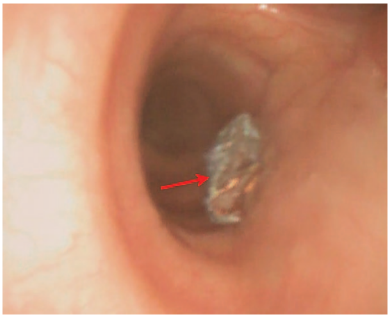

Figure 1-32. Bronchoscopic view. RA = aspirated bullet fragment in bronchus intermedius

bullets encountered is required, especially when radiographs reveal bullets that have not yet been accounted for by physical findings.
- Plain radiographs are helpful in determining the number and path of bullets.
- Utilization of “broad field” radiography is useful in seeing peripheral bullets that might otherwise not have been seen in standard radiographic views.

Further Reading:

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Case 1-18

Severe facial gunshot wound

Patient Presentation: A 46-year-old man presented to the ED with a gunshot wound to the face.

Clinical Features: The patient was laying on his left side, breathing spontaneously through the center of a large mangled lower face just superior to the identified tongue. He was able to follow commands. The patient's face and head were wrapped in gauze with active hemorrhage. The patient was hypoxic but otherwise had stable vital signs.

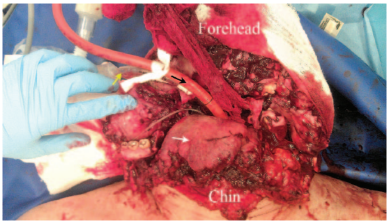

Figure 1-33. Massive facial wounds from gunshot injury post intubation. BA = orogastric tube, WA = tongue, YA = endotracheal tube

Differential Dx:

- Vascular injury
- Upper airway injury
- Central nervous system injury

Emergency Care: The patient was prepped for both rapid sequence intubation and a surgical airway. Since the patient was breathing spontaneously through his massive facial injury and his tongue was recognizable, ketamine was administered, preserving airway reflexes and spontaneous breathing, and the emergency physician attempted to see the glottic opening using video laryngoscopy. Vocal cords were easily identified, and the patient was orotracheally intubated. The patient's face was packed tightly with gauze to control the hemorrhage, and the patient was taken for a head and face CT scan.

Outcome: Although the patient was initially following commands, the head CT scan demonstrated subarachnoid and subdural hemorrhages with basilar skull fractures and pneumocephaly. He had numerous operative procedures over a complicated 7-week hospital course and ultimately died from this devastating injury.

Key Learning Points:

- Patients with severe facial injury can be orotracheally intubated despite distorted anatomy. In a spontaneously breathing patient with airway hemorrhage, air bubbles formed during exhalation can help locate the glottis.
- Administering low-dose ketamine to a patient with normal respiratory status generally preserves airway reflexes and respiratory drive and can be used to take a quick look to see if upper airway landmarks can be visualized. If they are visualized, orotracheal intubation is often successful; otherwise, a surgical airway will need to be performed.

- Massive tissue cavitation and explosive injury, as seen in this patient, is generally the result of a high-velocity (>1500 ft [457 m]/s), rifled round. Handgun bullet velocities (<900 ft [274 m]/s) generally do not cause this degree of injury.

Further Reading:

Demetriades D, Chahwan S, Gomez H, Falabella A, Velmahos G, Yamashita D. Initial evaluation and management of gunshot wounds to the face. *J Trauma*. 1998;45(1):39-41.

Fisher LA, Callaway DW, Sztajnkrycer MD. Incidence of fatal airway obstruction in police officers feloniously killed in the line of duty: a 10-year retrospective analysis. *Prehosp Disaster Med*. 2013;28(5):466-470.

Maurin O, de Régloix S, Dubourdieu S, et al. Maxillofacial gunshot wounds. *Prehosp Disaster Med*. 2015;30(3):316-319.

Orthopoulos G, Sideris A, Velmahos E, Troulis M. Gunshot wounds to the face: emergency interventions and outcomes. *World J Surg*. 2013;37(10):2348-2352.

Sali Bukhari SG, Khan I, Pasha B, Ahmad W. Management of facial gunshot wounds. *J Coll Physicians Surg Pak.* 2010;20(6):382-385.

Shackford SR, Kahl JE, Calvo RY, et al. Gunshot wounds and blast injuries to the face are associated with significant morbidity and mortality: results of an 11-year multi-institutional study of 720 patients. *J Trauma Acute Care Surg*. 2014;76(2):347-352.

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CHAPTER 2 Appendages

Case 2-1

Turtle bite

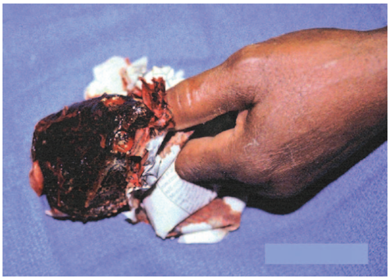

Figure 2-1. The decapitated head of a snapping turtle biting down onto the patient's left thumb

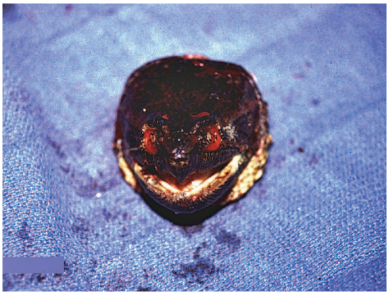

Figure 2-2. The decapitated turtle head after removal from the thumb

Patient Presentation: This patient presented to the emergency department (ED) with the head of a very large snapping turtle biting down on his left thumb. The patient had caught the turtle, decapitated it, and placed the turtle's head into a bucket. A short time later, while reaching into the bucket, he accidentally placed his left thumb into the turtle's mouth, and the turtle head reflexively bit down on his thumb. The patient could not remove the head and presented to the ED for assistance. He was in a mild amount of painful distress.

Clinical Features: The turtle's head was clamped down onto the patient's left thumb. No open wounds were noted.

Differential Dx:
- Musculoskeletal injury
- Fracture
- Open wound
- Tendon or joint injury

Emergency Care: The turtle's head was pried off using two pliers. There were no significant wounds to his finger.

Outcome: The patient was discharged.

Key Learning Points:
- Pliers are yet another tool that the emergency medicine physician should have in the departmental toolbox.

- An anecdotal statement was made by this patient that decapitated turtle heads will continue to reflexively bite down for up to 9 days after decapitation. Non–peer-reviewed, online discussions corroborate this postdecapitation reflex.
- The force of a turtle bite is dependent on several factors, including the size of the turtle and the shape of the turtle head. Forces of up to 400 N have been observed.

Further Reading:

Herrel A, O'Reilly JC, Richmond AM. Evolution of bite performance in turtles. *J Evol Biol.* 2002;15(6):1083-1094.

Case 2-2

Multiple subcutaneous broken needles

Patient Presentation: A 39-year-old male patient presented with bilateral arm swelling, pain, and a fever. He stated he had a long history of IV drug abuse and had broken off many needles in the process of self-injection.

Clinical Features: There were at least 50 recent puncture wounds on the anterior surfaces of his arms, antecubital fossa, and wrists. He had bilateral erythema, swelling, and warmth of his antecubital fossa, forearms, and wrists.

Differential Dx:

- Cellulitis
- Abscess
- Foreign body
- Deep venous thrombosis

Emergency Care: Radiographs of the left and right elbows demonstrated multiple broken needle fragments in the subcutaneous tissues of the antecubital fossae. A chest radiograph demonstrated an embolized needle fragment in the right peripheral lung. The patient was admitted to the hospital for management of his bilateral arm cellulitis.

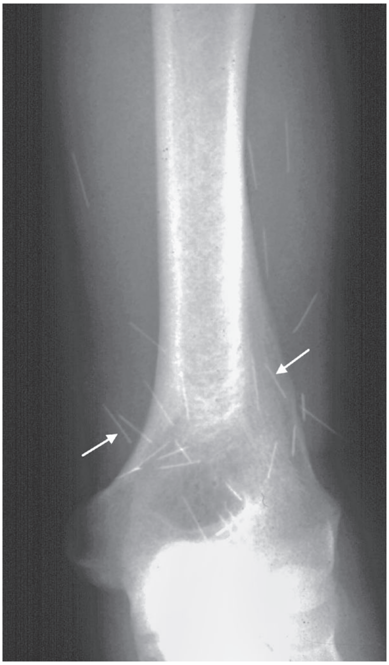

Figure 2-3. Elbow x-ray (left). WA = multiple needle fragments

Reproduced with permission from Brunette DD, Plummer DW. Pulmonary embolization of needle fragments resulting from intravenous drug abuse, *Am J Emerg Med.* 1988 Mar;6(2):124-127.

Outcome: IV antibiotics, elevation, and splinting of his arms resulted in a good therapeutic response. He was discharged, and the cellulitis had resolved by a follow-up clinic appointment 2 weeks later. No intervention was performed for the previously embolized pulmonary needle fragment.

Key Learning Points:

- Metallic foreign bodies may be present and asymptomatic for years, and their presence is not necessarily an indication for removal.
- The decision to remove a broken needle involves the duration the needle has been in place, the location and depth of its position, and the presence of complications (eg, abscess). Broken needles involving vascular structures, nerves, tendons, ligaments, and joints are more likely to require removal.
- Not all patients who abuse IV drugs are adept at self-injection.
- Needles broken within the vascular space can embolize to the heart and/or lungs.

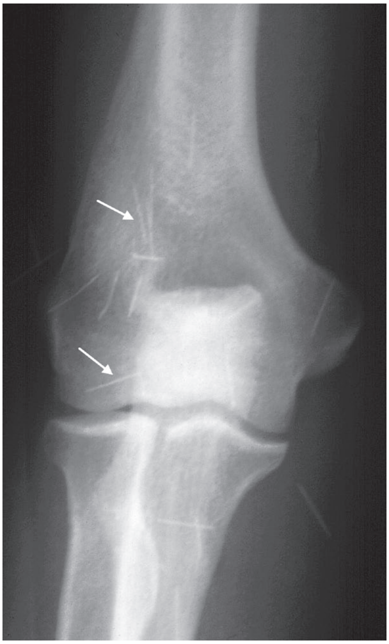

Figure 2-4. Elbow x-ray (right). WA = multiple needle fragments

Reproduced with permission from Brunette DD, Plummer DW. Pulmonary embolization of needle fragments resulting from intravenous drug abuse, *Am J Emerg Med.* 1988 Mar;6(2):124-127.

Figure 2-5. Chest x-ray. WA = embolized needle fragment to right lung

Reproduced with permission from Brunette DD, Plummer DW. Pulmonary embolization of needle fragments resulting from intravenous drug abuse, *Am J Emerg Med.* 1988 Mar;6(2):124-127.

Further Reading:

Brunette DD, Plummer DW. Pulmonary embolization of needle fragments resulting from intravenous drug abuse. *Am J Emerg Med*. 1988;6(2):124-127.

Galdun JP, Paris PM, Weiss LD, Heller MB. Central embolization of needle fragments: a complication of intravenous drug abuse. *Am J Emerg Med*. 1987;5(5):379-382.

Hart BL, Newell JD, Davis M. Pulmonary needle embolism from intravenous drug abuse. *Can Assoc Radiol J*. 1989;40(6):326-327.

Lewis TD, Henry DA. Needle embolus: a unique complication of intravenous drug abuse. *Ann Emerg Med*. 1985;14(9):906-908.

Williams MF, Eisele DW, Wyatt SH. Neck needle foreign bodies in intravenous drug abusers. *Laryngoscope*. 1993;103(1 pt 1):59-63.

Case 2-3

Gila monster bite

Patient Presentation: A young adult presented after being bitten by a Gila monster. By report, a friend of the patient managed to pry the Gila monster from the forearm.

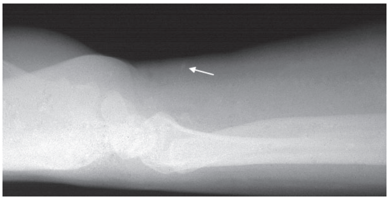

Figure 2-6. Wrist x-ray. WA = retained broken tooth from Gila monster

Clinical Features: The patient was in mild to moderate distress. There was an open wound to the volar surface of the patient's distal forearm, with associated swelling and erythema but no active bleeding. While in the ED, the patient developed hypotension, tachycardia, nausea with vomiting, and diaphoresis. A wrist radiograph demonstrated a small retained tooth from the Gila monster.

Figure 2-7. Gila monster (Shutterstock)

Differential Dx:
- Gila monster bite

Emergency Care: Supportive treatment was given including IV fluids and analgesia. The Gila monster tooth was removed, and the patient was admitted to the intensive care unit.

Outcome: The patient recovered without complication.

Key Learning Points:
- Gila monster bites are quite uncommon because they are slow-moving creatures.
- Clinical manifestations of Gila monster envenomation include hypotension, tachycardia, nausea with vomiting, and diaphoresis.
- A medication introduced in 2005 for the treatment of type 2 diabetes (exenatide) was developed from the venom of Gila monsters.

Further Reading:
Furman BL. The development of Byetta (exenatide) from the venom of the Gila monster as an anti-diabetic agent. *Toxicon*. 2012;59(4):464-471.

Hooker KR, Caravati EM, Hartsell SC. Gila monster envenomation. *Ann Emerg Med*. 1994;24(4):731-735.

Strimple PD, Tomassoni AJ, Otten EJ, Bahner D. Report on envenomation by a Gila monster (Heloderma suspectum) with a discussion of venom apparatus, clinical findings, and treatment. *Wilderness Environ Med*. 1997;8(2):111-116.

Case 2-4

Nail gun finger injury

Patient Presentation: A 35-year-old carpenter presented with a nail gun injury involving his left index finger. The nail was a 4-in (10-cm) galvanized steel (#10) nail, and the wood was 2 × 8 in (5 × 20 cm).

Figure 2-8. RA = nail, WA = 2 × 8 in wooden plank

Clinical Features: The patient was in moderate painful distress. His left index finger was firmly attached to the piece of wood, and on visual inspection the path of the nail appeared to be through the proximal interphalangeal (PIP) joint.

Differential Dx:

- Injury to bone, tendon, ligament, joint, nerve, and vasculature

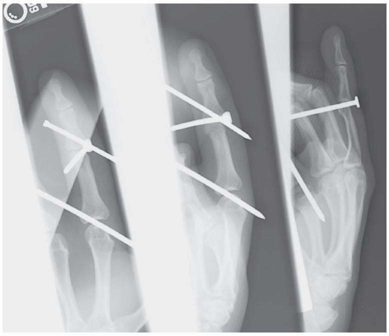

Figure 2-9. Finger radiograph preremoval of nail

Emergency Care: The patient received fentanyl 100 µg IV. A radiograph demonstrated no fractures, but the injury appeared to involve the PIP joint. A digital nerve block was performed. An electric drill obtained from the hospital facilities and maintenance department was used to drill holes alongside the projected course of the nail through the wood. The wood overlying the nail was carefully chiseled out, and the nail removed in a sideways fashion (toward the reader). The nail was then cut and manually extracted from the index finger. Vigorous irrigation of the open joint injury was performed. A post removal radiograph demonstrated no fractures, but there was air in the proximal interphalangeal joint. The patient received cefazolin and was discharged with analgesics and cephalexin.

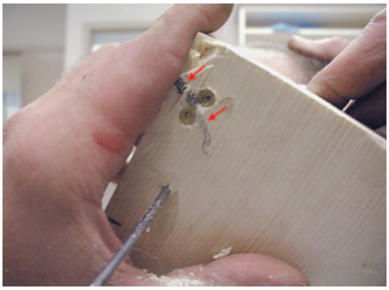

Figure 2-10. RA = projected path of embedded nail

Outcome: The patient had two subsequent ED visits over the next 11 days with no related complications.

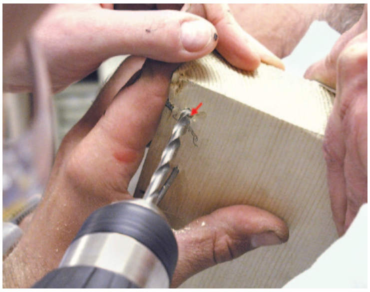

Figure 2-11. RA =drilling along projected path of embedded nail

Key Learning Points:

- Management of this nail gun injury was especially challenging as the nail was long, traversed a joint, and was deeply embedded in wood.

Further Reading:

Dollahite H, Collinge C. Removal of a nail from bone after nail gun injury: a case report and utility of a classic technique. *J Orthop Trauma*. 2012;26(8):e129-e131.

Hussey K, Knox D, Lambah A, Curnier AP, Holmes JD, Davies M. Nail gun injuries to the hand. *J Trauma*. 2008;64(1):170-173.

Ling SJ, Ong NC, North JB. Eighty-seven cases of a nail gun injury to the extremity. *Emerg Med Austral*. 2013;25(6):603-607.

Rhee PC, Fox TJ, Kakar S. Nail gun injuries to the hand. *J Hand Surg*. 2013;38(6):1242-1246.

Figure 2-12. Nail shortened after removal from wood

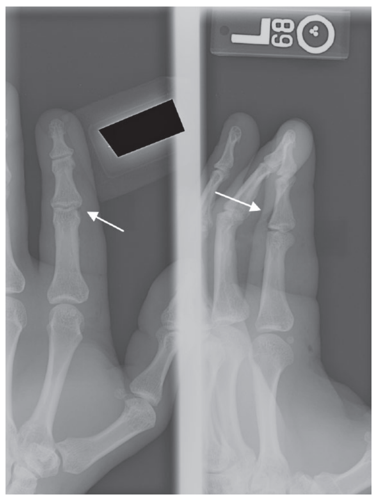

Figure 2-13. Finger radiograph post nail removal. WA = air in the proximal interphalangeal joint

Case 2-5

Nail gun injury to multiple fingers

Patient Presentation: A young carpenter accidentally shot his left hand with a nail gun.

Clinical Features: The patient was in mild distress. There was good color and sensation to his fingertips. The nail went through his index and long fingers and was bent twice approximately 90°.

Differential Dx:

- Bone, joint, tendon, and nailbed injury

Emergency Care: A radiograph demonstrated no bone or joint involvement. A hand-held rotary tool with a metal cutting disk was utilized for removal. The nail was cut between the index and long finger, and the remaining nail fragments were pulled out with a plier. The wounds were irrigated, and the patient was discharged home on antibiotics.

Outcome: The patient did not return to the ED for follow-up.

Key Learning Points:

- This finger nail gun injury was straightforward and relatively easy to manage.
- Shortening the nail can make manipulation and removal easier.

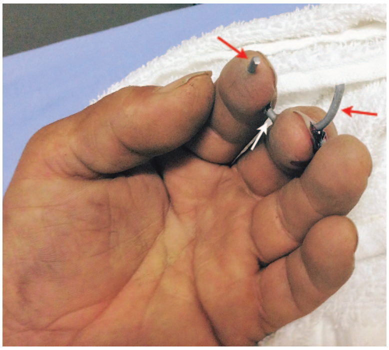

Figure 2-14. RA = nail embedded in two fingers, WA = site where nail was cut

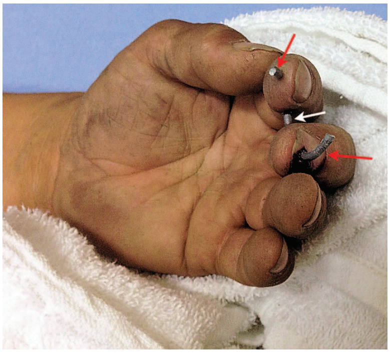

Figure 2-15. RA = nail embedded in two fingers, WA = site where nail was cut

Further Reading:

Dollahite H, Collinge C. Removal of a nail from bone after nail gun injury: a case report and utility of a classic technique. *J Orthop Trauma*. 2012;26(8):e129-e131.

Hussey K, Knox D, Lambah A, Curnier AP, Holmes JD, Davies M. Nail gun injuries to the hand. *J Trauma*. 2008;64(1):170-173.

Ling SJ, Ong NC, North JB. Eighty-seven cases of a nail gun injury to the extremity. *Emerg Med Austral*. 2013;25(6):603-607.

Rhee PC, Fox TJ, Kakar S. Nail gun injuries to the hand. *J Hand Surg*. 2013;38(6):1242-1246.

Case 2-6

Nail gun injury to the hand

Patient Presentation: A young carpenter presented with a nail gun injury to his left hand.

Clinical Features: The patient presented in moderate painful distress. The nail was embedded with significant force, with the web space of the left hand indented and firmly affixed to the wood by the nail.

Differential Dx:

- Ligaments, tendons, muscles, or vascular injury

Emergency Care: Parenteral analgesia was administered. A chisel was used to split the piece of wood from both ends. After the wood was split from both ends, the middle section was split along the same plane that the nail traversed, freeing the hand and nail from the wood. The nail was then pushed backward and pulled out of the hand.

Outcome: The patient was discharged from the ED and did not return.

Key Learning Points:

- There is no one method for treating nail gun injuries to the hand. Creative techniques to minimize collateral damage to tissues are required when the hand is affixed to lumber.

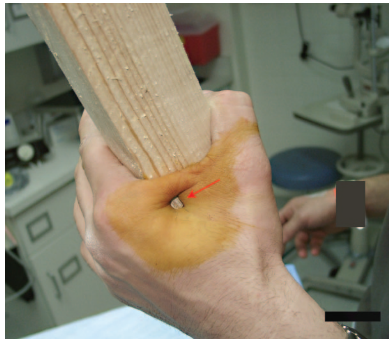

Figure 2-16. RA = Nail forcefully embedded into the wood through the web space

Figure 2-17. Splitting the wood with a hammer and chisel

Figure 2-18. Splitting opposite end of the wood

Figure 2-19. Splitting middle section of the wood

Further Reading:

Dollahite H, Collinge C. Removal of a nail from bone after nail gun injury: a case report and utility of a classic technique. *J Orthop Trauma*. 2012;26(8):e129-e131.

Hussey K, Knox D, Lambah A, Curnier AP, Holmes JD, Davies M. Nail gun injuries to the hand. *J Trauma*. 2008;64(1):170-173.

Ling SJ, Ong NC, North JB. Eighty-seven cases of a nail gun injury to the extremity. *Emerg Med Austral*. 2013;25(6):603-607.

Rhee PC, Fox TJ, Kakar S. Nail gun injuries to the hand. *J Hand Surg*. 2013; 38(6):1242-1246.

Case 2-7

Nail gun injury to the foot

Patient Presentation: A 27-year-old suffered an accidental nail gun injury to his right foot.

Clinical Features: The patient was alert and in moderate pain. The nail entered his work boot on the dorsum of his distal foot and could be visualized exiting the sole of the work boot.

Differential Dx:

- Penetrating injury to bone, joint, tendon, ligament, and soft tissues

Emergency Care: A foot radiograph demonstrated the nail penetrating the proximal phalanx of the great toe. The patient underwent conscious sedation with propofol, and the nail was removed without difficulty using pliers. The patient was given a dose of IV ciprofloxacin and a prescription for oral ciprofloxacin.

Outcome: The patient was followed in the orthopedics clinic and healed without complications.

Figure 2-20. Foot x-ray. WA = nail penetrating through the boot and into the big toe proximal phalanx, WDA = boot clips

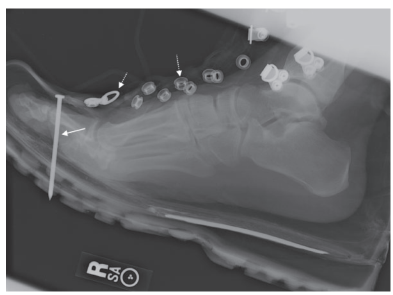

Figure 2-21. Foot x-ray. WA = nail penetrating through the big toe proximal phalanx and into the sole of the boot, WDA = boot clips

Key Learning Points:

- Nail gun injuries to the extremities are common.
- Methods of removal are many and determined by the size and depth of the nail, the anatomic body part involved (eg, bone vs soft tissue), and if the nail is firmly embedded into other material like wood.
- Puncture wounds to the sole of the foot with nails through the bottom of a shoe or sneaker are also very common.
- *Pseudomonas aeruginosa* is a common pathogen in nail puncture wounds suffered to the sole of the foot through a shoe.

Further Reading:

Dollahite H, Collinge C. Removal of a nail from bone after nail gun injury: a case report and utility of a classic technique. *J Orthop Trauma*. 2012;26(8):e129-e131.

Laughlin RT, Reeve F, Wright DG, Mader JT, Calhoun JH. Calcaneal osteomyelitis caused by nail puncture wounds. *Foot Ankle Int*. 1997;18(9):575-577.

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Ridha H, Orakzai SH, Kearns SR, Roche-Nagle G, Keogh P, O'Flanagan SJ. Nail-gun limb injuries. *Ir Med J*. 2002;95(2):50-51.

Rubin G, Chezar A, Raz R, Rozen N. Nail puncture wound through a rubber-soled shoe: a retrospective study of 96 adult patients. *J Foot Ankle Surg.* 2010;49(5):421-425.

Case 2-8

Finger stuck in a tire lug hole

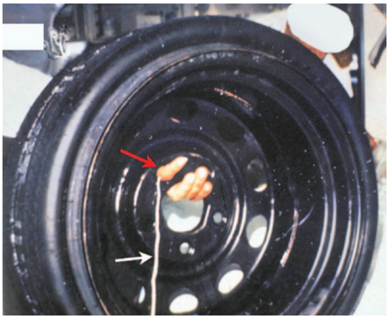

Figure 2-22. RA = index finger stuck in a tire lug hole, WA = vasoline gauze strip

Patient Presentation: This patient presented with his right index finger stuck in a lug hole of a normal-sized automobile tire. The patient was changing his tire when he placed his finger through the lug hole and subsequently could not withdraw his finger. He presented to the ED with a couple of friends helping him to carry the tire.

Clinical Features: The patient was in mild painful distress. The finger was firmly lodged through the lug hole and was significantly swollen. Although there were no open wounds, the sharp edges of the lug hole were in danger of cutting into his finger.

Differential Dx:

- Vascular compromise from compression injury
- Musculoskeletal injury
- Laceration of the finger

Emergency Care: Proximal radial and median nerve blocks were performed for anesthesia. Numerous personnel were required to perform the following maneuvers to free the finger. The tire was supported and elevated, and the distal finger was compressed with twill tape to promote drainage of the edema. Several gauze strips soaked with petroleum jelly (0.5 in [1.27 cm] wide by 3 ft [0.91 m] long) were pushed through the space between the lug hole and the finger with a hemostat. These petroleum impregnated gauze strips were pulled tightly from both ends. With continuous compression of the distal finger, the tire was rotated in a back and forth motion over the gauze strips, and the finger was slowly pushed backward through the lug hole until freed.

Outcome: No significant musculoskeletal or vascular injury was sustained.

Key Learning Points:

- *"Necessity is the mother of invention"*—an English phrase without a known author.

Further Reading:

Sclar D. How to change a tire. Available at: http://www.dummies.com/home-garden/car-repair/how-to-change-a-tire/. Accessed May 19, 2018.

Case 2-9

Finger stuck in steel pipe

Patient Presentation: A 5-year-old child placed her left little finger into a hole in a steel railing at an indoor sporting arena and could not remove it. The building's maintenance workers were able to cut a section of the pipe containing the trapped finger.

Figure 2-23. RA = little finger stuck in a hole of a steel pipe

Clinical Features: The child was in no distress. Her left little finger was firmly entrapped in the steel pipe. No bleeding or open wounds were present.

Differential Dx:

- No surprises here.

Emergency Care: Efforts to gently pull the finger out using lubrication were unsuccessful and painful. The patient was taken to the dentistry clinic. She was sedated with ketamine. A wedge-shaped section of pipe was cut out with a high-speed dental drill. Cold water was continually poured onto the metal pipe to prevent heating and thermal burns.

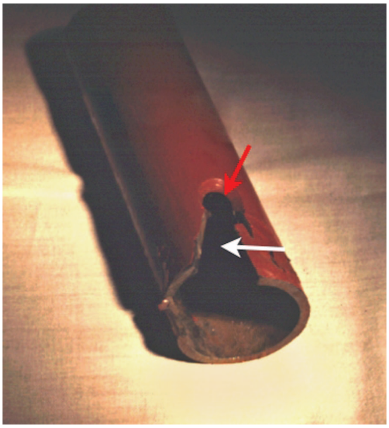

Figure 2-24. RA = original hole in the pipe where the finger was trapped, WA = wedge section cut out of pipe to free the finger

Outcome: The patient tolerated the sedation and finger extraction well.

Key Learning Points:

- This case happened before the advent of portable hand-held high-speed rotary tools with metal cutting bits or disks that are now typically used for such purposes in our ED.
- In the author's experience encompassing 36 years of emergency medicine practice, human beings appear to have an innate propensity to stick body parts into holes, openings, and cracks without apparent reason or purpose.

Further Reading:

Etetafia MO, Nwajeiwajei CO. Successful removal of strangulating metal penile ring using a dental handpiece. *BMJ Case Rep*. 2014. pii: bcr2014205030.

Gan W, Guo HQ, Zeng LQ, et al. Treatment of penile strangulation and sexual psychological analysis of the patients [in Chinese]. *Zhonghua Nan Ke Xue*. 2011; 7(6):535-537.

Sazwan RS, Hashairi F, Shaik Farid AW, Abu Yazid MN. The use of dental drill in removing entrapped finger by metal ring in emergency department. *Med J Malaysia*. 2012;67(3):349-350.

Case 2-10

High-pressure hand injection injury with paint sprayer

Patient Presentation: A 46-year-old man presented with left hand pain after sustaining a high-pressure injection injury. He was adjusting the tip of a pneumatic paint sprayer when his left palm received an 800 to 1000 lb per square in (PSI) injection injury.

Figure 2-25. RA = site of high-pressure injection injury

Clinical Features: The left hand and index, long, and ring fingers were moderately swollen. There was a circular entrance wound. The patient complained of numbness in his long and ring fingers. Finger examination was moderately painful, and he exhibited markedly decreased range of motion, which was concerning for compartment syndrome.

Differential Dx:

- Nerve, bone, tendon, joint, and vascular injury

Figure 2-26. Hand x-ray. WA = foreign material (paint)

Emergency Care: The patient was treated with IV cefazolin and opioid. A plain radiograph revealed no bony or joint abnormalities, but it did demonstrate foreign material. The patient was taken directly to the operating room.

Outcome: The patient had two orthopedic washout procedures in a 24-hour time period. Intraoperatively, white oil-based paint was scattered through the volar aspects of his hand, and in particular the web space of the index finger. This paint was tediously removed during both procedures trying to avoid injury to adjacent nerve and tendons. Two dorsal fasciotomies over the second and fourth metacarpal bones were also performed during the initial operative procedure. Twelve days after the initial injury he had mild swelling of his hand, no signs of infection, and almost full range of motion, although he was densely hypesthetic over his index finger web space.

Key Learning Points:

- High-pressure injection injuries can result in significant injury and permanent dysfunction.
- High-pressure injuries can present initially with modest outward clinical signs.

Further Reading:

Amsdell SL, Hammert WC. High-pressure injection injuries in the hand: current treatment concepts. *Plast Reconstr Surg*. 2013;132(4):586e-591e.

Chaudhry S, Gould S, Gupta S. High-pressure paint gun injection injury to the palm. *Am J Orthoped*. 2013;42(8):379-382.

Hart RG, Smith GD, Haq A. Prevention of high-pressure injection injuries to the hand. *Am J Emerg Med*. 2006;24(1):73-76. ISSN: 0735-6757.

Hogan CJ, Ruland RT. High-pressure injection injuries to the upper extremity: a review of the literature. *J Orthop Trauma*. 2006;20(7):503-511.

Case 2-11

High-pressure injection injury of the finger

Patient Presentation: A 25-year-old man presented with a high-pressure injection injury of his right long finger. The injury involved clean tap water injection at a pressure of 6000 PSI.

Clinical Features: The patient was in mild to moderate painful distress. His right long finger had a single wound, and the entire finger was swollen with tenderness to palpation extending to the base of the finger.

Differential Dx:

- High-pressure injection injury with bone, joint, or soft tissue injury

Emergency Care: A lateral finger radiograph demonstrated soft tissue edema with air and fluid. The patient received analgesia and was sent to the operating room for incision and drainage.

Outcome: The patient underwent two separate incision and drainage procedures with closure of all surgical wounds. The patient had a slow but uncomplicated recovery of finger function.

Key Learning Points:

- High-pressure injection accidents result in significant injuries.
- The initial clinical appearance can underestimate the degree of injury.
- Prognosis depends on type of material injected, location of injection, injection pressure, and the timing and success of surgical debridement.
- Many patients have significant residual sequelae.

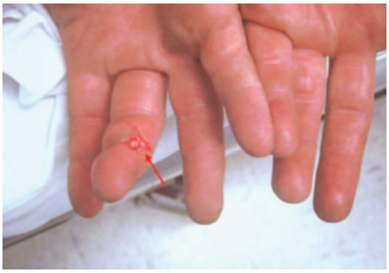

Figure 2-27. RA = high pressure injection site

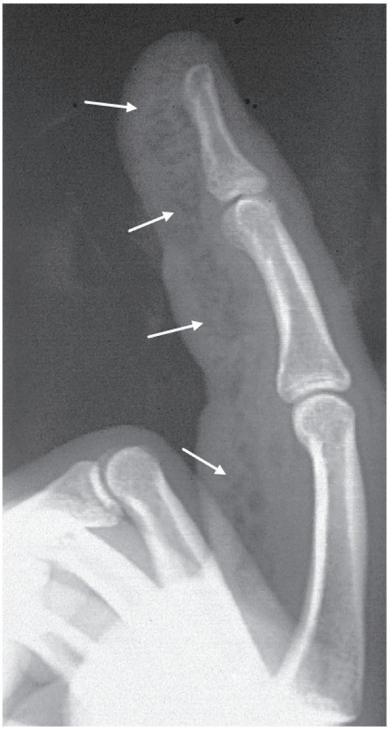

Figure 2-28. Finger x-ray. WA = soft tissue edema with air and fluid

Further Reading:

Amsdell SL, Hammert WC. High-pressure injection injuries in the hand: current treatment concepts. *Plast Reconstr Surg*. 2013;132(4):586e-591e.

Cannon TA. High-pressure injection injuries of the hand. *Orthop Clin North Am*. 2016;47(3):617-624.

Pappou IP, Deal DN. High-pressure injection injuries. *J Hand Surg*. 2012; 37(11):2404-2407.

Temiz G, Şirinoğlu H, Güvercin E, et al. A useful option to obtain maximal foreign body removal and better prognosis in high pressure injection injuries: negative pressure wound therapy with instillation. *J Plast Reconstr Aesthet Surg*. 2016;69(4):570-572.

Verhoeven N, Hierner R. High-pressure injection injury of the hand: an often underestimated trauma: case report with study of the literature. *Strategies Trauma Limb Reconstr*. 2008;3(1):27-33.

Case 2-12

Iguana bite

Patient Presentation: Young male presented for evaluation of a wound caused by an iguana bite. The patient stated that the iguana's teeth were clamped down on his hand. The iguana was subsequently beaten to death with a baseball bat in order to release its clinched teeth.

Figure 2-29. Iguana bite wound (dorsal-lateral)

Clinical Features: The iguana bite wound on the left hand was significant, but there were no motor or sensory deficits, as well as no joint involvement.

Differential Dx:

- Bone, joint, nerve, tendon, ligament, or vascular injury

Emergency Care: The wounds were vigorously irrigated with normal saline, and the two gaping wounds were loosely approximated with sutures. The patient was started on antibiotics.

Figure 2-30. Iguana bite wound (volar-hypothenar)

Outcome: The patient was lost to follow-up.

Key Learning Points:

- Iguanas do bite, usually because of a provocative action by a human.

Further Reading:

Hsieh S, Babl FE. Serratia marcescens cellulitis following an iguana bite. *Clin Infect Dis.* 1999;28(5):1181-1182.

Merin DS, Bush SP. Severe hand injury following a green iguana bite. *Wilderness Environ Med.* 2000;11(3):225-226.

Case 2-13

Bow and arrow injury

Patient Presentation: A 46-year-old man was practicing archery prior to deer hunting season. In the process of loading the high-powered crossbow, the patient accidentally shot himself in the left forearm.

Clinical Features: The patient was in mild painful distress. Color, motor, and sensory examination was intact distal to the injury. An arrow entered and exited the left forearm.

Differential Dx:
- Vascular, nerve, joint, and musculoskeletal injury

Emergency Care: A forearm radiograph revealed the track of the arrow and no bony involvement. The entrance and exit wounds were infiltrated with lidocaine, and the patient was given IV midazolam and fentanyl. The sharp point of the arrow was cut off, and the arrow was pulled backward through the wound. A Penrose drain was placed along the entire tract, the wounds were left open, and the patient was discharged on cephalexin.

Outcome: The patient was discharged from the ED, and no subsequent ED visits occurred.

Key Learning Points:
- The case demonstrates the unusual accidental shooting of oneself with a crossbow.
- One of the more common mechanisms for hunters to injure themselves while bow hunting is falling out of their deer stand.
- There are two cases in the forensic medical literature of successful suicide using a crossbow.

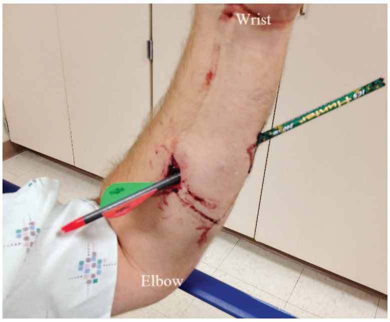

Figure 2-31. Penetrating arrow injury to the forearm

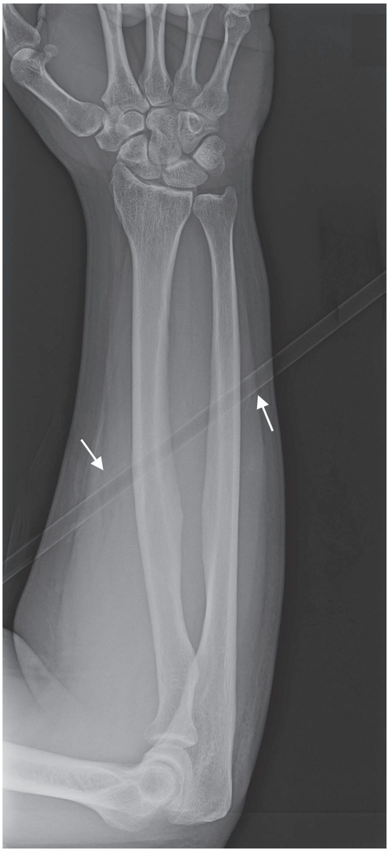

Figure 2-32. Forearm x-ray. WA = arrow

Further Reading:

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Mann DL, Littke N. Shoulder injuries in archery. *Can J Sport Sci.* 1989;14(2):85-92.

Palsbo SE. Epidemiology of recreational archery injuries: implications for archery ranges and injury prevention. *J Sports Med Phys Fitness*. 2012;52(3):293-299.

Vanwormer JJ, Holsman RH, Petchenik JB, Dhuey BJ, Keifer MC. Epidemiologic trends in medically-attended tree stand fall injuries among Wisconsin deer hunters. *Injury*. 2016;47(1):220-225.

Wilson CI, Altschul S, Mead A, Flannagan LM. Bloodstain pattern analysis in a case of suicide with a compound bow and arrow. *Am J Forensic Med Pathol*. 2004;25(1):80-82.

Zatopkova L, Hejna P. Fatal suicidal crossbow injury—the ability to act. *J Forensic Sci*. 2011;56(2):537-540.

Case 2-14

Gangrene from frostbite

Patient Presentation: A 60-year-old man presented initially with frostbite of his feet. He was admitted and treated for third- and fourth-degree frostbite and discharged from the hospital. The patient had significant psychiatric disease, was noncompliant with his care plan, and was lost to follow-up. He returned to the ED 2 months later for continued bilateral foot pain.

Figure 2-33. Severe frostbite injury

Clinical Features: The patient was afebrile and in no painful distress. Removal of his boots revealed advanced gangrene of both feet, exposed metatarsals, and the nonadherent dressing from his initial hospitalization adhered to necrotic tissue.

Differential Dx:
- Bilateral necrotic gangrene

Emergency Care: The patient was started on antibiotics and admitted to the hospital.

Outcome: The patient underwent below-the-knee and left transmetatarsal amputations.

Key Learning Points:
- Psychosocial determinants of health play a critical role in the delivery and success of medical care.

Further Reading:

Gonzaga T, Jenabzadeh K, Anderson CP, Mohr WJ, Endorf FW, Ahrenholz DH. Use of intra-arterial thrombolytic therapy for acute treatment of frostbite in 62 patients with review of thrombolytic therapy in frostbite. *J Burn Care Res.* 2016;7(4):e323-e334.

Grieve AW, Davis P, Dhillon S, Richards P, Hillebrandt D, Imray CH. A clinical review of the management of frostbite. *J R Army Med Corps*. 2011;157(1):73-78.

Heil K, Thomas R, Robertson G, Porter A, Milner R, Wood A. Freezing and non-freezing cold weather injuries: a systematic review. *Br Med Bull.* 2016;117(1):79-93.

Pinzur MS, Weaver FM. Is urban frostbite a psychiatric disorder? *Orthopedics*. 1997;20(1):43-45.

Case 2-15

Diabetic wound gangrene

Patient Presentation: This patient had a severe congenital neuropathy. She suffered an accidental lower leg laceration and self-treated her injury by applying a gauze dressing, followed by multiple layers of increasingly tighter ace wrap applications without examining her wound. A little over 2 weeks later, she presented to the ED for her first evaluation of this injury. The tight ace wraps were removed revealing advanced gangrene.

Figure 2-34. RA = advanced foot gangrene, WA = exposed tibia

Clinical Features: There was a sharply demarcated level of complete tissue loss at the proximal edge of the ace wrap. The wound was mummified, completely dry without odor, and without signs of significant infection.

Differential Dx:
- Ongoing infection and vascular insufficiency above the line of demarcation

Emergency Care: No specific treatment was rendered in the ED.

Outcome: The patient was admitted and underwent a below-the-knee amputation without complication.

Key Learning Points:
- Emergency physicians never know what is underneath a dressing. Be prepared for a surprise, and always wear personal protective equipment.

Further Reading:

Haji Zaine N, Hitos K, Vicaretti M, Fletcher JP, Begg L, Burns J. Characteristics of non-diabetic foot ulcers in Western Sydney, Australia. *J Foot Ankle Res*. 2016;9:6.

Peter-Riesch B. The diabetic foot: the never-ending challenge. *Endocrine Dev*. 2016;31:108-134.

Case 2-16

Self-trephination of subungual hematoma

Patient Presentation: A young male presented complaining of finger pain. He had suffered a crush injury to his right long finger 1 day prior. About 2 hours before coming to the ED, using an electric drill with a small diameter bit, he drilled a hole in his nail plate to release the subungual hematoma. This resulted in significant improvement in his pain. However, he became concerned about the risk of infection and thus presented to the ED.

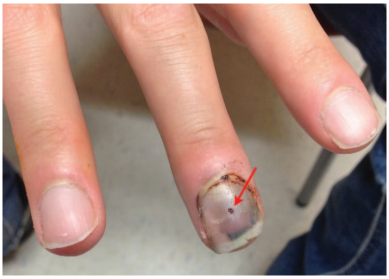

Figure 2-35. RA = trephination hole made by a home electric drill

Clinical Features: The patient was in no painful distress. A well-placed trephination hole was evident, and there was no sign of infection and no active bleeding.

Differential Dx:
- Bony injury
- Risk of subsequent infection

Emergency Care: The nail plate was irrigated, and the patient started on outpatient antibiotics.

Outcome: The patient did not return to the ED.

Key Learning Points:
- Management of nail bed injuries, lacerations, and subungual hematomas has been historically controversial but appeared to be easily and effectively self-treated at home by this patient.

Further Reading:

Gellman H. Fingertip-nail bed injuries in children: current concepts and controversies of treatment. *J Craniofac Surg*. 2009;20(4):1033-1035.

Patel L. Management of simple nail bed lacerations and subungual hematomas in the emergency department. *Ped Emerg Care*. 2014;30(10):742-745. ISSN: 1535-1815.

Case 2-17

Conradi-Hünermann disorder

Patient Presentation: A middle-aged patient presented for upper respiratory symptoms.

Clinical Features: The patient was awake, well appearing, and in no respiratory distress. The lungs were clear to auscultation. The patient was noted to be short-statured with bilateral hand deformities.

Figure 2-36. Conradi-Hünermann disorder

Differential Dx:
- Viral upper respiratory illness
- Pharyngitis
- Pneumonia
- Reactive airway disease

Emergency Care: The patient was treated symptomatically for a viral upper respiratory illness. When asked about her hands, the patient stated she had Conradi-Hünermann disorder.

Outcome: The patient was treated for a viral upper respiratory illness. The patient had no prior medical records at our institution, and the definitive diagnosis of Conradi-Hünermann syndrome had been made at an outside institution. The patient was lost to follow-up.

Key Learning Points:
- Conradi-Hünermann disorder is a rare congenital anomaly caused by mutations of the emopamil-binding protein (EBP) gene. It affects women almost exclusively.
- Clinical expression is widely variable but includes skeletal malformations, skin abnormalities, cataracts, and short stature.
- Deposition of calcium near the epiphyseal heads of long bones is characteristic. Shortening of the humerus and femur can also occur.
- Treatment is directed at specific symptoms and includes orthopedic, ophthalmologic, and dermatologic care.

Further Reading:

Capelozza Filho L, de Almeida Cardoso M, Caldeira EJ, Capistrano A, da Silva Cordeiro A, Rocha D. Ortho-surgical management of a Conradi-Hünermann syndrome patient: rare case report. *Clin Case Rep*. 2015;3(8):694-701.

Jeong HS, Funari T, Gordon K, Richard G, Agim NG. Concurrent chondrodysplasia punctata type 2 (Conradi-Hünermann-Happle Syndrome) and ichthyosis vulgaris in teenaged twin girls. *Pediatr Dermatol*. 2017;34(5):e245-e248.

Kabirian N, Hunt LA, Ganjavian MS, Akbarnia BA. Progressive early-onset scoliosis in Conradi disease: a 34-year follow-up of surgical management. *J Pediatr Orthoped*. 2013;33(2):e4-e9.

Omobono E, Goetsch W. Chondrodysplasia punctata (the Conradi-Hünermann syndrome). A clinical case report and review of the literature [in Italian]. *Minerva Pediatr*. 1993;45(3):117-121.

Case 2-18

Impaled tree branch in leg

Patient Presentation: A 24-year-old man was driving a golf cart in a wooded area when a large tree branch reportedly came up through the floor of the golf cart and impaled his left leg.

Clinical Features: The patient was in moderate to severe painful distress with stable vital signs. A 2-in (5-cm) diameter tree branch was firmly embedded in his left knee. The patient's skin was tenting in the posterior proximal lateral thigh. His dorsalis pedis and posterior tibial pulses were intact, as was his distal sensation.

Figure 2-37. RA = tree branch impaled into the medial left knee

Differential Dx:
- Vascular, neurologic, musculoskeletal, and joint injury

Emergency Care: The patient was given opioids and antibiotics and transferred to the operating room.

Outcome: The tree branch was carefully removed. There were no injuries to any major blood vessels or nerves. The knee joint was not involved. The wound was incised and drained. The patient was taken back to the operating room several times for additional washout procedures. He left the hospital with a wound vacuum in place. It took approximately 3 months for the wound to completely heal.

Key Learning Points:
- Data from the National Electronic Injury Surveillance System Database estimated 84,018 golf cart related injuries from 2013 to 2017. Injuries to children (age <14) accounted for 26.6% of the cases.
- The highest number of golf cart associated injuries is in 10- to 14-year-old males.

Further Reading:
McGwin G, Zoghby JT, Griffin R, Rue LW 3rd. Incidence of golf cart-related injury in the United States. *J Trauma*. 2008;64(6):1562-1566.

Miller B, Yelverton E, Monico J, Replogle W, Jordan JR. Pediatric head and neck injuries due to golf cart trauma. *Int J Pediatr Otorhinolaryngol*. 2016;88:38-41.

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Watson DS, Mehan TJ, Smith GA, McKenzie LB. Golf cart-related injuries in the U.S. *Am J Prev Med*. 2008;35(1):55-59.

Case 2-19

Metal pipe impaled into the lateral knee

Patient Presentation: A 25-year-old man was driving a car that struck a flatbed truck carrying long pieces of wood wrapped in metal. The patient was wearing a seatbelt and was found by first responders hemorrhaging from a leg wound. One of the pieces of metal had speared the car and then impaled the patient's lower left extremity. A tourniquet was placed, the ends of the post were cut, and the patient was extricated. Fentanyl and ketamine were given to control pain, and he was transported to the hospital.

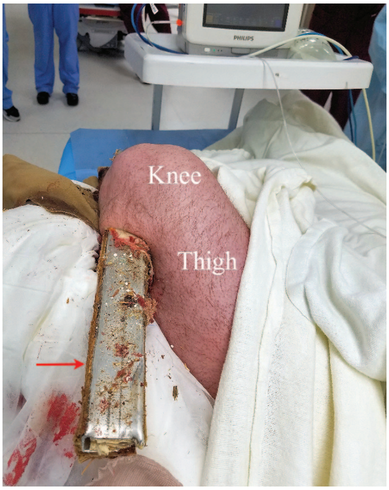

Figure 2-38. RA = metal post impaled into the lateral knee (superior view)

Clinical Presentation: The patient was in severe pain. Blood pressure was normal, but the patient was tachycardic. The metal post entered the distal lateral thigh and exited the proximal lateral knee. Distal pulses were intact to the left lower extremity, and the patient had grossly normal sensation.

Differential Dx:

- Multiple blunt traumatic injuries
- Penetrating injury to the left leg with possible bone, nerve, ligament, tendon, muscular, joint, and vascular injury

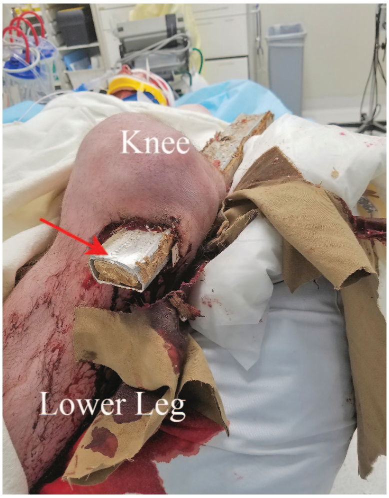

Figure 2-39. RA = metal post impaled into the lateral knee (inferior view)

Emergency Care: Given the extreme pain and the need for further diagnostic imaging with subsequent operative intervention, the patient underwent rapid sequence intubation followed by sedation. A knee radiograph shows the metal post, a distal femur fracture, and the shattered proximal tibia. Antibiotics were administered in the ED, and the tourniquet remained in place. The patient had multiple computed tomography (CT) scans that revealed no significant central nervous system, chest, abdomen, or pelvis injuries, and he was taken to the operating room.

Outcome: The patient had a complicated orthopedic course, including initial removal of the foreign body, multiple operative procedures for open reduction and external fixator placement for his femur and tibia fractures, repair of an avulsed patellar tendon, and multiple washout procedures for postoperative wound infection. He remained in physical rehabilitation for a prolonged period of time.

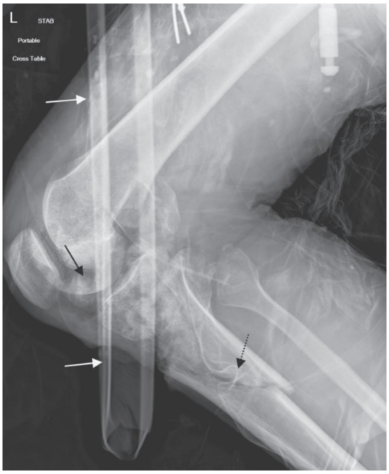

Figure 2-40. Knee x-ray. BA = fracture of distal femur, BDA = fracture of proximal tibia, WA = metal post

Key Learning Points:

- The impaled large foreign body was visually dramatic and potentially distracting for the physician. Instead, priority should be given to the organized and sequential evaluation of this patient with blunt and penetrating injuries. The emergency physician must always adhere to the ABCs of critical trauma care: *A*irway, *B*reathing, and *C*irculation (including hemorrhage control).
- Tourniquets can be left secured in the ED during the initial resuscitation and do not need to be taken down immediately upon presentation to the ED.

Further Reading:

Morgan T, Butler S, Schwab CW. Impalement injury: case study and management guidelines. *Crit Care Nurse*. 1988;8(3):82-85.

Murphy CG, Butler JS, Green C, Egan BM, Sparkes J. Lower limb impalement injury with reinforced steel cables. *Am Surg*. 2013;79(2):E63-E64.

Sarwark JP, McCarthy DM, Pearce C, Seth A, Issa N. Leg and abdominal impalement with rebar. *Am J Emerg Med*. 2015;33(8):1110.e1-e2.

Case 2-20

Pyrotechnic rocket (firework) injury

Patient Presentation: A 16-year-old presented for evaluation of injuries suffered when a pyrotechnic rocket (firework) exploded in close proximity to him on the Fourth of July.

Clinical Features: The patient was in moderate to severe painful distress. There was a large 10-cm open and gaping wound to the left anterior thigh with mild venous bleeding. The distal lower extremity examination was unremarkable.

Differential Dx:
- Vascular, nervous, muscular, joint, or bony injury

Emergency Care: A left femur radiograph demonstrated a comminuted femur fracture with the retained rocket foreign body. The patient received opioid analgesia and an IV antibiotic and was admitted to the hospital.

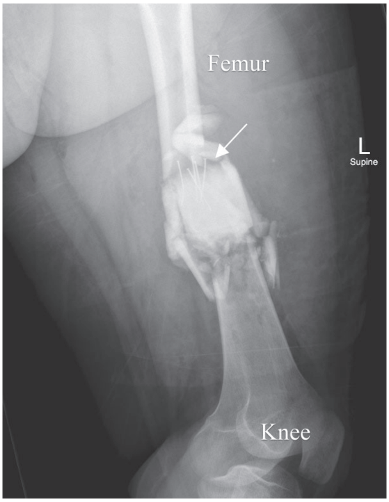

Figure 2-41. Femur x-ray. WA = retained pyrotechnic rocket with a femur fracture

Outcome: The patient had a long hospital course including nine separate operations. Subsequent to the initial hospitalization, the patient had five additional scheduled admissions to the hospital for follow-up operative procedures. Two years after the original injury, the patient was using a brace and crutches with weight-bearing as tolerated and undergoing physical therapy.

Key Learning Points:
- From 1990 to 2014, an estimated 136,991 patients under the age of 20 years presented to United States EDs for evaluation of firework-related injuries. Of note, the annual pediatric injury rate from fireworks decreased by 30% over that same time period.
- Seventy-six percent of pediatric firework injures occurred in males with an average age of 11 years.
- The hands (30%) are the most frequently injured body part, with burns accounting for 60% of hand injuries.

Further Reading:

Billock RM, Chounthirath T, Smith GA. Pediatric firework-related injuries presenting to United States emergency departments, 1990-2014. *Clin Pediatr*. 2017;56(6):535-544.

Moore JX, Mcgwin G, Griffin RL. The epidemiology of firework-related injuries in the United States: 2000-2010. *Injury*. 2014;45(11):1704-1709.

Sandvall BK, Jacobson L, Miller EA, et al. Fireworks type, injury pattern, and permanent impairment following severe fireworks-related injuries. *Am J Emerg Med*. 2017;35(10):1469-1473.

Case 2-21

Pitchfork injury

Patient Presentation: A young male accidentally impaled his right lower leg with a pitchfork.

Clinical Features: The patient was in mild to moderate painful distress. Color, motor, and sensory examination distal to the injury were intact.

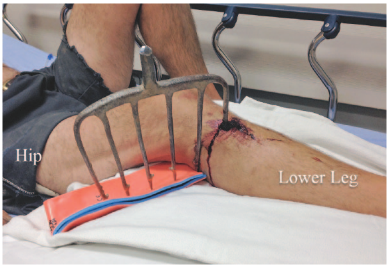

Figure 2-42. Pitchfork impaled into the lower leg

Differential Dx:

- Vascular, nerve, musculoskeletal, and joint injury

Emergency Care: The patient was given IV opioid medication. A radiograph did not show any bony abnormality or joint involvement. The pitchfork was removed by backward traction without difficulty.

Outcome: The patient was discharged with no further follow-up information available.

Key Learning Points:

- Unusual and rare infections can arise as a complication of pitchfork injury.

Further Reading:

Destina L, Sutton DA, Helon AL, et al. Severe osteomyelitis caused by Myceliophthora thermophila after a pitchfork injury. *Ann Clin Microbiol Antimicrob*. 2006;5(21).

Karger B, Rothschild MA, Pfeiffer H. Accidental sharp force fatalities—beware of architectural glass, not knives. *Forensic Sci Int*. 2001;123(2-3):135-139.

Kemp HB, Bedford AF, Fincham WJ. Petriellidium boydii infection of the knee: a case report. *Skeletal Radiol*. 1982;9(2):114-117.

Case 2-22

Deliberate self-inflicted impalement of a ball point pen

Patient Presentation: Young patient with significant psychiatric illness presented after forcefully inserting a ballpoint pen into his forearm.

Clinical Features: The patient was in mild painful distress. There was a circular wound in the forearm, but the ballpoint pen was not externally visible.

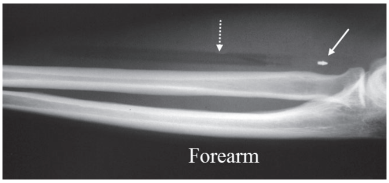

Figure 2-43. Forearm x-ray. Ball point pen embedded into forearm. WA = tip of pen, WDA = shaft of pen

Differential Dx:

- Foreign body, vascular, nerve, musculoskeletal injury

Emergency Care: A forearm radiograph revealed the anatomic location of the radiolucent shaft of the ballpoint pen and the metallic point of the pen. Under local anesthesia, the ballpoint pen was located and removed through the entrance wound.

Outcome: The patient was discharged and lost to follow-up.

Key Learning Points:

- Ballpoint pens have been deliberately placed into the cranium via the orbit, ingested into the stomach and colon, and placed high up in a male urethra.
- Ballpoint pens have also been accidentally ingested by children.

Further Reading:

Conway WC, Sugawa C, Ono H, Lucas CE. Upper GI foreign body: an adult urban emergency hospital experience. *Surg Endosc*. 2007;21(3):455-460.

Forde JC, Casey RG, Grainger R. An unusual penpal: case report and literature review of posterior urethral injuries secondary to foreign body insertion. *Can J Urol*. 2009;16(4):4757-4759.

Muller KE, Arató A, Lakatos PL, Papp M, Veres G. Foreign body impaction in the sigmoid colon: a twenty-euro bet. *World J Gastroenterol*. 2013;19(24):3892-3894.

Nguyen HS, Oni-Orisan A, Doan N, Mueller W. Transnasal penetration of a ballpoint pen: case report and review of literature. *World Neurosurg*. 2016;96:611.e1-e611.e10.

Rameau A, Anand SM, Nguyen LH. Ballpoint pen ingestion in a 2-year-old child. *Ear Nose Throat J*. 2011;90(7):E20-E22.

Su Y, Changchien C. Self-inflicted, trans-optic canal, intracranial penetrating injury with a ballpoint pen. *J Surg Case Rep*. 2016;3.

Case 2-23

Impaled metal pipe through the upper arm

Patient Presentation: A young male was involved in a high-speed motorcycle crash in which the motorcycle ran into a chain link fence. His right arm was impaled by a metal fence post. The prehospital rescue personnel transported the patient with the post in place after cutting it from its anchor point.

Clinical Features: There was a 2-in (5-cm) in diameter metal pipe impaled through the patient's right upper arm.

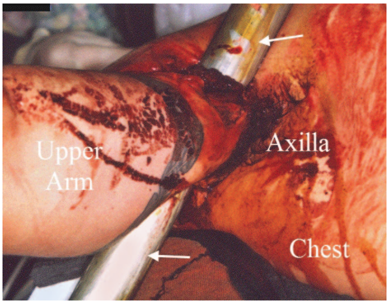

Figure 2-44. WA = metal pipe impaled into the right upper arm

Differential Dx:

- Vascular, neurologic, muscular, tendon, or bony injury

Emergency Care: The patient was treated symptomatically for his pain and went to the operating room for pipe removal.

Outcome: This patient was lost to follow-up.

Key Learning Points:

- Prehospital health care professionals need to have equipment available at the scene to effectively treat and manage impalement injuries. In order to free the patient from the impalement, tools and the skills to cut wood, steel, and concrete are required.

Further Reading:

Angelopoulos S, Mantzoros I, Kyziridis D, et al. A rare case of a transabdominal impalement after a fall from a ladder. *Int J Surg Case Rep*. 2016;22:40-43.

Paul S, Lee CL. Trauma case review: survival following impalement. *Crit Care Nurse*. 1994;14(2):55-59.

Singhal M, Kumar MV, Prakash P, Gupta A, Kumar S, Sagar S. Rare case of impalement of two occupants of a vehicle by the same object: insights into the management of complex thoracic impalements. *Chin J Traumatol*. 2012;15(1):50-53.

Case 2-24

Mangshan pit viper bite

Patient Presentation: A 33-year-old suffered a bite to his right forearm from a Mangshan pit viper.

Figure 2-45. Mangshan pit viper (Shutterstock)

Clinical Features: The patient was in no painful distress and was well appearing. Examination of his forearm revealed one small puncture wound and two small abrasions without bleeding or bruising.

Differential Dx:

- Envenomation

Emergency Care: This patient was admitted for observation.

Outcome: The patient was initially admitted for a 24-hour period and had local wound measures including arm elevation. His laboratory tests, including coagulation factors, were normal, and he was discharged home. He was followed daily by the ED with examinations and laboratory testing. Two days after the bite, the patient developed bruising around the bite site. Fibrinogen and INR had modest abnormalities. Four days post bite, the patient had a fibrinogen level <40 mg/dL, an INR of 1.5, and a thrombin time of >300 seconds. Physical examination revealed multiple cutaneous ecchymoses. Given the extremely rare nature of this toxic exposure, the poison center was closely involved in the patient's care. At their recommendation, the patient was treated with three vials of green pit viper antivenom in the ED and then admitted to the hospital. Following this, his coagulation studies steadily improved with eventual return to normal.

Key Learning Points:

- The Mangshan pit viper is an extremely rare and endangered species of snake located only in the surrounding area of Mount Mang in China, with little known data on envenomation.
- The main effects of envenomation appear to be hematologic as in this case.
- There is no specific antivenom for this species. A prior case report of Mangshan pit viper envenomation using green pit viper antivenom with a seemingly good response and outcome has been reported.
- The green pit viper antivenom used for this patient was procured from an out-of-state zoo.
- The formal case report on this incident is the first reference in the Further Reading section.

Further Reading:

Olives TD, Topeff JM, Willhite LA, Kubic VL, Keyler DE, Cole JB. Complete clinical course of envenomation by Protobothrops mangshanensis: delayed coagulopathy and response to Trimeresurus albolabris antivenom. *Clin Toxicol.* 2016;54(3):290-292.

Valenta J, Stach Z, Michalek P. Exotic snake bites in the Czech Republic—epidemiological and clinical aspects during 15-year period (1999-2013). *Clin Toxicol.* 2014;52:258-264.

Valenta J, Stach Z, Otahal M. Protobothrops mangshanensis bite: first clinical report of envenoming and its treatment. *Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub.* 2012;156(2):183-185.

Case 2-25

Impaled wooden splinter

Patient Presentation: A 35-year-old carpenter presented for evaluation of injuries after the wood he was cutting with a circular saw exploded. The chief complaint on the electronic medical chart was "splinter."

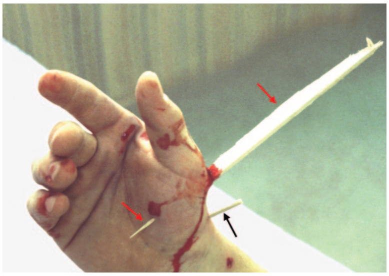

Figure 2-46. BA = smaller splinter, RA = wooden splinter through and through the hand

Clinical Presentation: The patient was in mild painful distress. A large wooden splinter traversed the thenar eminence. A smaller piece of wood was embedded as well. Color, sensation, and vascular supply appeared intact. Motor testing was not initially performed for fear of further splintering or breaking the impaled wood.

Differential Dx:

- Nerve, vascular, muscular, bone, or joint injury

Figure 2-47. Hand x-ray. Wooden foreign body present but not visualized

Emergency Care: A radiograph was performed with the impaled foreign bodies in place demonstrating no bony injury. The splinters are radiolucent. Local wound anesthetic was injected into the wound edges. The point of the short piece of wood exiting the palmer thenar eminence was cut at the skin surface because it was not very stable and there was concern that the small tip would break off in the process of removing the larger end. After the tip was cut, the larger end was pulled out backward. The two separate pieces of wood were compared, and their ends appeared to match up, indicating the piece of wood traversing the thenar eminence had been removed in its entirety. The second smaller splinter was removed easily as it was superficially embedded.

Outcome: The patient was placed on antibiotics and was lost to follow-up.

Key Learning Points:

- Wood, as demonstrated in this case, may not be visualized on plain radiography.
- Ultrasound, plain radiography, and CT and magnetic resonance imaging (MRI) scanning are the main methods for visualizing foreign bodies.

- The medical imaging modality chosen for detection and localization of foreign bodies depends on the anatomic part being investigated, the depth of the foreign body, as well as the material of the foreign body. Plain radiography detects glass and metal very well. Most foreign bodies are well visualized with ultrasound provided the foreign body is not deeply embedded. The deeper the embedded foreign body, the poorer the visualization with ultrasound. Almost all foreign bodies are well localized with CT scanning regardless of their depth. Wood is well visualized with MRI.
- MRI should not be performed for visualization of metallic foreign bodies.

Further Reading:

Faguy K. Imaging foreign bodies. *Radiol Technol*. 2014;85(6):655-678.

Haghnegahdar A, Shakibafard A, Khosravifard N. Comparison between computed tomography and ultrasonography in detecting foreign bodies regarding their composition and depth: an in vitro study. *J Dent (Shiraz)*. 2016;17(3):177-184.

Javadrashid R, Fouladi DF, Golamian M, et al. Visibility of different foreign bodies in the maxillofacial region using plain radiography, CT, MRI and ultrasonography: an in vitro study. *Dentomaxillofac Radiol*. 2015;44(4):20140229.

Kourelis K, Mourtzouchos K, Haronis V, Goulioumis A, Asimakopoulos A. Ultrasound-guided removal of impalpable, radiolucent vegetative foreign bodies embedded into facial soft tissues of a toddler. *Int J Pediatr Otorhinolaryngol*. 2016;91:64-66.

Paziana K, Fields JM, Rotte M, Au A, Ku B. Soft tissue foreign body removal technique using portable ultrasonography. *Wilderness Environ Med*. 2012;23(4):343-348.

CHAPTER 3

Central Nervous System

Case 3-1

A migrating lumbar bullet

Patient Presentation: A 19-year-old man suffered multiple gunshot wounds involving his eye, mandible, thigh, and lower back.

Clinical Presentation: The patient was awake, oriented, and in moderate painful distress. His left eye had an obvious penetrating injury, and his left lower mandible was swollen with intraoral bleeding. The thigh wound appeared to be a through-and-through injury. He had a single wound to his lower back, with decreased strength in his left lower extremity.

Differential Dx:

- Penetrating injuries to the airway, eye, brain, spinal cord, thorax, and abdomen

Emergency Care: Given the patient's presentation with two wounds to the head and neck with intraoral bleeding, rapid sequence intubation was performed with etomidate and succinylcholine. Multiple computed tomography (CT) scans demonstrated a subdural and intraparenchymal brain hemorrhage and a penetrating mandibular bone injury. A lateral lumbar spine radiograph demonstrated a bullet lodged in the L2-L3 intervertebral disk space.

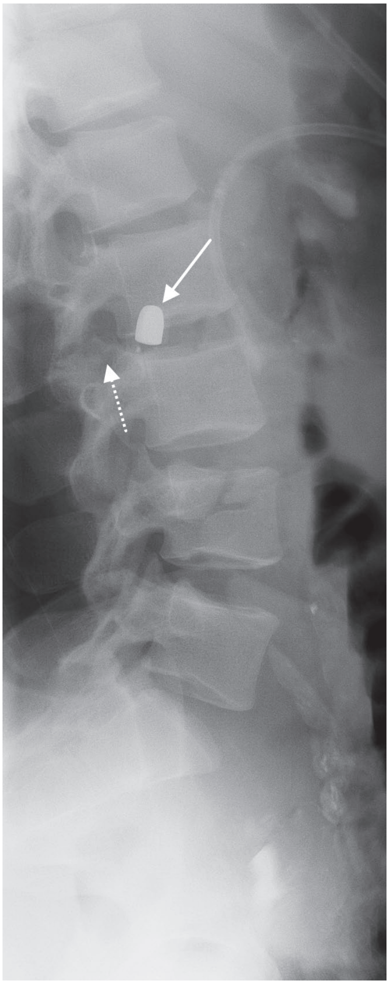

Figure 3-1. Lumbar x-ray. WA = bullet lodged in the L2-L3 disc space, WDA = spinal canal

Outcome: The patient had a complicated hospital course, initially undergoing decompression of his subdural hematoma. At the time of discharge, he was awake and alert. He lost his eye and was discharged with incomplete left lower extremity motor deficits. He returned 1 month later with increasing back and radicular pain. Repeat lumbar imaging demonstrated that the bullet originally in the L2-L3 disc interspace had migrated posteriorly into the central spinal canal. He underwent bullet removal using fluoroscopy.

Key Learning Points:

- Bullets can migrate immediately at the time of the initial penetrating injury, such as embolizing from the femoral vein into the pulmonary artery.
- Bullets can migrate subsequent to the initial event, as in the case presented.
- Bullets can migrate into more unfavorable positions, including central nervous system, joints, and cardiovascular and pulmonary structures, necessitating delayed removal.

Further Reading:

Chan YC, Al-Mahfoudh R, Thennakon S, Eldridge P, Pillay R. Migrating intrathecal high-velocity projectile. *Br J Neurosurg*. 2015;29(4):585-586.

Ghori SA, Khan MS, Bawany FI. Delayed Cauda Equina syndrome due to a migratory bullet. *J Coll Physicians Surg Pak*. 2014; 24(suppl 3):S219-S220.

Gutierrez V, Radice F. Late bullet migration into the knee joint. *Arthroscopy*. 2003;19(3): E15.

Nehme AE. Intracranial bullet migrating to pulmonary artery. *J Trauma*. 1980;20(4): 344-346.

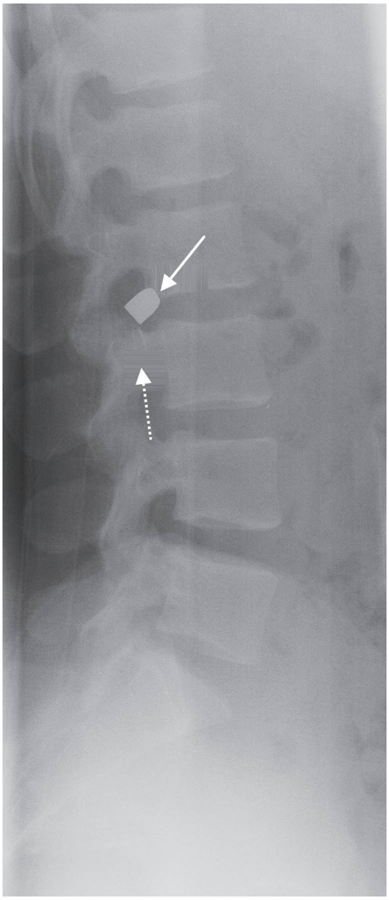

Figure 3-2. Lumbar x-ray. WA = bullet migrated into the spinal canal, WDA = spinal canal

Case 3-2

Ventriculoperitoneal shunt malfunction

Patient Presentation: A 70-year-old man presented after a fall. The patient was standing and lost his balance. Past medical history was significant for a penetrating traumatic brain injury with permanent neurologic sequela including hydrocephalus for which a ventriculoperitoneal (VP) shunt had been placed. In the emergency department (ED) he denied headache, nausea, or vomiting. His only complaint was minor pain at the small contusion site on his scalp as a result of the fall.

Figure 3-3. Noncontrast head CT scan. WA = enlarged ventricles, WDA = shunt

Clinical Features: Previously established baseline abnormal neurologic findings appeared stable on ED examination. Palpation of his VP shunt in the lateral neck revealed a 1 cm discontinuity.

Differential Dx:

- Shunt malfunction with increasing hydrocephalus, shunt infection, seizure, and syncope

Emergency Care: The patient appeared to be at his neurologic baseline and was asymptomatic. However, given the history of loss of balance in the presence of a VP shunt, a noncontrast head CT scan was performed. The CT scan showed dilated ventricles with an appropriately positioned VP shunt tip compared to his previous scan done 4 years previously. A shunt series showed frank discontinuity of the shunt tubing in the lateral neck.

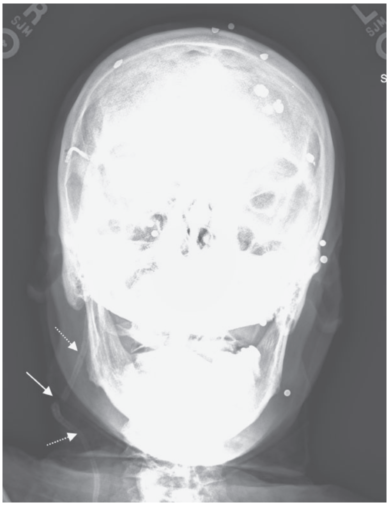

Figure 3-4. Shunt series. WA = disconnected shunt ends, WDA = shunt tubing

Outcome: The neurosurgery service was consulted, and the shunt was aspirated. The opening pressure was 14 cm with good flow. Cultures were not indicative of an infection. Given the patient's stable baseline neurologic examination with no new deficits, and without any symptoms, the decision was made to not intervene with a shunt revision. The patient was followed in the neurology clinic with no subsequent adverse events.

Key Learning Points:

- A shunt series should accompany the head CT scan in evaluating a problem potentially related to shunt malfunction.
- The VP shunt in this patient had been placed many years prior to this presentation. Given the normal pressure found on shunt aspiration and lack of clinical symptoms or signs, it is possible that the shunt was functional through the formation of a fibrous tract communicating with the ends of the disconnection.
- Medicine is as much an art as it is a science. History and physical examination, despite advanced technology, is still critical to decision-making. It is extremely important to factor in clinical symptoms and physical findings into every decision. Despite radiographic findings of increased hydrocephalus and discontinuity in the VP shunt, this patient was at baseline and in fact continued to do well without neurosurgical intervention.

Further Reading:

Afat S, Pjontek R, Hamou HA, et al. Imaging of ventriculoperitoneal shunt complications: comparison of whole body low-dose computed tomography and radiographic shunt series. *J Comput Assist Tomog*. 2016;40(6):991-996.

Clyde BL, Albright AL. Evidence for a patent fibrous tract in fractured, outgrown, or disconnected ventriculoperitoneal shunts. *Pediatr Neurosurg*. 1995;23(1):20-25.

Park DB, Hill JG, Thacker PG, et al. The role of limited head computed tomography in the evaluation of pediatric ventriculoperitoneal shunt malfunction. *Pediatr Emerg Care*. 2016;32(9):585-589.

Case 3-3

Hydrocephalus, subdural hematomas, and pneumocephaly

Patient Presentation: A 55-year-old with congenital hydrocephalus presented to an outside hospital after a fall. Noncontrast head CT obtained before the fall shows her chronically enlarged ventricles. Post fall she had a head CT scan (not pictured) that showed bilateral subdural hematomas with compression of her chronically enlarged ventricles. She had her subdural hematomas evacuated, but postoperatively she had a decreasing level of consciousness and was transferred to our facility.

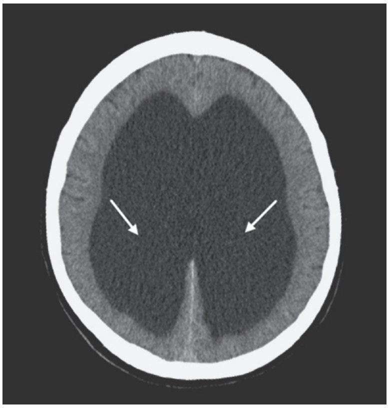

Figure 3-5. Noncontrast head CT scan. Baseline hydrocephalus. WA = enlarged lateral ventricles

Clinical Presentation: The patient had a nonfocal neurologic examination but a decreased level of consciousness.

Differential Dx:
- Infection
- VP shunt malfunction
- Worsening hydrocephalus
- Progressive or recurrent subdural hematoma

Emergency Care: A repeat noncontrast head CT scan was performed post subdural hematoma evacuation and demonstrated significant pneumocephaly, bilateral subdural hygromas, and compressed ventricles due to the pneumocephaly.

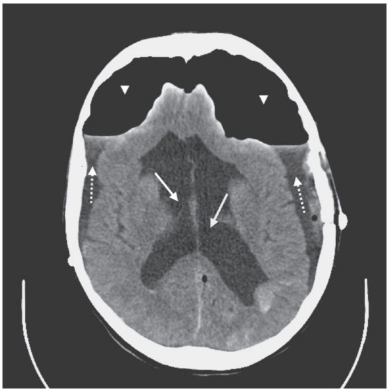

Figure 3-6. Noncontrast head CT scan. Post craniotomy for evacuation of bilateral subdural hematomas. WA = compressed lateral ventricles, WAH = pneumocephaly, WDA = bilateral subdural hygromas

Outcome: The worsening neurologic examination was thought secondary to increased intracranial pressure from the pneumocephaly. Her programmable shunt was evaluated and adjusted so that the output of the shunt would be at a minimum, in order to facilitate expansion of ventricles and shrinking of her pneumocephalus. The patient was also placed on high-flow oxygen therapy and remained supine. The patient had gradual improvement in mental status with a reduction in the pneumocephaly and was discharged. Follow-up noncontrast CT scan demonstrated improvement with decreasing pneumocephaly and increasing ventricle size with residual subdural hygromas.

Key Learning Points:

- Despite the impressive degree of hydrocephalus, the patient had an unimpressive neurologic examination at her baseline.

Further Reading:

Schrander-Stumpel C, Fryns JP. Congenital hydrocephalus: nosology and guidelines for clinical approach and genetic counselling. *Eur J Pediatr.* 1998;157(5):355-362.

Figure 3-7. Noncontrast head CT scan. Improved appearance post VP shunt manipulation. WA = normalizing ventricular size, WAH = markedly reduced pneumocephaly, WDA = persistent subdural hygromas

Case 3-4

Moyamoya disease

Patient Presentation: A 55-year-old woman had a sudden decrease in level of consciousness associated with vomiting. She was endotracheally intubated at the scene for airway protection. The patient had a mechanical aortic valve and was on warfarin.

Figure 3-8. Noncontrast head CT scan. WA = intraparenchymal and intraventricular hemorrhage

Clinical Presentation: The patient was intubated and sedated on arrival to the ED. Neurologic examination showed withdrawal to painful stimuli of the left upper and left lower extremities. Pupils were equal size and reactive to light.

Differential Dx:

- Ischemic stroke
- Occult trauma
- Epidural or subdural hematoma
- Central nervous system infection
- Subarachnoid hemorrhage
- Intraparenchymal hemorrhage

Emergency Care: An emergent noncontrast head CT scan demonstrated a large intraparenchymal and intraventricular hemorrhage. The patient's international normalized ratio (INR) was 3.7. The patient was administered prothrombin complex concentrate and vitamin K.

Outcome: The hospital course of this patient was complicated. An external ventricular drain was placed, and intrathecal tissue plasminogen activator was administered. A cerebral angiogram showed dilated lenticulostriate vessels indicative of moyamoya disease. The patient had a percutaneous endoscopic gastrostomy (PEG) and tracheostomy placed. Neurologic examination at discharge revealed spontaneous opening of her eyes and the ability to follow commands with her left side only. The patient was restarted on warfarin after several weeks had passed. Three months after the initial event, she underwent unilateral successful end-to-side bypass grafting from her superficial temporal artery to the distal middle cerebral artery. She was scheduled for a second bypass grafting on the contralateral side but had an intervening acute-on-chronic subdural hematoma from a supratherapeutic INR. She has been left with cognitive, speech, and right-sided motor deficits.

Key Learning Points:

- Reversal of anticoagulants is complicated because there are now numerous anticoagulant agents available with varying mechanism of action. Reversing or restarting an anticoagulant requires a risk vs benefit analysis.
- Anticoagulating a patient with moyamoya disease is thought to increase the likelihood of a second hemorrhage and is generally contraindicated. In this patient with a mechanical aortic valve, the risk of a rebleed with moyamoya was weighed against the risk of an embolic event from a nonanticoagulated mechanical aortic valve.

Further Reading:

Cheng J, Ye Q, Ye ZS, Li ZQ, Xu AD. Five-year experience of 101 adult patients with moyamoya disease at a single institution in Eastern China. *J Clin Neurosci.* 2016;32:30-34.

Huang Z, Huang Z, Ding X, Men W, et al. Clinical features and outcomes in 154 patients with haemorrhagic moyamoya disease: comparison of conservative treatment and surgical revascularization. *Neurolog Res*. 2015;37(10):886-892.

Jeon JP, Kim JE. A recent update of clinical and research topics concerning adult moyamoya disease. *J Korean Neurosurg Soc*. 2016;59(6):537-543.

Sun H, Wilson C, Ozpinar A, et al. Perioperative complications and long-term outcomes after bypasses in adults with moyamoya disease: a systematic review and meta-analysis. *World Neurosurg*. 2016;92:179-188.

Case 3-5

Ossification of anterior and posterior longitudinal cervical spine ligaments

Patient Presentation: This elderly patient presented for evaluation of injuries suffered in a fall and was complaining of neck pain as well as arm and leg weakness.

Clinical Features: The patient was awake and alert, with marked decrease in strength to his upper and lower extremities bilaterally, along with subjective decrease in sensation. Respirations were unlabored. A noncontrast cervical spine CT demonstrated an injury at the C5-C6 level. Specifically, there was significant ossification of the anterior and posterior longitudinal ligaments with an acute fracture through these calcified ligaments resulting in anterior subluxation with resultant narrowing of the spinal canal.

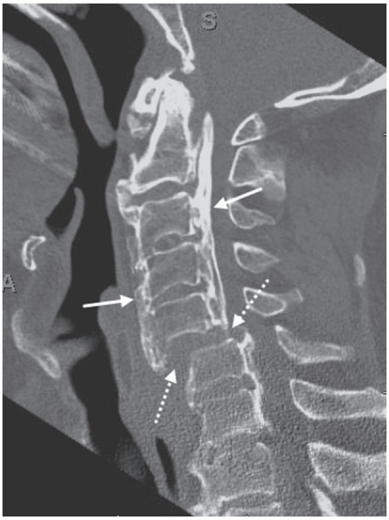

Figure 3-9. Cervical spine CT scan. WA = ossified anterior and posterior longitudinal ligaments, WDA = acute fracture through C5-C6 involving the calcified ligaments

Differential Dx:
- Cervical spinal cord injury
- Spinal epidural hematoma
- Fracture and/or dislocation

Emergency Care: The patient remained in cervical collar immobilization for the duration of ED care and was admitted to the neurosurgery service.

Outcome: This patient was lost to follow-up.

Key Learning Points:
- The ossification of the posterior ligament effectively narrows the diameter of the canal, making injury to the spinal cord more likely with any subluxation or dislocation.
- This patient suffered a fracture through the ossified anterior and posterior longitudinal ligaments resulting in an unstable cervical spine with significant subluxation and resultant spinal cord injury.

Further Reading:

Abiola R, Rubery P, Mesfin A. Ossification of the posterior longitudinal ligament: etiology, diagnosis, and outcomes of nonoperative and operative management. *Global Spine J*. 2016;6(2):195-204.

Inamasu J, Guiot BH, Sachs DC. Ossification of the posterior longitudinal ligament: an update on its biology, epidemiology, and natural history. *Neurosurgery*. 2006;58(6):1027-1039.

Nozawa S, Shimizu K, Miyamoto K, Sakaguchi Y, Nishimoto H, Hosoe H. Sudden onset of paraparesis caused by hypertrophy of the thoracic posterior longitudinal ligament. *Spinal Cord*. 2003;41(1):53-55.

Case 3-6

Ossification of the posterior longitudinal ligament

Patient Presentation: A 55-year-old man was hit by a car.

Clinical Features: This patient presented awake and alert with no movement in his bilateral upper extremities and 2/5 strength in his lower extremities.

Differential Dx:

- Spinal cord injury
- Epidural spinal hematoma
- Bony compression of spinal cord
- Fracture
- Dislocation
- Vascular injury

Emergency Care: Cervical spine radiography revealed ossification of the posterior longitudinal ligament (OPLL). Axial imaging from a cervical spine CT scan demonstrated narrowing of the spinal canal with likely impingement of the spinal cord by the OPLL. The patient was treated with a methylprednisolone protocol (standard practice at the time of this case but no longer thought to be beneficial).

Outcome: At the time of discharge 7 days later, the patient had 5/5 strength in his lower extremities and 3 to 4/5 strength in his upper extremities.

Figure 3-10. Cervical spine x-ray. WA = ossified posterior longitudinal ligament

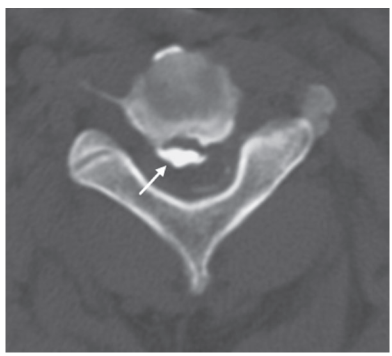

Figure 3-11. Cervical spine CT scan. WA = ossified posterior longitudinal ligament. Note the resultant narrowing of the spinal canal

Key Learning Points:

- OPLL narrows the diameter of the spinal canal and can lead to spinal cord injury with minor traumatic mechanisms without fracture or dislocation of the spine.

Further Reading:

Abiola R, Rubery P, Mesfin A. Ossification of the posterior longitudinal ligament: etiology, diagnosis, and outcomes of nonoperative and operative management. *Global Spine J*. 2016;6(2):195-204.

Inamasu J, Guiot BH, Sachs DC. Ossification of the posterior longitudinal ligament: an update on its biology, epidemiology, and natural history. *Neurosurgery*. 2006;58(6):1027-1039.

Nozawa S, Shimizu K, Miyamoto K, Sakaguchi Y, Nishimoto H, Hosoe H. Sudden onset of paraparesis caused by hypertrophy of the thoracic posterior longitudinal ligament. *Spinal Cord*. 2003;41(1):53-55.

Case 3-7

Ruptured dermoid cyst

Patient Presentation: A 62-year-old presented for evaluation of injuries after a high-speed motor vehicle crash.

Clinical Features: The patient was awake and neurologically intact. He was in moderate painful distress complaining of a headache and facial trauma. Facial lacerations and a large scalp contusion were present, as well as a chest contusion and a closed ankle deformity.

Differential Dx:

- Multiple traumatic injuries

Emergency Care: Given the mechanism of injury, the presence of a large scalp contusion, and complaint of a severe headache, a noncontrast head CT scan was obtained. This demonstrated multiple air/fluid levels vs multiple fat/fluid levels in the cerebral spinal fluid (CSF) in the lateral ventricles.

Outcome: On the second hospital day, the history of a remote (10 years prior) ruptured dermoid cyst was obtained, and it was discovered that the abnormal head CT scan finding was due to fat/CSF levels that had persisted for the 10-year duration. The patient recovered completely.

Key Learning Points:

- Read every diagnostic imaging study in a systematic manner. The finding in this patient is subtle and unusual and could easily have been missed looking for acute hemorrhage.

Figure 3-12. Noncontrast head CT scan. WA = fat/cerebral spinal fluid levels

Figure 3-13. Noncontrast head CT scan. WA = fat/cerebral spinal fluid levels

Further Reading:

Meyer DR, Lessner AM, Yeatts RP, Linberg JV. Primary temporal fossa dermoid cysts. Characterization and surgical management. *Ophthalmology*. 1999;106(2):342-349.

Rajapakse A, Diack A. Ruptured intracranial dermoid: an unusual cause of headache in an older patient. *Headache*. 2008;48(2):294-296.

Smith AS, Benson JE, Blaser SI, Mizushima A, Tarr RW, Bellon EM. Diagnosis of ruptured intracranial dermoid cyst: value MR over CT. *AJNR Am J Neuroradiol.* 1991;12(1):175-180.

Case 3-8

Ependymoma

Patient Presentation: A 12-year-old presented with new onset headaches starting 8 days prior. The patient had no prior history of headaches.

Figure 3-14. Noncontrast head CT scan. WA = ependymoma

Clinical Features: The patient was in mild to moderate painful distress. He had a normal physical and neurologic examination.

Differential Dx:

- Meningitis
- Encephalitis
- Tumor
- Arteriovenous malformation
- Aneurysm
- Occult trauma
- Migraine

Emergency Care: A noncontrast head CT scan was performed demonstrating a heterogeneous intraventricular mass with hydrocephalus. Differential favors ependymoma vs other rare lesions such as central neurocytoma, choroid plexus tumors, etc.

Outcome: The patient underwent resection of this tumor with placement of a VP shunt. He was discharged with mild cognitive deficits affecting memory. He subsequently developed seizures that were difficult to control.

Key Learning Points:

- Pediatric patients complaining of new onset headaches that are constant and associated with mild to moderate painful distress should be concerning for significant intracranial pathology.

Further Reading:

Lin FY, Chintagumpala M. Advances in management of pediatric ependymomas. *Curr Oncol Rep*. 2015;17(10):47.

Mclendon RE, Lipp E, Satterfield D, et al. Prognostic marker analysis in pediatric intracranial ependymomas. *J Neuro-Oncol*. 2015;122(2):255-261.

Vitanza NA, Partap S. Pediatric ependymoma. *J Child Neurol*. 2016;31(12):1354-1366.

Case 3-9

Dramatic thoracic and cervical spine injuries

Patient Presentation: Three patients presented with injuries from unrelated motor vehicle crashes.

Clinical Features: All three patients presented with multiple traumatic injuries in addition to their spinal injuries.

Differential Dx:
- Multiple traumatic injury

Emergency Care: All three patients were aggressively resuscitated initially. The diagnostic workup included multiple CT scans and sagittal spine reconstructions that revealed a dramatic lower thoracic fracture-dislocation, a longitudinal atlanto-occipital dislocation in a pediatric patient, and a severely displaced cervical spine fracture/dislocation in an adult.

Outcome: The patients noted in Images 3-15 and 3-16 died as a result of their injuries. The patient in Figure 3-17 survived with no biceps function, minimal triceps function, and no lower extremity function.

Figure 3-15. Thoracic spine CT scan. WA = fracture/dislocation

Key Learning Points:
- Atlanto-occipital dislocations are classified as anterior, posterior, or longitudinal, and are rarely survivable.
- In pediatric patients, the basion-dens distance should be <12 mm. The pediatric case presented here had a significantly large increase in this distance, making this a longitudinal dislocation.
- Pediatric patients can survive atlanto-occipital dislocation, although most have significant other traumatic injuries and many have subsequent neurologic deficits.

Further Reading:

Astur N, Klimo P Jr, Sawyer JR, Kelly DM, Muhlbauer MS, Warner WC Jr. Traumatic atlanto-occipital dislocation in children: evaluation, treatment, and outcomes. *J Bone Joint Surg Am.* 2013;95(24):e194 (1-8).

Bulas DI, Fitz CR, Johnson DL. Traumatic atlanto-occipital dislocation in children. *Radiology*. 1993;188(1):155-158.

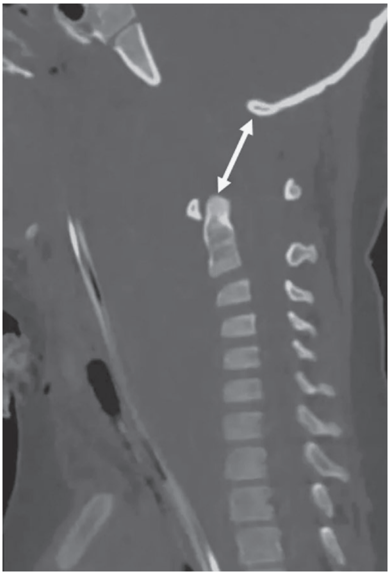

Figure 3-16. Cervical spine CT scan. WA = Longitudinal atlanto-occipital dislocation

Figure 3-17. Cervical spine CT scan. WA = C6-C7 fracture/dislocation

Chaput CD, Torres E, Davis M, Song J, Rahm M. Survival of atlanto-occipital dissociation correlates with atlanto-occipital distraction, injury severity score, and neurologic status. *J Trauma*. 2011;71(2):393-395.

Cooper Z, Gross JA, Lacey JM, Traven N, Mirza SK, Arbabi S. Identifying survivors with traumatic craniocervical dissociation: a retrospective study. *J Surg Res*. 2010;160(1):3-8.

Tubbs RS, Patel C, Loukas M, Oskouian RJ, Chapman JR. Traumatic atlanto-occipital dislocation: do children and adolescents have better or worse outcomes than adults? A narrative review. *Childs Nerv Sys*. 2016;2(8):1387-1392.

Case 3-10

Pituitary tumor

Patient Presentation: A 66-year-old woman presented with a sore throat, dysphagia, and a painful neck mass.

Clinical Features: The patient was alert and in no painful distress. Vital signs were normal. There were several right-sided cervical lymph nodes that were tender on palpation. The rest of the physical examination was unremarkable.

Differential Dx:

- Infectious etiologies including cervical adenitis, tonsillitis, epiglottitis, supraglottitis
- Metastatic lymphadenopathy from head and/or neck cancer

Figure 3-18. Head CT scan. WA = incidental finding of a pituitary tumor

Emergency Care: The patient had a head and neck CT scan that had two findings. There was bilateral cervical lymphadenopathy from an unclear etiology, likely the cause of her sore throat. The second finding was incidental: a pituitary mass resulting in bony erosion of the sella turcica.

Outcome: The patient was admitted to the hospital. The otolaryngologist believed the neck pathology was a noninfectious inflammatory process involving the supraglottic structures that was observed with gradual improvement without specific treatment. The cervical adenopathy and dysphagia resolved. The neurosurgery department was consulted for the pituitary mass. The suprasellar mass was further imaged by magnetic resonance imaging (MRI). The patient received multiple lab tests including cortisol, follicle stimulating hormone, luteinizing hormone, prolactin, thyroid stimulating hormone, and free T3 and T4. These were all within normal limits. The 25-hydroxy vitamin D level was low at 11.5 ng/mL. A serum protein electrophoresis and urine protein electrophoresis were ordered. The patient was discharged with instructions to return to the neurosurgery clinic in 2 weeks, but the patient never showed and was lost to follow-up.

Key Learning Points:

- Incidental findings on diagnostic brain MRI imaging of middle age to elderly patients are common. Most of these incidental findings are cysts, meningiomas, aneurysms, previous unrecognized stroke, or neoplasms. Approximately 3% to 4% of brain MRI incidental findings require additional diagnostic or therapeutic intervention.
- Appropriate additional diagnostic evaluation and subsequent therapeutic intervention of incidental findings on any diagnostic imaging test can be challenging.

- Point of care reference materials can increase practice compliance, ensuring appropriate additional diagnostic testing and therapeutic intervention.

Further Reading:

Bos D, Poels MM, Adams HH, et al. Prevalence, clinical management, and natural course of incidental findings on brain MR images: the population-based Rotterdam scan study. *Radiology*. 2016; 281(2):507-515.

Boutet C, Vassal F, Celle S, et al. Incidental findings on brain magnetic resonance imaging in the elderly: the PROOF study. *Brain Imaging Behav*. 2017;11(1):293-299.

Zygmont ME, Shekhani H, Kerchberger JM, Johnson JO, Hanna TN. Point-of-care reference materials increase practice compliance with societal guidelines for incidental findings in emergency imaging. *J Am Coll Radiol*. 2016;13(12 pt A):1494-1500.

Case 3-11

Fahr disease

Patient Presentation: A 52-year-old who recently immigrated to the United States presented with a first-time, generalized tonic-clonic seizure.

Clinical Features: The patient was initially mildly postictal but cleared rapidly and had a normal and nonfocal neurologic examination.

Differential Dx:

- Central nervous system disease including infection, tumor, trauma, as well as metabolic and endocrine causes for seizures

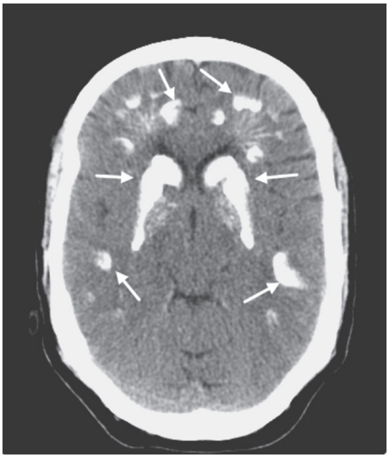

Figure 3-19. Noncontrast head CT scan. WA = extensive calcifications

Emergency Care: A noncontrast head CT scan revealed extensive calcifications of the subcortical white matter, basal ganglia, and choroid plexus in a bilateral symmetrical distribution throughout the cerebral and cerebellar hemispheres. The patient was found to have an extremely low serum calcium level upon admission with an ionized calcium of 2.36 mg/dL and a total calcium of 4.9 mg/dL.

Outcome: The patient was admitted to the hospital. The diagnostic findings were thought to be compatible with idiopathic basal ganglia calcification or Fahr disease. The patient was initially treated with calcium gluconate, 1,25-dihydroxyvitamin D3, calcium acetate, and valproate. The patient was discharged with calcitrol and valproic acid.

Key Learning Points:

- Patients who present with new onset seizures should have a full diagnostic evaluation, even in the setting of a likely etiology for the seizure, such as alcohol withdrawal.
- Basal ganglia calcification can be from genetic defects, hypoparathyroidism, or an unknown etiology. Neurologic and psychiatric symptoms and signs can be associated with this disease.

Further Reading:

Cormack S, Chan P, Persaud R, Vila-Rodriguez F. Index electroconvulsive therapy course to treat severe suicidality and depression in Fahr disease. *J ECT*. 2016;32(1):72-73.

Roiter B, Pigato G, Perugi G. Late-onset mania in a patient with movement disorder and basal ganglia calcifications: a challenge for diagnosis and treatment. *Case Rep Psychiatry*. 2016;2016:1393982.

Takeuchi T, Muraoka K, Yamada M, Nishio Y, Hozumi I. Living with idiopathic basal ganglia calcification 3: a qualitative study describing the lives and illness of people diagnosed with a rare neurological disease. *Springerplus*. 2016;5(1):1713.

Case 3-12

Porencephalic cyst

Patient Presentation: This 2-year-old presented to the ED for evaluation of a fever. She had a known large porencephalic cyst with a VP shunt.

Clinical Features: The patient was alert and interactive, with a nonfocal motor examination.

Differential Dx:
- Infection from a variety of sources, including her VP shunt

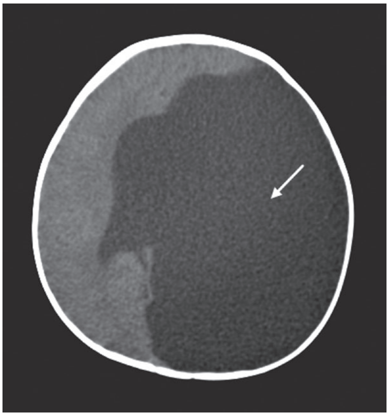

Figure 3-20. Noncontrast head CT scan. WA = large porencephalic cyst

Emergency Care: Review of her medical record revealed the patient had an abnormal fetal ultrasound and subsequent brain MRI at birth revealing middle and posterior cerebral artery infarcts and resultant large porencephalic cyst. As a newborn, slow reflexes (gag, Moro, rooting) were noted. Muscle tone was slightly diminished with a mild decrease in grip strength. A cranial ultrasound that was performed as part of her fever evaluation showed increased fluid. A subsequent noncontrast head CT scan showed the large porencephalic cyst.

Outcome: The patient had right-sided motor deficits and cognitive delay but was otherwise alert and verbally communicative.

Key Learning Points:
- Intrauterine fetal ultrasound can diagnose a myriad of anatomic abnormalities.
- Congenital porencephalic cysts appear as a fluid-filled cavity in the cerebral hemisphere. Porencephalic cysts are rare and result from destruction of brain tissue following vascular injury such as a fetal stroke. The cysts are lined with white matter and are intra-axial.

Further Reading:

Abergel A, Lacalm A, Massoud M, Massardier J, des Portes V, Guibaud L. Expanding porencephalic cysts: prenatal imaging and differential diagnosis. *Fetal Diagn Ther*. 2017;41(3):226-233.

Trabacca A, Dicuonzo F. Images in clinical medicine. Living with one hemisphere—a large porencephalic cyst. *N Engl J Med*. 2009;361(16):1584.

Williams T, Wilkinson AG, Kandasamy J, Cooper S, Boardman JP. Antenatal diagnosis of intracranial haemorrhage and porencephalic cyst. *BMJ Case Rep*. 2015;2015. pii: bcr2014209130.

Case 3-13

Third ventricle colloid cyst

Patient Presentation: A 35-year-old presented with a first-time generalized seizure.

Clinical Features: The patient arrived at the ED in status epilepticus.

Differential Dx:
- Central nervous system infection
- Neoplasm
- Trauma
- Toxicologic exposure
- Metabolic or endocrine disorder

Emergency Care: The patient underwent rapid sequence intubation, and his seizures were medically controlled with benzodiazepines and a propofol infusion. An emergent noncontrast head CT scan demonstrated a third ventricle colloid cyst with acute obstructive hydrocephalus and resultant uncal herniation.

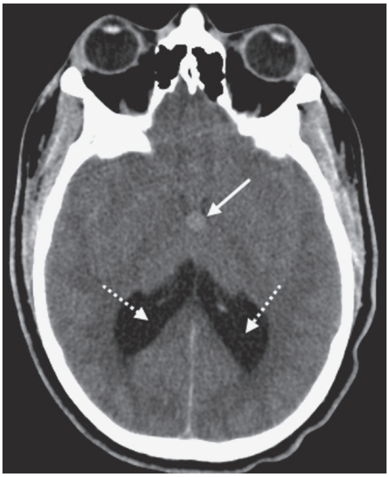

Figure 3-21. Noncontrast head CT scan. WA = third ventricle colloid cyst, WDA = acute obstructive hydrocephalus

Outcome: The patient was taken directly to the operating room for emergent placement of a ventriculostomy. He developed bilateral occipitoparietal infarcts. His colloid cyst was subsequently resected. Long-term follow-up revealed significant cognitive and bilateral focal motor deficits.

Key Learning Points:
- Fifty percent of symptomatic patients with third ventricle colloid cysts present with acute obstructive hydrocephalus, with a 3% chance of hospital mortality.
- Incidental colloid cysts can be selectively observed over time or endoscopically removed.

Further Reading:

Beaumont TL, Limbrick DD Jr, Rich KM, Wippold FJ 2nd, Dacey RG Jr. Natural history of colloid cysts of the third ventricle. *J Neurosurg*. 2016;125(6):1420-1430.

Margetis K, Christos PJ, Souweidane M. Endoscopic resection of incidental colloid cysts. *J Neurosurg*. 2014;120(6):1259-1267.

Sheikh AB, Mendelson ZS, Liu JK. Endoscopic versus microsurgical resection of colloid cysts: a systematic review and meta-analysis of 1,278 patients. *World Neurosurg*. 2014;82(6):1187-1197.

Case 3-14

Calculating hemocrit level using layered bilateral subdural hematomas

Patient Presentation: An 83-year-old presented with an altered mental state. The patient was taking warfarin for atrial fibrillation and had fallen 1 month prior to presentation. For the past 2 days, he had been unsteady on his feet with a markedly decreased mental status.

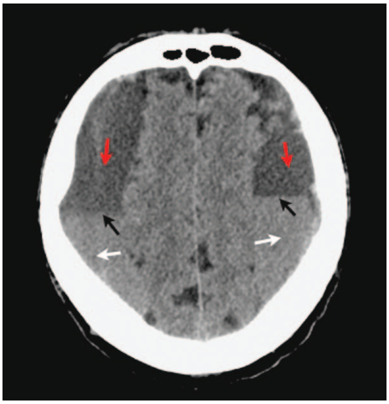

Figure 3-22. Noncontrast head CT scan. BA = interface level of plasma and cells estimating the hemocrit level of blood at 41%, RA = plasma, WA = cells

Clinical Features: His Glasgow Coma Score was 7, he was not following commands, and he was not protecting his airway. His pupils were equal and reactive.

Differential Dx:

- Central nervous system pathology including infection, trauma, hemorrhagic or ischemic stroke, metabolic or endocrine pathology, poisoning

Emergency Care: This patient underwent rapid sequence intubation using lidocaine, etomidate, and succinylcholine, and he was subsequently sedated with propofol. Fresh frozen plasma and activated factor VII were administered to reverse his anticoagulation. A noncontrast head CT scan demonstrated bilateral subdural hematomas with hematocrit levels, without midline shift or uncal herniation.

Outcome: The patient was taken to the operating room for decompression of his subdural hematomas. The patient had significant neurologic sequelae; he was discharged to a long-term care facility able to move all four extremities with purpose, but he was unable to follow commands.

Key Learning Points:

- A noncontrast head CT scan demonstrates a layering hematocrit level from subdural hematomas. The radiographic estimate of this patient's hematocrit was 41%, and the laboratory measured hematocrit level was 38%.
- Several new oral anticoagulants are available for the primary prevention of stroke in the setting of atrial fibrillation. Anticoagulants that inhibit factor Xa or thrombin directly do not need routine lab monitoring and are associated with less intracranial hemorrhage, but they are more expensive and lack specific reversal agents when hemorrhage does occur.

Further Reading:

Hernandez-Olmedo M, Suarez-Fernandez C. Progress of anticoagulation therapy in atrial fibrillation [in Spanish]. *Medicina Clínica*. 2015;145(3):124-130.

Tan S, Aronowitz P. Hematocrit effect in bilateral subdural hematomas. *J Gen Intern Med*. 2013;28(2):321.

Case 3-15

Posterior reversible encephalopathy syndrome

Patient Presentation: A 24-year-old man presented with a first-time seizure. His medical history included end-stage renal disease secondary to Alport syndrome, hypertension, and pulmonary tuberculosis for which he was on therapy. His presenting blood pressure was 160/105 mm Hg.

Clinical Features: The patient was unresponsive, not protecting his airway, with a moderate accumulation of saliva in his posterior pharynx. He had nonpurposeful movement of all four extremities, pinpoint pupils, and very shallow respirations.

Figure 3-23. Head MRI scan. WA = multifocal T2 hyperintensities

Differential Dx:

- First time seizure due to central nervous system infection
- Primary or metastatic brain neoplasm
- Endocrine or metabolic abnormality
- Trauma
- Poisoning

Emergency Care: The patient underwent rapid sequence intubation for airway protection and ventilator failure. Additional seizures occurred after intubation, and he received midazolam, phenytoin, and propofol. A noncontrast head CT scan showed some ill-defined hypodensities but did not show any mass effect; a lumbar puncture was then performed.

Outcome: An axial T2-weighted image from a brain MRI demonstrated multifocal T2 hyperintensities involving the cortical gyri and adjacent subcortical white matter in both cerebral hemispheres, most pronounced posteriorly in the right parietal-occipital lobes consistent with posterior reversible encephalopathy syndrome (PRES). The patient had aggressive blood pressure lowering and had gradual improvement in his mental status. He was discharged on several antihypertensive medications and phenytoin.

Key Learning Points:

- PRES is also referred to as reversible posterior leukoencephalopathy syndrome (RPLS).
- Hypertension, renal disease, eclampsia, and immunosuppressant medications are several risk factors for developing PRES.
- Treatment consists of blood pressure management, control of seizure activity, and general supportive care. Cytotoxic drugs should be discontinued or decreased in dose.

Further Reading:

Altinkaya SO, Nergiz S, Küçük M, Yüksel H, Dayanir Y. Posterior reversible encephalopathy syndrome in obstetric patients. Report of three cases with literature review. *Clin Exp Obstet Gynecol*. 2014;41(6):730-733.

Rykken JB, Mckinney AM. Posterior reversible encephalopathy syndrome. *Semin Ultrasound CT MR*. 2014;35(2):118-135.

Thompson RJ, Sharp B, Pothof J, Hamedani A. Posterior reversible encephalopathy syndrome in the emergency department: case series and literature review. *West J Emerg Med*. 2015;6(1):5-10.

Yoon S, Cho BM, Oh SM, Park SH, Jang IB, Lee JY. Clinical and radiological spectrum of posterior reversible encephalopathy syndrome. *J Cerebrovasc Endovasc Neurosurg*. 2013;15(3):206-213.

Case 3-16

Cortical vein and superior sagittal sinus thrombosis

Patient Presentation: A 32-year-old with no significant prior medical history presented complaining of a severe headache with nausea that started 6 days prior to presentation. The pain was right occipital with radiation into the neck. The patient did not have any additional associated symptoms.

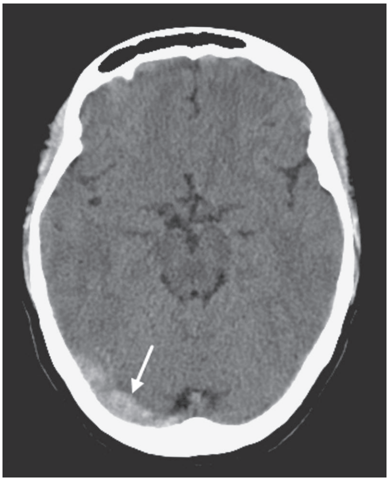

Figure 3-24. Noncontrast head CT scan. WA = hyperdense cortical vein (vein of Trolard)

Clinical Features: The patient appeared to be in moderate painful distress but had a normal neurologic examination.

Differential Dx:

- Intracranial pathology from vascular or infectious causes
- Primary or metastatic neoplasm
- Metabolic, endocrine, or toxicologic etiology

Emergency Care: The patient was given hydromorphone for pain and ondansetron for nausea. Prochlorperazine was subsequently administered, and the headache resolved. Given the duration and severity of the headache, a noncontrast head CT scan was performed. This revealed a hyperdense cortical vein in the right parietal region extending anteriorly and inferiorly, presumably the vein of Trolard. This appearance is highly suspicious for cortical vein thrombosis. The patient was anticoagulated with enoxaparin. A sagittal image from a head CT scan venogram confirmed the cortical vein thrombosis extending into the superior sagittal sinus. Of note, the patient had a strong family history of idiopathic thrombotic events. This patient was also on oral contraceptives. An exhaustive workup evaluating for inherited thrombophilia was negative. The patient was started on warfarin and had no complications.

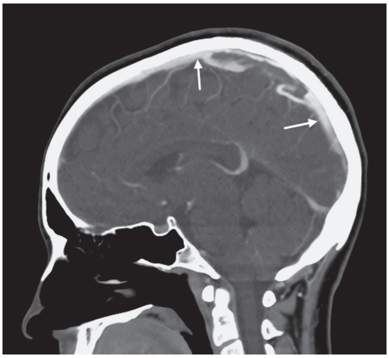

Figure 3-25. Head CT scan venogram. WA = thrombosis of saggital sinus

Key Learning Points:

- Spontaneous cerebral venous thrombosis is uncommon.
- Severe headache is the most common symptom, but focal neurologic deficits, seizures, or altered mental status can also be present.
- Prothrombotic disease or medications are often the inciting etiology.

Further Reading:

Al-Hashel JY, John JK, Vembu P. Venous thrombosis of the brain. Retrospective review of 110 patients in Kuwait. *Neurosciences (Riyadh)*. 2104;19(2):111-117.

Lee DJ, Ahmadpour A, Binyamin T, Dahlin BC, Shahlaie K, Waldau B. Management and outcome of spontaneous cerebral venous sinus thrombosis in a 5-year consecutive single-institution cohort. *J Neurointerv Surg*. 2017;9(1):34-38.

Case 3-17

Craniopharyngioma

Patient Presentation: A 49-year-old presented with a 2-week history of increasing confusion and worsening headache. The patient had an extensive psychiatric history, including psychosis and polysubstance abuse. On the day of presentation, he became lost when attempting to drive to a friend's residence.

Clinical Features: The patient was alert and oriented. He had a nonfocal neurologic examination except for disconjugate gaze, especially when attempting to look upward.

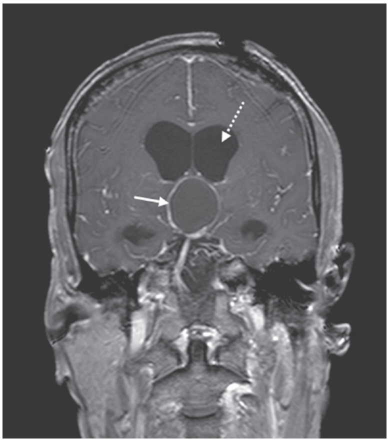

Figure 3-26. Contrast enhanced head MRI scan. WA = craniopharyngioma, WDA = obstructive hydrocephalus

Differential Dx:

- Exacerbation of psychosis
- Toxicologic exposure
- Central nervous system infection
- Metabolic or endocrine disorder
- Trauma
- Primary or metastatic neoplasm
- Benign intracranial tumor

Emergency Care: The patient underwent a head CT scan, followed by an MRI scan of the brain. A postcontrast coronal T1-weighted image from brain MRI shows a 2.9 × 2.6 × 2.9 cm predominantly cystic suprasellar mass with an enhancing rim, consistent with a craniopharyngioma. This mass caused moderate obstructive hydrocephalus.

Outcome: The patient had an external ventricular drain placed emergently, and the intracranial pressure was normal. The patient then underwent a transsphenoidal resection of the suprasellar cyst as well as placement of a VP shunt. He was also treated for central diabetes insipidus, adrenal insufficiency, and hypothyroidism with hydrocortisone and levothyroxine (panhypopituitarism picture).

Key Learning Points:

- It would have been easy to ascribe the patient's increasing confusion to his preexisting psychosis and/or polysubstance abuse and not pursue other diagnoses. Diagnostic premature closure is, unfortunately, a frequent mistake.
- It is important for the emergency medicine physician to form a broad differential and consider potential "worst-case scenario" diagnoses before "best-case scenario" diagnoses.

Further Reading:

Buchfelder M, Schlaffer SM, Lin F, Kleindienst A. Surgery for craniopharyngioma. *Pituitary*. 2013;16(1):18-25.

Fernandez-Miranda JC, Gardner PA, Snyderman CH, et al. Craniopharyngioma: a pathologic, clinical, and surgical review. *Head Neck*. 2012;34(7):1036-1044.

Muller HL. Craniopharyngioma. *Endocr Rev*. 2014;35(3):513-543.

Case 3-18

Third nerve palsy

Patient Presentation: A 30-year-old presented with a 4-day history of headache and double vision.

Clinical Features: The patient had a dense right cranial nerve III palsy with upper eyelid ptosis, a down and lateral gaze position, and a 4-mm nonreactive pupil on the right. The rest of the exam ination was unremarkable.

Figure 3-27. Right-sided third nerve palsy with ptosis and a down and lateral gaze

Differential Dx:

- Vascular pathology including aneurysm, vasculitis, thrombotic or embolic event, trauma, migraine headache variant, and tumor

Emergency Care: The patient had a noncontrast head CT scan revealing what was thought to be a thrombosed posterior communicating artery aneurysm. The patient was admitted for further diagnostic evaluation.

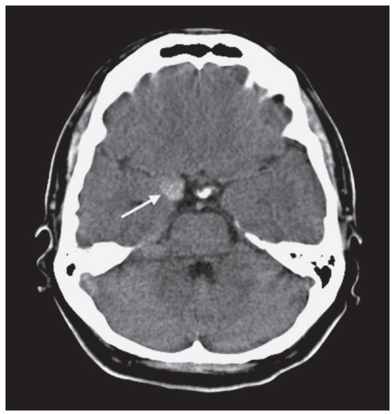

Figure 3-28. Noncontrast head CT scan. WA = initial radiographic diagnosis was a thrombosed posterior communicating artery aneurysm. However, operative diagnosis was an extravascular blood clot without aneurysm

Outcome: MRI and angiography confirmed the preliminary diagnosis. A workup for a hypercoagulable state was unremarkable. Unfortunately, no recovery of third nerve function was observed on follow-up, and the patient had a craniotomy 3 months after the initial presentation. The unexpected operative finding was the absence of any aneurysm. Instead, an extravascular blood clot was pressing on the third cranial nerve and right internal carotid artery. The clot was removed with decompression of the nerve and artery. A postoperative angiogram revealed no pathology. The cranial nerve deficit improved only modestly.

Key Learning Points:

- An acute cranial nerve deficit is a focal neurologic finding and requires aggressive diagnostic evaluation.

Further Reading:

Fang C, Leavitt JA, Hodge DO, Holmes JM, Mohney BG, Chen JJ. Incidence and etiologies of acquired third nerve palsy using a population-based method. *JAMA Ophthalmol*. 2017;135(1):23-28.

Howard BM, Barrow DL. Neuro-ophthalmology and intracranial aneurysms. *World Neurosurg*. 2015;83(3):291-293.

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Koskela E, Setälä K, Kivisaari R, Hernesniemi J, Laakso A. Neuro-ophthalmic presentation and surgical results of unruptured intracranial aneurysms—prospective Helsinki experience of 142 patients. *World Neurosurg*. 2015;83(4):614-619.

Williamson RW, Wilson DA, Abla AA, et al. Clinical characteristics and long-term outcomes in patients with ruptured posterior inferior cerebellar artery aneurysms: a comparative analysis. *J Neurosurg*. 2015;123(2):441-445.

Case 3-19

Infant epidural hematoma

Patient Presentation: A 9-month-old with a history of developmental delay presented with an altered mental state. The patient was reportedly dropped off at daycare in good health but then had a progressive decline in level of consciousness.

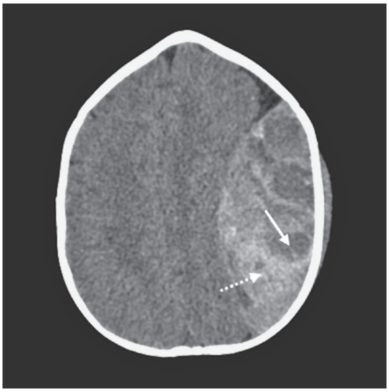

Figure 3-29. Noncontrast head CT scan. Large, heterogeneous epidural hematoma with hyper-acute-on-acute hemorrhage. WA = hypodensity, WDA = hyperdensity

Clinical Features: The infant presented with eyes closed, minimally responsive to painful stimuli, and not spontaneously interactive with the environment. He had a dilated and unresponsive left pupil. At times, there appeared to be decorticate posturing or seizure activity. There were no external signs of trauma.

Differential Dx:
- Central nervous system infection
- Trauma
- Seizure
- Metabolic or endocrine abnormality
- Primary central nervous system tumor
- Poisoning

Emergency Care: The patient was unresponsive and not protecting his airway. He underwent rapid sequence intubation with etomidate and succinylcholine and was subsequently sedated with propofol. Fosphenytoin was administered. An ED focused assessment with sonography for trauma (FAST) was unremarkable. Emergency non-contrast head CT scan revealed a large epidural hematoma with a skull fracture. The epidural hematoma had heterogeneous density suggestive of hyperacute-on-acute hemorrhage. The patient went emergently to the operating room for decompression.

Outcome: This patient made an uneventful recovery. Skeletal survey did not reveal any other bony injuries. The mechanism of trauma was never ascertained despite significant investigation. At the time of discharge, he had a brain MRI that showed postsurgical changes without any specific anatomic abnormalities. He was alert, interactive, and thought to be at his baseline neurologic status.

Key Learning Points:
- A large epidural hematoma in this age group is uncommon.
- Good neurologic outcome despite a clinical examination indicative of severe brain injury and radiographic evidence for herniation is possible with rapid emergency care and surgical decompression.

Further Reading:

Ciurea AV, Tascu A, Brehar FM, Nuteanu L, Rizea R. A life-threatening problem in infants: supratentorial epidural hematoma. *J Med Life*. 2009;2(2):191-195.

Irie F, Le Brocque R, Kenardy J, Bellamy N, Tetsworth K, Pollard C. Epidemiology of traumatic epidural hematoma in young age. *J Trauma*. 2011;71(4):847-853.

Paiva WS, Andrade AF, Mathias Júnior L, et al. Management of supratentorial epidural hematoma in children: report on 49 patients. *Arquivos De Neuro-Psiquiatria*. 2010;68(6):888-892.

Skadorwa T, Zygańska E, Eibl M, Ciszek B. Distinct strategies in the treatment of epidural hematoma in children: clinical considerations. *Ped Neurosurg*. 2013;49(3):166-171.

Case 3-20

Cervical rib

Patient Presentation: A 29-year-old woman presented with left lateral neck pain that radiated into her left shoulder, upper arm, and elbow. There was no history of trauma.

Clinical Features: The patient was in mild painful distress and had a normal neurologic and musculoskeletal examination.

Differential Dx:
- Musculoskeletal pain, radiculopathy from cervical disc disease
- Peripheral neuropathy

Emergency Care: The patient had a cervical spine radiograph demonstrating a left-sided cervical rib. The signs, symptoms, and radiograph were thought to be consistent with thoracic outlet syndrome.

Outcome: The patient was treated symptomatically and referred to clinic. Unfortunately, the patient was lost to follow-up.

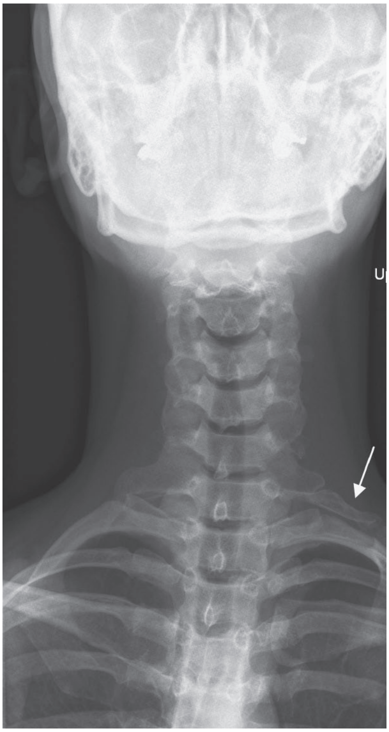

Figure 3-30. Cervical spine x-ray. WA = cervical rib

Key Learning Points:
- Thoracic outlet syndrome refers to a diverse group of symptoms and signs.
- It is generally thought to be caused by anatomic abnormalities, primarily involving ribs, muscles, or fibrous bands in and around the thoracic outlet near the first rib.
- It is generally categorized into three groups: patients presenting with primarily neurologic symptoms such as pain, those with venous compressive signs and symptoms, and those with arterial compressive symptoms and signs.
- Treatment ranges from conservative management to aggressive surgical procedures.

Further Reading:

Chwei-chin Chuang D, Fang F, Nai-Jen Chang T, Chuieng-Yi Lu J. Thoracic outlet syndrome: past and present—88 surgeries in 30 years at Chang Gung. *Plastic Reconstruct Surg Glob Open*. 2016;4(6):e728.

Higashihara M, Konoeda F, Sonoo M. Neurological signs and symptoms of true neurogenic thoracic outlet syndrome [in Japanese]. *Brain Nerve*. 2016;68(5):521-529.

Klaassen Z, Sorenson E, Tubbs RS, et al. Thoracic outlet syndrome: a neurological and vascular disorder. *Clin Anat*. 2014;27(5):724-732.

Povlsen B, Hansson T, Povlsen SD. Treatment for thoracic outlet syndrome. *Cochrane Database Syst Rev*. 2014;1:CD007218.

Case 3-21

Reversible cerebral vasoconstrictive syndrome

Patient Presentation: A 48-year-old presented with an altered mental status. The patient had a history of migraine headaches. The patient had suffered a wrist fracture 2 weeks previously; she presented to the orthopedics clinic for follow-up when she was noted to have an altered mental status and was transferred to the ED.

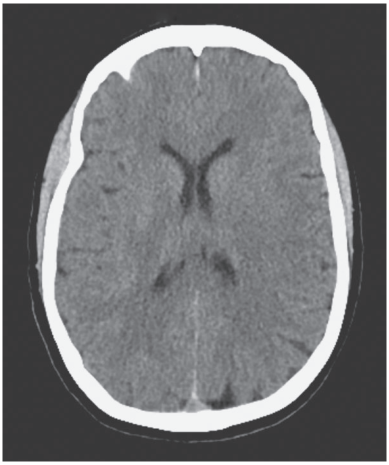

Figure 3-31. Noncontrast head CT scan. Normal study

Clinical Features: The patient was lethargic, confused, had slurred unintelligible speech, and was unable to follow simple commands. She was afebrile with a supple neck and no signs of trauma.

Differential Dx:

- Opioid overdose
- Occult trauma
- Central nervous system pathology such as infection or tumor
- Fat embolism
- Illicit substance abuse
- Metabolic encephalopathy
- Occult hypoglycemia

Emergency Care: The patient was taking opioid medication for her wrist fracture, and 2 mg of naloxone had a modest effect on her mental status. She became increasingly agitated and combative, ultimately requiring rapid sequence intubation to facilitate the safe provision of deep sedation. Subsequent workup included a normal noncontrast head CT scan, a normal brain MRI, a normal urine toxicology screen, and a normal CSF analysis. She was admitted to the hospital.

Outcome: The patient was weaned from sedation 24 hours after admission and was extubated. At that time, she had a normal mental status and neurologic examination. Further history obtained from the patient revealed she had taken rizatriptan for the first time on the day before admission. Her presentation and time course were suggestive of reversible cerebral vasoconstrictive syndrome (RCVS), a side effect of the rizatriptan.

Key Learning Points:

- Onset of RCVS is generally heralded by a thunderclap headache.
- There can be a clinical and radiographic overlap of signs and symptoms between RCVS and PRES.

- RCVS is associated with pregnancy, migraine history, and vasoconstrictive medications. Neurosurgical procedures, hypercalcemia, aneurysms, cerebral arterial thrombosis, and cerebral artery dissection have also been linked to RCVS.
- There are a handful of reported cases of RCVS related to rizatriptan use.
- Approximately one in three patients with RCVS develop ischemic or hemorrhagic stroke, or reversible brain edema.
- Management is supportive with blood pressure monitoring. Routine use of vasoactive (dilating) medications is not warranted.
- The majority of patients recover without sequelae.

Further Reading:

Anzola GP, Brighenti R, Cobelli M, et al. Reversible cerebral vasoconstriction syndrome in puerperium: a prospective study. *J Neuro Sci*. 2017;375:130-136.

Choi HA, Lee MJ, Choi H, Chung CS. Characteristics and demographics of reversible cerebral vasoconstriction syndrome: a large prospective series of Korean patients. *Cephalalgia*. 2018;38(4):765-775.

Coffino SW, Fryer RH: Reversible cerebral vasoconstriction syndrome in pediatrics: a case series and review. *J Child Neurol*. 2017;32(7):614-623.

Feil K, Forbrig R, Thaler FS, et al. Reversible cerebral vasoconstriction syndrome and posterior reversible encephalopathy syndrome associated with intracranial hypotension. *Neurocrit Care*. 2017;6(1):103-108.

Kato Y, Hayashi T, Mizuno S, et al. Triptan-induced reversible cerebral vasoconstriction syndrome: two case reports with a literature review. *Intern Med*. 2016;55(23):3525-3528.

Perdices M, Herkes G. Reversible cerebral vasoconstriction syndrome. *Neuropsychol Rehabil*. 2018;28(2):223-233.

Topcuoglu MA, Chan ST, Silva GS, Smith EE, Kwong KK, Singhal AB. Cerebral vasomotor reactivity in reversible cerebral vasoconstriction syndrome. *Cephalalgia*. 2017;37(6):541-547.

Case 3-22

Cerebral malaria

Patient Presentation: A 68-year-old woman returned from a vacation in Africa 3 weeks prior to presentation. The patient initially presented to an outside hospital with a chief complaint of fever and moderate headache. Of note, she had taken chloroquine prophylaxis for malaria.

Figure 3-32. Noncontrast head CT scan. Normal study

Clinical Features: Examination at the referring hospital revealed an ill-appearance, a temperature of 40°C (104°F), and a normal neurologic examination.

Differential Dx:

- Given her recent trip to Africa, an infectious etiology, including malaria, was a strong consideration.

Emergency Care: The patient was admitted to the outside hospital, and within 24 hours had a decline in mental status. Her blood smear revealed *Plasmodium falciparum*, and the patient was transferred to our facility.

On arrival, she was afebrile with obvious jaundice. Her eyes were open, but she followed only intermittent simple commands and would only move her right side to painful stimulus. The patient was intubated, and a noncontrast head CT scan was performed, which did not show any pathology. A dialysis catheter was placed in the ED, and the patient was treated with 600 mg of quinidine gluconate.

Outcome: The patient had a complicated hospital course. She underwent exchange transfusion with 14 units of packed red blood cells. She developed idiopathic thrombocytopenia purpura, had a small right thalamic infarct, and needed vasopressor support for hypotension. Ultimately, the patient recovered and was discharged neurologically intact.

Key Learning Points:

- More than 240 million people worldwide develop symptoms of malaria each year, and the majority are infected with *P. falciparum*.
- Approximately 860,000 deaths worldwide occur each year from malaria.

Further Reading:

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Santos LC, Abreu CF, Xerinda SM, Tavares M, Lucas R, Sarmento AC. Severe imported malaria in an intensive care unit: a review of 59 cases. *Malar J*. 2012;11:96.

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Case 3-23

Maggots

Patient Presentation: A 60-year-old presented for evaluation of an ulcer on his forehead. He had not been previously evaluated for this problem. He stated that it had been present for several months and was not the result of any trauma.

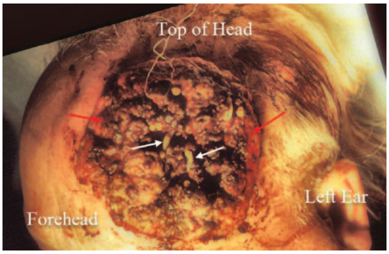

Figure 3-33. RA = squamous cell carcinoma of the forehead, WA = maggots

Clinical Features: The patient was wearing a bandana to cover the ulcer. When the bandana was removed, there was a large, fungating, malodorous, friable mass involving the left superior side of his forehead and scalp. Scattered throughout the mass were numerous maggots.

Differential Dx:
- Squamous or basal cell carcinoma
- Malignant melanoma
- Kerion
- Foreign body with inflammatory changes
- Intracranial extension of the pathology noted

Emergency Care: No specific emergency care was rendered.

Outcome: A noncontrast head CT scan was performed and did not reveal any intracranial pathology. The patient was admitted to the hospital for further management. The final pathology revealed a squamous cell carcinoma. The patient was lost to follow-up.

Key Learning Points:
- Pressure ulcers, chronic venous ulceration, diabetic ulcers, and other acute and chronic wounds have been effectively treated with maggot therapy. The larvae secrete proteolytic enzymes that liquefy necrotic tissue that is subsequently ingested while leaving healthy tissue intact.
- Comparative trials of standard wound management vs maggot therapy are inconclusive.

Further Reading:

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Davydov L. Maggot therapy in wound management in modern era and a review of published literature. *J Pharm Pract*. 2011;24(1):89-93.

Linger RJ, Belikoff EJ, Yan Y, et al. Towards next generation maggot debridement therapy: transgenic Lucilia sericata larvae that produce and secrete a human growth factor. *BMC Biotechnol*. 2016;16:30.

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Stadler F, Shaban RZ, Tatham P. Maggot debridement therapy in disaster medicine. *Prehosp Disaster Med*. 2016;31(1):79-84.

Zarchi K, Jemec GE. The efficacy of maggot debridement therapy—a review of comparative clinical trials. *Int Wound J*. 2012;9(5):469-477.

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CHAPTER 4 Cardiovascular and Pulmonary

Case 4-1

Fatal asthma

Patient Presentation: A 64-year-old woman with a history of asthma presented in cardiac arrest from a presumed severe asthma exacerbation. She underwent prehospital endotracheal intubation. Her initial cardiac rhythm was asystole, and she was treated with epinephrine, atropine, and transported to the hospital.

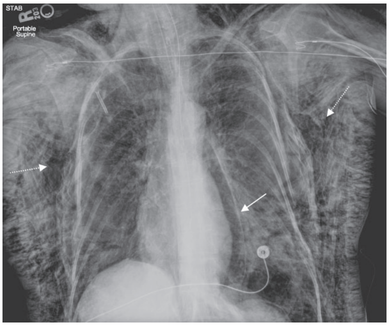

Figure 4-1. Chest x-ray. WA = pneumopericardium, WDA = extensive subcutaneous emphysema

Clinical Features: On arrival to the emergency department (ED), the patient was in cardiopulmonary arrest. Most notable on initial physical examination was the presence of severe widespread swelling from subcutaneous emphysema that involved her entire head, face, and extended through her torso down to the lower extremities. She had extremely high airway pressures evident by difficult manual bag ventilation.

Differential Dx:

- This patient had status asthmaticus.
- Hypoxia and acidosis from the inability to ventilate likely resulted in the cardiac arrest.
- A tension pneumothorax could have resulted in poor cardiac function and decreased venous return with a cardiac tamponade-like syndrome.

Emergency Care: The patient was treated aggressively with nebulized albuterol, IV methylprednisolone, and IV epinephrine and sodium bicarbonate. Bilateral needle thoracostomies for possible tension pneumothorax were performed with no rush of air and no improvement in either ventilation or hemodynamics. She was ventilated at a rate of 6 breaths/min to allow for her markedly prolonged expiratory phase, and attempts at manual compression of her chest were made. A supine portable chest radiograph demonstrated severe subcutaneous emphysema as well as a significant pneumopericardium. The mediastinum was narrow and appeared compressed. A subxiphoid pericardiocentesis was performed with a large rush of air heard and palpated through the needle. Within a minute of the pericardiocentesis, the patient regained a stable pulse. Bilateral thoracostomies were then performed, and the patient was admitted to the intensive care unit.

Outcome: Despite return of spontaneous circulation, the patient had suffered diffuse anoxic brain injury, and subsequently died.

Key Learning Points:

- Asthma exacerbations lead to a prolonged expiratory phase, and it is vitally important to decrease the ventilator rate to avoid dynamic hyperinflation.
- Manual thoracic compression to assist exhalation may be helpful.
- Cardiac arrest from asthma is typically from hypoxia and respiratory acidosis. Tension pneumothorax is another common etiology for asthma-related cardiac arrest.
- Tension pneumopericardium has been most frequently reported from penetrating and blunt trauma, barotrauma caused by mechanical ventilation, and iatrogenic complications from various invasive procedures. Pneumomediastinum from asthma occurs relatively frequently, but tension pneumopericardium with hemodynamic compromise from asthma is distinctly rare.

Further Reading:

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Leung PO, Lai CC. Tension pneumopericardium. *J Emerg Med.* 2014;46(5):687-688.

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Case 4-2

Ruptured left diaphragm

Patient Presentation: A 50-year-old presented for evaluation of injuries suffered in a motor vehicle crash.

Clinical Features: The patient was awake, tachypneic, and in moderate to severe respiratory distress. She had several painful orthopedic extremity injuries.

Differential Dx:
- Multiple traumatic injuries

Emergency Care: An initial chest radiograph demonstrated multiple right-sided rib fractures, a right pneumothorax, and a suspected left diaphragmatic rupture. The patient underwent rapid sequence endotracheal intubation, with placement of a right thoracostomy tube and a large-bore orogastric tube. A repeat chest radiograph demonstrated the now obvious left diaphragmatic rupture with the orogastric tube located in the stomach that had herniated into the left hemithorax.

Outcome: The patient was taken to the operating room for repair of the diaphragmatic injury. Several orthopedic injuries underwent subsequent open reduction and internal fixation, and the patient recovered.

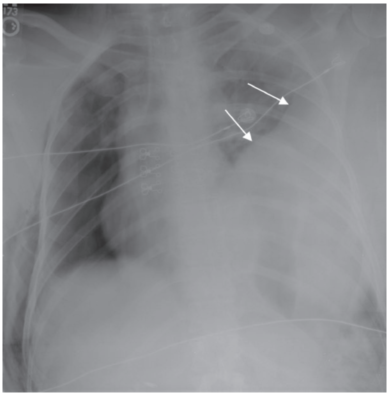

Figure 4-2. Chest x-ray. WA = ruptured left hemidiaphragm

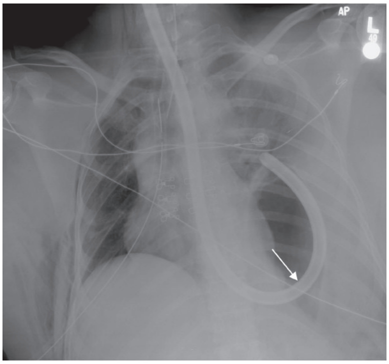

Figure 4-3. Chest x-ray. WA = orogastric tube in the stomach with a ruptured left hemidiaphragm

Key Learning Points:
- Approximately 1% to 2% of thoracoabdominal trauma patients will have a diaphragmatic rupture.
- A high index of suspicion for diaphragmatic injury is important as initial radiographic studies may be inconclusive.
- Delayed diagnosis of rupture with or without herniation of intra-abdominal contents into the thorax occurs.
- Placement of a large-bore orogastric tube may result in definitive diagnosis and can improve the respiratory status of patients with a herniated stomach into the left hemithorax.
- Bedside ED ultrasound has been utilized in the diagnosis.

Further Reading:

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Bunya N, Sawamoto K, Uemura S, et al. How to manage tension gastrothorax: a case report of tension gastrothorax with multiple trauma due to traumatic diaphragmatic rupture. *Int J Emerg Med*. 2017;10(1):4.

Gao J, Du DY, Li H, et al. Traumatic diaphragmatic rupture with combined thoracoabdominal injuries: difference between penetrating and blunt injuries. *Chin J Traumatol*. 2015;18(1):21-26.

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Thiam O, Konate I, Guete ML, et al. Traumatic diaphragmatic injuries: epidemiological, diagnostic and therapeutic aspects. *Springerplus*. 2016;5(1):1614.

Case 4-3

Kartagener syndrome

Patient Presentation: This adult patient presented with a cough. The patient had a history of recurrent cough and pneumonia.

Clinical Features: The patient was alert and intermittently coughing but in no respiratory distress.

Differential Dx:
- Pneumonia
- Bronchitis
- Tracheitis
- Reactive airway disease
- Viral upper respiratory illness
- Pharyngitis

Emergency Care: The patient had a chest radiograph that demonstrated situs inversus with bilateral lower lobe infiltrates. Chart review revealed this patient to have a diagnosis of Kartagener syndrome.

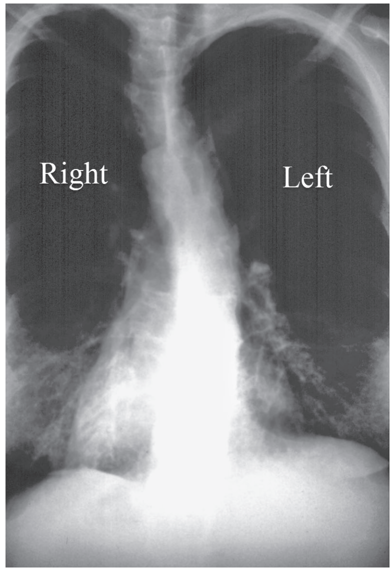

Figure 4-4. Chest x-ray. Dextrocardia and situs inversus

Outcome: The patient had an uncomplicated admission for pneumonia.

Key Learning Points:
- Primary ciliary dyskinesia is a defect in airway cilia to beat normally.
- Fifty percent of patients with primary ciliary dyskinesia also have situs inversus, chronic sinusitis, and chronic bronchiectasis, otherwise known as Kartagener syndrome.

Further Reading:

Lucas JS, Burgess A, Mitchison HM, et al. Diagnosis and management of primary ciliary dyskinesia. *Arch Dis Child*. 2014;99(9):850-856.

Shapiro AJ, Zariwala MA, Ferkol T, et al. Diagnosis, monitoring, and treatment of primary ciliary dyskinesia: PCD foundation consensus recommendations based on state of the art review. *Pediatr Pulmonol*. 2016;51(2):115-132.

Case 4-4

Liddle syndrome

Patient Presentation: A 22-year-old presented with severe chest and back pain. He had a history of Liddle syndrome.

Clinical Features: The patient was in severe painful distress. Physical examination did not reveal any abnormalities.

Differential Dx:
- Myocardial infarction
- Pericarditis
- Aortic dissection
- Pulmonary embolism
- Myocarditis
- Spontaneous pneumothorax
- Esophageal disease

Emergency Care: The patient had a normal electrocardiogram. A chest radiograph did not reveal any abnormalities, but computed tomography (CT) chest angiogram revealed an acute complicated aortic dissection that involved his renal arteries.

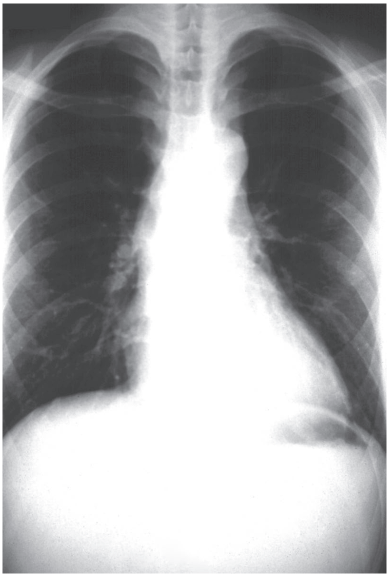

Figure 4-5. Chest x-ray. Aortic dissection not radiographically evident

Outcome: The patient went immediately to the operating room for successful repair of his dissection. However, he did develop renal failure with eventual end-stage renal disease requiring hemodialysis 7 years post aortic dissection repair.

Key Learning Points:
- Liddle syndrome is a rare autosomal dominant genetic disorder in which renal tubules increase sodium reabsorption and potassium secretion.
- The classic triad is hypertension, hypokalemia, and metabolic alkalosis.
- Aortic dissection has been associated with Liddle syndrome and its accompanying hypertension.
- Liddle syndrome is named after Dr. Grant Liddle, former chair of Internal Medicine at Vanderbilt University, where the author of this book attended medical school. It was paramount for a medical student at Vanderbilt University to include Liddle syndrome in the differential diagnosis of every patient presenting with hypertension. This is the only case the author has seen.
- Treatment includes the use of potassium-sparing diuretics such as triamterene and amiloride.

Further Reading:

Abbass A, D'Souza J, Khalid S, et al. Liddle syndrome in association with aortic dissection. *Cureus*. 2017;9(5):e1225.

Awadalla M, Patwardhan M, Alsamsam A, Imran N. Management of Liddle syndrome in pregnancy: a case report and literature review. *Case Rep Obstet Gynecol*. 2017;2017:6279460.

Cui Y, Tong A, Jiang J, Wang F, Li C. Liddle syndrome: clinical and genetic profiles. *J Clin Hypertens (Greenwich)*. 2017;19(5):524-529.

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Pichurin PN, Schwartz GL. Genetic testing helps to confirm the diagnosis and initiate appropriate treatment, a case of Liddle syndrome. *J Am Soc Hypertens*. 2017; 11(3):134-135.

Sabbadin C, Armanini D. Syndromes that mimic an excess of mineralocorticoids. *High Blood Press Cardiovasc Prev*. 2016;23(3):231-235.

Case 4-5

Aortic dissection with massive aortic valve regurgitation

Patient Presentation: A 56-year-old with a history of chronic obstructive pulmonary disease (COPD) presented with an altered mental status in respiratory distress. An empty bottle of trazodone was discovered at the scene. He was bag-valve-mask ventilated.

Clinical Features: The patient was unresponsive, bradycardic, and hypotensive. He was cool and diaphoretic with responsive pupils.

Differential Dx:

- Poisoning
- Acute central nervous system event
- Metabolic or endocrine etiology
- Sepsis
- Cardiovascular or pulmonary pathology

Emergency Care: The patient underwent rapid sequence intubation with etomidate and rocuronium. A focused assessment with sonography for trauma (FAST) examination was unremarkable. An EKG demonstrated ST-T wave changes. Shortly after ED arrival, the patient had a ventricular fibrillation cardiac arrest. Advanced cardiac life support protocol was performed. A bedside ED transesophageal echocardiography (TEE) probe was placed. Return of spontaneous circulation was obtained after 12 minutes. TEE imaging revealed an aortic dissection flap. The aortic dissection flap flipped back and forth through the aortic valve with each cardiac cycle. A contrast-enhanced chest CT scan was obtained demonstrating the dissection flap in relation to the ascending and descending aorta and its large extent. The dissection extended into the carotid arteries, subclavian vessels, and the superior mesenteric artery. The flap was noted to be close to the left main coronary artery. The nature and extent of the dissection precluded operative repair.

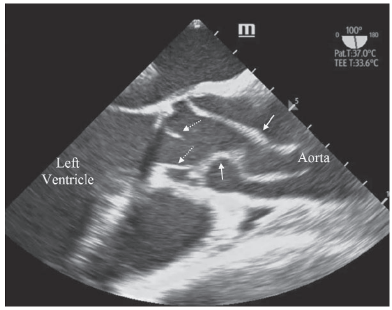

Figure 4-6. Cardiac ultrasound. WA = aortic dissection flap in systole, WDA = aortic valve

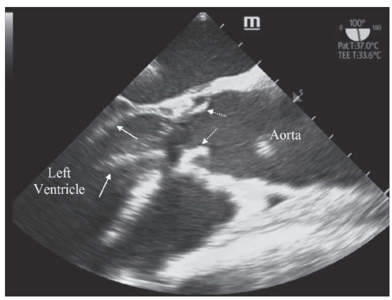

Figure 4-7. Cardiac ultrasound. WA = aortic dissection flap in diastole, WDA = aortic valve

Figure 4-8. Contrast chest CT scan. BAH = aortic dissection flap, WA = ascending aorta, WDA = descending aorta

Outcome: The patient was admitted to the intensive care unit and died within a few hours.

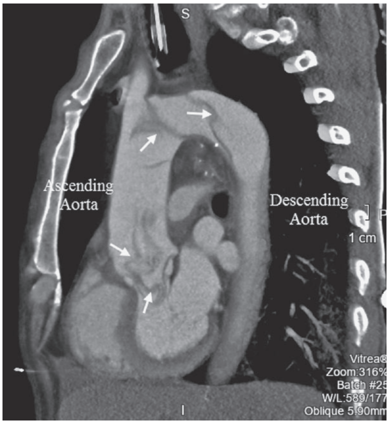

Figure 4-9. Contrast chest CT scan. WA = extensive dissection flap

Key Learning Points:

- In rare cases of type A aortic dissection, circumferential intimal disruption causes massive aortic regurgitation leading to prolapse of the intimal flap into the left ventricle.
- Patients who present with acute neurologic findings and electrocardiographic evidence of cardiac ischemia should be suspected of having a type A aortic dissection.
- Patients with asymmetry in blood pressure and/or pulse character in the upper extremities with acute cardiac ischemia should be suspected of a type A aortic dissection.
- TEE is extremely useful in guiding therapeutic management in an intubated, hemodynamically unstable patient in the ED.

Further Reading:

Hurley KF, Ducharme J. The utility of multiple imaging modalities to diagnose acute aortic dissection. *CJEM*. 2008;10(1):75-80.

Shively BK. Transesophageal echocardiography in the diagnosis of aortic disease. *Semin Ultrasound CT MR*. 1993;14(2):106-116.

Strayer RJ, Shearer PL, Hermann LK. Screening, evaluation, and early management of acute aortic dissection in the ED. *Curr Cardiol Rev*. 2012;8(2):152-157.

Yamabi H, Imanaka K, Sato H, Matsuoka T. Extremely localized aortic dissection and intussusception of the intimal flap into the left ventricle. *Ann Thorac Cardiovasc Surg*. 2011;17(4):431-433.

Case 4-6

Bullet embolism

Patient Presentation: A young male suffered a single gunshot wound to the thigh. This patient had never suffered a gunshot wound previously.

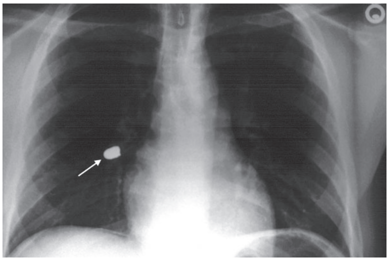

Figure 4-10. Chest x-ray. WA = bullet embolized from femoral vein to right pulmonary artery

Clinical Features: This patient was awake and alert, hemodynamically stable, and in moderate painful distress. He had a single wound to his anterior proximal thigh, with a moderate nonpulsatile hematoma. Color, motor, and sensation examination of the involved extremity was normal distally.

Differential Dx:
- Vascular, nerve, osseous injury
- Muscular and soft tissue injury

Emergency Care: A femur radiograph did not demonstrate a bullet. Since there was an entrance wound but no exit wound, further radiographs were obtained. A chest x-ray revealed a bullet in the mid-lung field. It was deduced that the bullet seen on his chest x-ray had embolized via his femoral vein and was lodged in his right pulmonary artery.

Outcome: Using an endovascular approach, this bullet was removed by interventional radiology with a good outcome.

Key Learning Points:
- It is important to take inventory of the number of gunshot wounds and the number of bullets found on radiographic examinations, keeping in mind that differentiating bullet entrance from bullet exit wounds is difficult and inaccurate.
- Patients should be asked if they have suffered prior gunshot wounds, as unfortunately this tends to be a recurrent event in some patient's lives.
- Management of isolated bullet embolism to the pulmonary artery depends on the symptoms, position, comorbid conditions, and risk of retrieval. Some bullet emboli can be managed conservatively by leaving them in place.

Further Reading:
Demirkilic U, Yilmaz AT, Tatar H, Ozturk OY. Bullet embolism to the pulmonary artery. *Interact Cardiovasc Thorac Surg*. 2004;3(2):356-358.
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Kortbeek JB, Clark JA, Carraway RC. Conservative management of a pulmonary artery bullet embolism: case report and review of the literature. *J Trauma*. 1992;33(6):906-908.

Case 4-7

Pneumopericardium and left ventricle chamber air (two patients)

Patient Presentation: Two patients presented after independent falls from significant heights.

Clinical Features: Both patients were critically ill with numerous injuries.

Differential Dx:

- Multiple traumatic injuries

Emergency Care: Both of these patients had portable chest radiographs. The first patient had a large pneumopericardium. The second patient had a left ventricle filled with air.

Outcome: Both patients died in the ED.

Key Learning Points:

- Diagnostic imaging of the thorax is mandatory in the management of significant blunt multiple trauma. Modalities include bedside ultrasound, plain radiography, and CT scan. These modalities are complimentary as they provide different clinical data with different speeds of data acquisition.
- Tension pneumopericardium from air does occur in patients with severe blunt chest trauma.

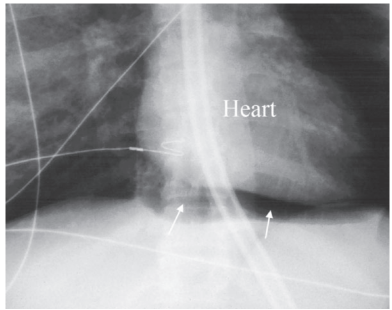

Figure 4-11. Chest x-ray of the first patient. WA = pneumopericardium

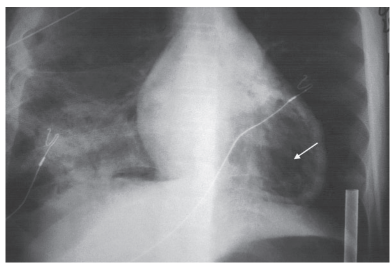

Figure 4-12. Chest x-ray of the second patient. WA = air within the left ventricle chamber

Further Reading:

Golota JJ, Orłowski T, Iwanowicz K, Snarska J. Air tamponade of the heart. *Kardiochirurgia I Torakochirurgia Polska*. 2016;13(2):150-153.

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Saada M, Goarin JP, Riou B, et al. Systemic gas embolism complicating pulmonary contusion. Diagnosis and management using transesophageal echocardiography. *Am J Respir Crit Care Med*. 1995;152(2):812-815.

Shaikh N, Ummunisa F. Acute management of vascular air embolism. *J Emerg Trauma Shock*. 2009;2(3):180-185.

Stegmaier J, Kirchhoff C, Biberthaler P. Tension pneumopericardium—a rare complication in multiply injured patients [in German]. *Der Unfallchirurg*. 2006;109(3):245-250.

Case 4-8

Persistent left superior vena cava

Patient Presentation: A 10-year-old was injured in a motor vehicle crash. The patient was unresponsive at the scene and was endotracheally intubated by paramedics.

Clinical Features: The patient had obvious head injury with contusions and abrasions to the face and scalp. He had a Glasgow Coma Score of 7.

Differential Dx:

- Multiple traumatic injuries

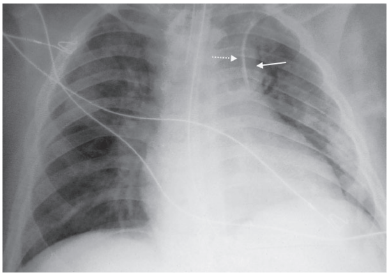

Figure 4-13. Chest x-ray. WA = persistent left superior vena cava, WDA = central venous catheter

Emergency Care: A central line was placed for vascular access using the left subclavian vein, and a postprocedure chest radiograph demonstrated the central line within a persistent left-sided superior vena cava. A head CT scan demonstrated significant brain edema without focal hemorrhage or hematoma.

Outcome: The patient had a complicated hospital course as a result of significant intracranial injury. Final outcome is unknown as this patient was lost to follow-up.

Key Learning Points:

- Persistent left superior vena cavas are rare, having been incidentally found in 0.17% of 4708 patients undergoing evaluation for an implantable electronic cardiac device.

Further Reading:

Steckiewicz R, Kosior DA, Rosiak M, Świętoń E, Stolarz P, Grabowski M. The prevalence of superior vena cava anomalies as detected in cardiac implantable electronic device recipients at a tertiary cardiology centre over a 12-year period. *Hellenic J Cardiol.* 2016;57(2):101-106.

Zhou Q, Murthy S, Pattison A, Werder G. Central venous access through a persistent left superior vena cava: a case series. *J Vasc Access.* 2016;17(5):e143-e147.

Case 4-9

Goodpasture syndrome

Patient Presentation: A 22-year-old presented with hemoptysis. She had a 2-week history of increasing myalgia, shortness of breath, weakness, and cough.

Clinical Features: The patient was pale, afebrile, and tachycardic. Oxygen saturation was 93% on room air. The patient displayed no respiratory distress, and breath sounds were clear but diminished.

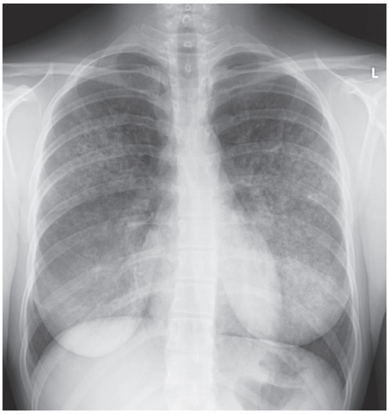

Figure 4-14. Chest x-ray. Diffuse, patchy air space process

Differential Dx:

- Pneumonia
- Cancer
- Tuberculosis
- HIV disease
- Atypical pneumonia
- Goodpasture syndrome
- Granulomatosis with polyangiitis (formerly Wegener granulomatosis)

Emergency Care: The patient was placed on oxygen with improvement in her oxygen saturation. A chest radiograph demonstrated a diffuse, patchy air-space process. Her hemoglobin was 6.0 g/dL, and urinalysis demonstrated 6 to 20 red blood cells/high power field without proteinuria. She was treated with IV azithromycin and sulfamethoxazole/trimethoprim. The patient received packed red blood cell transfusion and was admitted to the hospital.

Outcome: Serologic testing revealed high titers of antiglomerular basement membrane (anti-GBM) indicative of Goodpasture syndrome. She was treated with plasmapheresis, prednisone, and cyclophosphamide with marked improvement. She did not develop significant renal involvement. After remission, she had one subsequent relapse treated with rituximab and has remained symptom-free 10 years after the initial diagnosis.

Key Learning Points:

- Goodpasture syndrome is a disorder in which circulating antibodies are directed against an antigen intrinsic to the glomerular basement membrane (GBM).
- Goodpasture syndrome is rare, estimated at one case per million population.
- Prognosis depends upon the degree of renal involvement, particularly at the time of presentation. Those with intact renal function at 1 year generally do well.
- One-year survival is approximately 90% in treated patients, and relapse after treatment is uncommon.

Further Reading:

Devrieze BW, Hurley JA. Goodpasture syndrome (anti-glomerular basement membrane antibody disease). *StatPearls (Internet)*. Treasure Island, FL: StatPearls Publishing; 2018.

Dorval G, Guérin S, Berteloot L, et al. Antiglomerular basement disease in children: literature review and therapeutic options [in French]. *Arch Pediatr.* 2017; 24(10):1019-1028.

Greco A, Rizzo MI, De Virgilio A, et al. Goodpasture's syndrome: a clinical update. *Autoimmun Res*. 2015;14(3):246-253.

Touzot M, Poisson J, Faguer S, et al. Rituximab in anti-GBM disease: a retrospective study of 8 patients. *J Autoimmun*. 2015;60:74-79.

Case 4-10

Hemothorax from a rib exostosis

Patient Presentation: This pediatric patient presented with a chief complaint of shortness of breath and chest pain.

Clinical Features: The child was awake and hemodynamically stable. However, the child was somewhat ill appearing with mild respiratory distress.

Differential Dx:

- Pulmonary disease such as pneumonia, bronchitis, or reactive airway disease

Emergency Care: A chest x-ray was unremarkable. Despite the reassuring radiograph, the patient was admitted for observation based on her clinical appearance.

Figure 4-15. Chest x-ray. No acute abnormalities

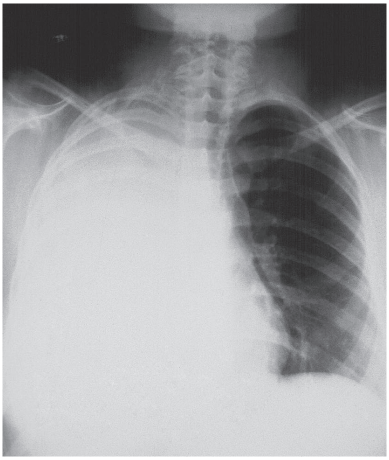

Figure 4-16. Chest x-ray. Massive right hemothorax

Outcome: Approximately 24 hours later, the patient's clinical condition acutely worsened with pain and respiratory distress. A repeat chest x-ray showed complete opacification of the hemithorax with a slight mediastinal shift to the left. A diagnostic thoracentesis returned frank blood. A 22 French chest tube was then inserted into the hemothorax with 1300 mL of frank blood output. The patient received blood transfusions, and despite continued thoracostomy tube output, her clinical status improved. A chest CT scan demonstrated multiple exostoses of the ribs, scapula, and clavicle. Active extravasation of contrast from an intercostal artery affected by one rib exostosis was evident. The patient was taken to the operating room where a rib resection was performed with surgical pathology noting an osteochondroma. The patient did well postoperatively.

Key Learning Points:

- The decision to admit this patient based on clinical appearance without a definitive diagnosis was fortuitous.
- Physical examination and intuition continue to play major roles in medicine even in the setting of more sophisticated technology.

Further Reading:

Blondel B, Launay F, Jacopin S, et al. Siblings with vascular involvement associated with hereditary multiples exostosis. *J Pediatr Orthop B*. 2013;22(5):501-504.

Hajjar WM, El-Medany YM, Essa MA, Rafay MA, Ashour MH, Al-Kattan KM. Unusual presentation of rib exostosis. *Ann Thorac Surg*. 2003;75(2):575-577.

Case 4-11

"Broken halo" sign

Patient Presentation: A 78-year-old was involved in a high-speed motor vehicle crash. The patient was complaining of chest pain and a headache.

Clinical Features: The patient was awake, alert, hemodynamically stable, and in moderate painful distress. The patient was tachycardic with clear breath sounds.

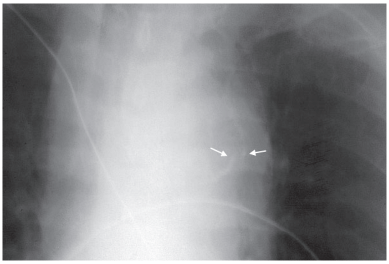

Figure 4-17. Chest x-ray. WA = broken calcification in the aortic knob

Differential Dx

- Multiple trauma, especially to the chest including pulmonary, cardiac, and great vessel injury

Emergency Care: A chest radiograph windowed to the area of interest demonstrated a disruption of the calcified vascular intima representing injury to her aorta. The two white arrows point to the ends of each fractured intimal site. A chest CT scan confirmed the presence of an aortic tear.

Outcome: The patient was taken to the operating room and had an open aortic repair with an uncomplicated postoperative hospital course.

Key Learning Points:

- Some radiographic findings are quite subtle and will not be appreciated unless specifically examined.
- The "broken halo" sign is a rare finding in aortic arch trauma. It is a visualized fracture through the calcified intima of the aorta.

Further Reading:

Perchinsky MJ, Long WB, Urman S, Borzotta A. 'The broken halo sign': a fractured calcified ring as an unusual sign of traumatic rupture of the thoracic aorta. *Injury*. 1994;25(10):649-652.

Case 4-12

Pediatric thoracic aortic injury

Patient Presentation: An 11-year-old was involved in a motor vehicle crash. The paramedics found the patient unconscious and vomiting. He underwent endotracheal intubation.

Clinical Features: The patient was unresponsive and tachycardic with an oxygen saturation of 90%. He had left upper extremity posturing.

Differential Dx:

- Multiple traumatic injuries

Emergency Care: A FAST examination revealed a left pneumothorax and a hemoperitoneum. A left thoracostomy tube was placed, and the massive transfusion protocol was initiated. A chest radiograph revealed widening of the mediastinum with loss of the aortic-pulmonary window. An axial image of a contrast-enhanced CT scan demonstrated a traumatic aortic pseudoaneurysm. Bilateral hemopneumothoraces, a grade IV splenic laceration with a moderate hemoperitoneum, and a grade II left renal laceration were also noted. Scattered subarachnoid hemorrhages and a small subdural hematoma were present on his head CT scan.

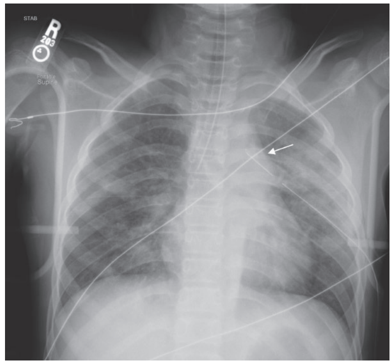

Figure 4-18. Chest x-ray. WA = widened mediastinum with loss of aortic-pulmonary window

Figure 4-19. Contrast chest CT scan. WA = traumatic aortic pseudoaneurysm

Outcome: The patient was emergently transferred to a local children's facility for endovascular stenting of his aortic injury. Stents normally utilized for adult aortic injury were too large in diameter for this patient. A stent generally used for endovascular repair of aortic coarctation in children was utilized. He was subsequently transferred back to our facility. He had a long and complicated hospital course. He was discharged alert, with purposeful extremity movements, and appropriate response to questions.

Key Learning Points:

- Use of aortic stents for pediatric aortic traumatic injury pose technical challenges.
- Use of balloon expandable aortic stents normally utilized for endovascular repair of pediatric aortic coarctation is generally safe and effective in pediatric traumatic aortic injury.

Further Reading:

Brinkman AS, Rogers AP, Archer CW, et al. Evolution in management of adolescent blunt aortic injuries—a single institution 22-y experience. *J Surg Res*. 2015;193(2):523-527.

Goldstein BH, Hirsch R, Zussman ME. Percutaneous balloon-expandable covered stent implantation for treatment of traumatic aortic injury in children and adolescents. *Am J Cardiol*. 2012;110(10):1541-1545.

Gombert A, Barbati ME, Grommes J, et al. Blunt thoracic aortic injury in case of a 15-year-old boy: difficulties and possibilities of the endovascular approach. *Ann Vasc Surg*. 2016;33(228):e15-e19.

Tashiro J, Hannay WN, Naves C, et al. Mechanism and mortality of pediatric aortic injuries. *J Surg Res*. 2015;198(2):456-461.

Case 4-13

Diaphragmatic injury with pericardial sac bowel

Patient Presentation: This patient was involved in a high-speed motor vehicle crash.

Clinical Features: The patient was hypotensive and complaining of chest and abdominal pain.

Differential Dx:

- Multiple traumatic injuries to thorax and abdomen

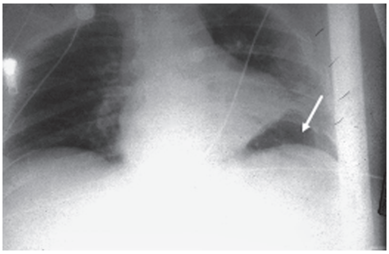

Figure 4-20. Chest x-ray. WA = bowel in the pericardial sac

Emergency Care: The patient was resuscitated, and a chest radiograph demonstrated an abnormal pocket of air overlying the left side of the heart. This could signify ventricular air from air embolism, pericardial air, or diaphragmatic hernia with bowel protrusion.

Outcome: The patient was taken to the operating room. Bowel was present within the pericardial sac as a result of diaphragmatic injury. This was repaired, and the patient did well.

Key Learning Points:

- Herniation of bowel contents into the pericardium is a rare event caused by injury to the central tendon of the diaphragm.
- Herniation of intestinal contents into the pericardium can occur at the time of injury or years later.

Further Reading:

Beless DJ, Organ BC. Delayed presentation of intrapericardial diaphragmatic hernia, an unusual cause of colon obstruction. *Ann Emerg Med*. 1991;20(4):415-417.

Dubroff RJ, Hoffman I. Intestinal tamponade: cardiac compression by intestinal contents. *J Am Soc Echocardiogr.* 1994;7(1):89-91.

Meng RL, Straus A, Milloy F, Kittle CF, Langston H. Intrapericardial diaphragmatic hernia in adults. *Ann Surg*. 1979;189(3):359-366.

Case 4-14

Pneumopericardium

Patient Presentation: This patient was ejected during a high-speed motor vehicle crash.

Clinical Features: He was unresponsive, in severe respiratory distress, and not protecting his airway. He had clinical shock and was hypotensive with a heart rate of 150 beats/min. Subcutaneous emphysema was palpated along his right chest wall.

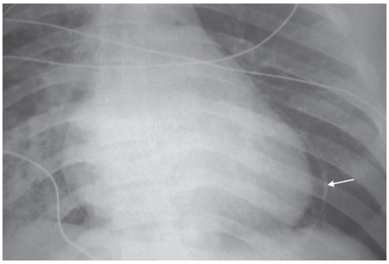

Figure 4-21. Chest x-ray. WA = pneumopericardium

Differential Dx:

- Multiple traumatic injuries

Emergency Care: A right-sided needle thoracostomy was performed given the hemodynamic instability and air palpated on the right chest wall. Rapid sequence intubation was performed. Shortly thereafter a right thoracostomy tube was placed. A chest radiograph showed a pneumopericardium. A pelvis radiograph revealed multiple fractures, and intraperitoneal hemorrhage was present with a grossly positive peritoneal aspiration.

Outcome: The patient was taken to the operating room where a laparotomy was performed, followed by a thoracotomy when the patient suffered cardiac arrest. The patient did not survive.

Key Learning Points:

- Although not thought to be present in this patient, tension pneumopericardium can occur as a result of blunt trauma with resultant hemodynamic instability.
- The presence of pneumopericardium is a poor prognostic sign in the setting of acute trauma.

Further Reading:

Cummings RG, Wesly RL, Adams DH, Lowe JE. Pneumopericardium resulting in cardiac tamponade. *Ann Thorac Surg*. 1984;37(6):511-518.

Haan JM, Scalea TM. Tension pneumopericardium: a case report and a review of the literature. *Am Surg*. 2006;72(4):330-331.

Katabathina VS, Restrepo CS, Martinez-Jimenez S, Riascos RF. Nonvascular, nontraumatic mediastinal emergencies in adults: a comprehensive review of imaging findings. *Radiographics*. 2011;31(4):1141-1160.

Case 4-15

Blunt traumatic inferior vena cava laceration

Patient Presentation: A16-year-old pedestrian was struck by a car. The patient had an altered mental status and was hemodynamically unstable.

Clinical Features: He was complaining of severe back and abdominal pain. The patient was awake and confused without respiratory distress. Hemorrhagic shock was clinically apparent.

Differential Dx:
- Multiple traumatic injuries

Emergency Care: A FAST examination revealed hemoperitoneum. The patient underwent rapid sequence intubation with succinylcholine and ketamine. The massive transfusion protocol was initiated. A contrast-enhanced CT scan revealed a large retroperitoneal hemorrhage and an inferior vena cava (IVC) injury. Sagittal and coronal images demonstrate the IVC with an interruption, clot, and contour abnormality. The patient was taken urgently to the operating room.

Figure 4-22. Contrast chest/abdomen CT scan. BA = retroperitoneal hemorrhage, WA = inferior vena cava (IVC), WDA = clot and contour abnormality in the IVC

Outcome: A 6.5-cm IVC laceration, whose distal endpoint was just proximal to the iliac veins, was identified and repaired with a bovine pericardial patch. Other injuries requiring management included a closed pelvic fracture, an open tibia-fibula fracture, and splenic laceration. The patient recovered.

Key Learning Points:
- IVC injuries are rare, occurring in <1% of blunt trauma patients.
- IVC injuries from blunt trauma have a mortality rate ranging from 34% to 70%.
- Contrast-enhanced CT imaging of IVC injuries from blunt trauma reveals retroperitoneal hematoma (75%), contrast extravasation and hepatic injury (83%), and contour abnormalities (50%).

Further Reading:

Cheaito A, Tillou A, Lewis C, Cryer H. Management of traumatic blunt IVC injury. *Int J Surg Case Rep.* 2016;28:26-30.

Jan WA, Samad A, Anwar R. Mortality and morbidity of abdominal inferior vena-caval injuries. *J Coll Physicians Surg Pak.* 2004;14(10):622-625.

Sam AD 2nd, Frusha JD, McNeil JW, Olinde AJ. Repair of a blunt traumatic inferior vena cava laceration with commercially available endografts. *J Vasc Surg.* 2006;43(4):841-843.

Figure 4-23. Contrast chest/abdomen CT scan. BA = retroperitoneal hemorrhage, WA = inferior vena cava (IVC), WDA = clot and contour abnormality in the IVC

Case 4-16

Fibrothorax from tuberculosis

Patient Presentation: A 71-year-old man presented with fever, cough, and shortness of breath.

Clinical Features: The patient was febrile, relatively well appearing, with an intermittent cough, but no respiratory distress.

Differential Dx:

- Pulmonary infection from a multitude of etiologies

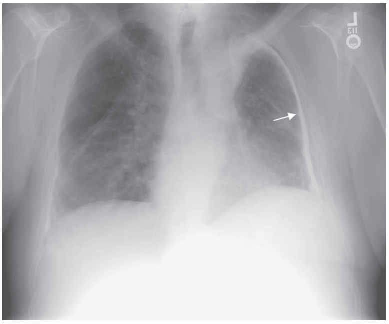

Figure 4-24. Chest x-ray. WA = pleural calcification

Emergency Care: The patient had a chest radiograph that demonstrated unusual findings. There were bilateral infiltrates present, and there were bilateral pleural calcifications, more marked on the left. Findings were compatible with fibrothorax from tuberculosis.

Outcome: The patient was admitted to the hospital for antibiotic administration and recovered from his pneumonia.

Key Learning Points:

- Using polymerase chain reaction, *Mycobacterium tuberculosis* complex DNA has been isolated and identified in calcified pleura from remains 1400 years old.

Further Reading:

Donoghue HD, Spigelman M, Zias J, Gernaey-Child AM, Minnikin DE. *Mycobacterium tuberculosis* complex DNA in calcified pleura from remains 1400 years old. *Lett Appl Microbiol.* 1998;27(5):265-269.

Case 4-17

Calcified left ventricular aneurysm

Patient Presentation: A 62-year-old patient with a history of end-stage renal failure and congestive heart failure presented with shortness of breath.

Clinical Features: This patient was in mild respiratory distress with rales present bilaterally.

Differential Dx:
- Pulmonary edema from congestive heart failure
- Pericardial effusion
- Pulmonary infection
- Reactive airway disease
- COPD

Emergency Care: A chest radiograph demonstrated a large calcified left ventricular aneurysm. A noncontrast chest CT scan further delineates the aneurysm.

Outcome: The patient was medically treated for congestive heart failure. This patient went on to have a left ventricular aneurysmectomy approximately 1 year later due to worsening symptoms of congestive heart failure and did well subsequently.

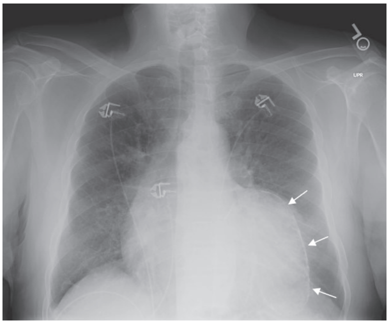

Figure 4-25. Chest x-ray. WA = calcified left ventricular aneurysm

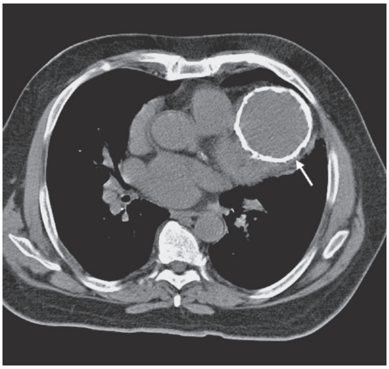

Figure 4-26. Noncontrast chest CT scan. WA = calcified left ventricular aneurysm

Key Learning Points:
- The differential diagnosis of this chest x-ray includes calcified pericardial cyst, pericardial calcification, a postinfectious process, or a calcified left ventricular aneurysm.
- In general, calcifications overlying the right ventricle tend to be pericardial calcifications, while those overlying the left ventricle tend to be calcified left ventricular aneurysms.

Further Reading:

Macgregor JH, Chen JT, Chiles C, Kier R, Godwin JD, Ravin CE. The radiographic distinction between pericardial and myocardial calcifications. *AJR Am J Roentgenol.* 1987;148(4):675-677.

Sugimura Y, Toyama M, Katoh M, Kotani M, Kato Y, Hisamoto K. Successful surgical repair of a giant calcified left ventricular aneurysm: a report of a case. *Ann Thorac Cardiovasc Surg.* 2012;18(4):352-354.

Case 4-18

Coccidioidomycosis

Patient Presentation: A 34-year-old presented with a 3-year history of intermittent mild hemoptysis. He had a 20-pack per year history of smoking and reported a negative PPD test 1 year prior.

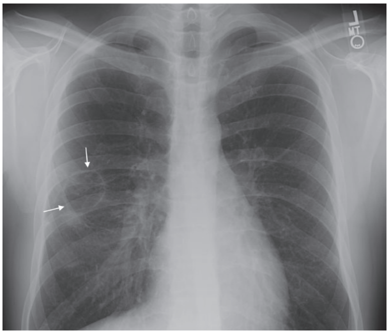

Figure 4-27. Chest x-ray. WA = cavitary lesion

Clinical Features: The patient was afebrile, in no respiratory distress, and was well appearing.

Differential Dx:

- Chronic bronchitis
- COPD
- Bronchiectasis
- Pulmonary infection
- Primary or metastatic pulmonary tumor

Emergency Care: Chest radiograph demonstrated a single, thin-walled cavitary lesion in the right mid lung. The patient was placed in isolation and admitted to the hospital.

Outcome: Coccidioidomycosis was diagnosed and treatment instituted. The patient was treated intermittently for the next 16 months and was eventually admitted with worsening symptoms and enlarging of the cavitary lesion. The patient underwent a wedge resection removal of this lesion.

Key Learning Points:

- Coccidioidomycosis is endemic to the southwestern United States where the fungus is known to live in the soil.
- Surgical resection for coccidioidomycosis is generally reserved for cavitary disease unresponsive to antifungal treatment, nodular disease where the diagnosis is unclear and cancer is still a possibility, or other complications of the disease.

Further Reading:

Ashfaq A, Vikram HR, Blair JE, Jaroszewski DE. Video-assisted thoracoscopic surgery for patients with pulmonary coccidioidomycosis. *J Thorac Cardiovasc Surg*. 2014;148(4):1217-1223.

Jaroszewski DE, Halabi WJ, Blair JE, et al. Surgery for pulmonary coccidioidomycosis: a 10-year experience. *Ann Thorac Surg*. 2009;8(6):1765-1772.

Case 4-19

Multiple congenital cardiovascular defects

Patient Presentation: An adult patient presented with severe respiratory distress. No prior medical history was available.

Clinical Features: The patient was in acute respiratory distress. He was hypoxic and had rales on lung auscultation.

Differential Dx:
- Congestive heart failure
- Pulmonary edema
- Acute respiratory distress syndrome
- Pulmonary infection

Emergency Care: A chest radiograph demonstrated pulmonary edema. The patient was treated with oxygen and furosemide with good response.

Outcome: The patient was admitted to the hospital. An extensive workup including a contrast-enhanced CT scan revealed several congenital defects, including partial anomalous pulmonary venous return, an atrial septal defect, and a persistent left-sided superior vena cava. The patient had markedly elevated right ventricular pressures that resulted in contrast backing up into her inferior vena cava and contributing veins. The patient was lost to follow-up.

Key Learning Points:
- The triad of partial anomalous pulmonary venous return, a persistent left-sided superior vena cava, and an atrial septal defect is a rare congenital anomaly.

Figure 4-28. Chest x-ray. Pulmonary edema

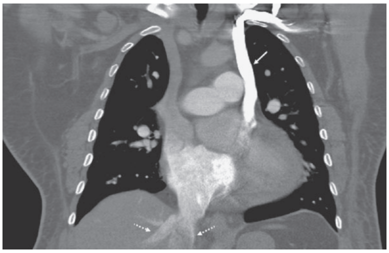

Figure 4-29. Contrast-enhanced chest CT scan. WA = persistent left superior vena cava, WDA = backup of contrast into the inferior vena cava and contributing veins secondary to elevated right-sided pressures

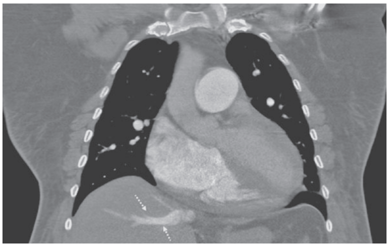

Figure 4-30. Contrast-enhanced chest CT scan. WDA = backup of contrast into the inferior vena cava and contributing veins secondary to elevated right-sided pressures

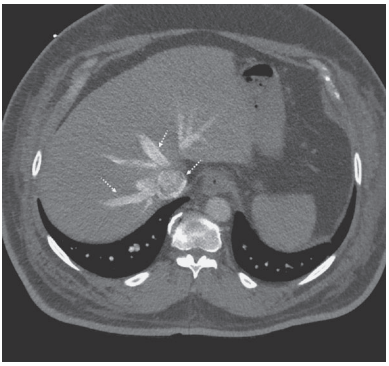

Figure 4-31. Contrast-enhanced chest CT scan. WDA = backup of contrast into the inferior vena cava and contributing veins secondary to elevated right-sided pressures

Further Reading:

Baron N. Association of left superior vena cava, sinus venosus defect and partial anomalous pulmonary venous return: an echographic and MDCT study. *Int J Cardiol.* 2014;172(3):e423-e424.

Ho M, Bhalla S, Bierhals A, Gutierrez F. MDCT of partial anomalous pulmonary venous return (PAPVR) in adults. *J Thorac Imag*. 2009;24(2):89-95.

Lewis CP, Bethencourt DM, Stephens RL, Cline JL, Tyndal CM. Robotic repair of sinus venosus atrial septal defect with partial anomalous pulmonary venous return and persistent left superior vena cava. *Innovations (Phila)*. 2014;9(5):388-390.

Rostagno C, Diricatti G, Galanti G, et al. Partial anomalous venous return associated with intact atrial septum and persistent left superior vena cava: a case report and literature review. *Cardiologia.* 1999;44(2):203-206.

Sahin T, Kilic T, Celikyurt U, Bildirici U, Ural D. Persistent left superior vena cava and partial anomalous pulmonary venous return in an old asymptomatic female patient. *Cardiol Res Pract*. 2009;2009:152164.

Van Meter C, LeBlanc JG, Culpepper WS 3rd, Ochsner JL. Partial anomalous pulmonary venous return. *Circulation*. 1990;82(5 suppl):IV195-IV198.

Case 4-20

Traumatic loculated hemopneumothorax

Patient Presentation: A 16-year-old pedestrian was struck by a car. There was loss of consciousness.

Clinical Features: The patient was awake and in moderate to severe pain. He had an open mandibular fracture, a shoulder dislocation, a chest wall contusion, an ankle fracture with significant deformity, and was in mild respiratory distress.

Differential Dx:

- Multiple blunt traumatic injuries

Emergency Care: A chest radiograph demonstrated a left lower lobe opacity concerning for pulmonary contusion. Given his multiple painful injuries, including two orthopedic injuries requiring reduction, the patient underwent rapid sequence intubation. A contrast-enhanced chest CT scan demonstrated a loculated hemopneumothorax at the left lung base with extension into a left lower lobe laceration with surrounding pulmonary contusion. A left thoracostomy tube was placed.

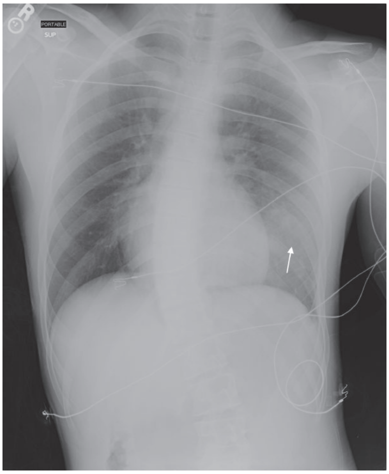

Figure 4-32. Chest x-ray. WA = pulmonary contusion

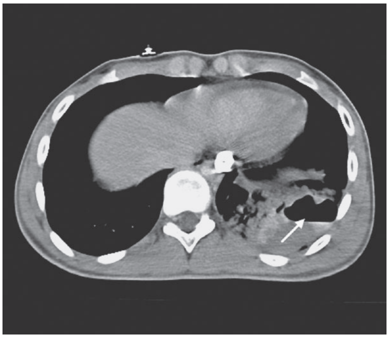

Figure 4-33. Contrast-enhanced chest CT scan. WA = loculated hemopneumothorax and left lower lobe laceration

Outcome: The hemopneumothorax resolved. The patient had all his orthopedic and facial injuries managed and repaired without complication.

Key Learning Points:

- Depending on the exact location of a loculated hemopneumothorax, percutaneous thoracostomy tube drainage may need interventional radiologic guidance for safe placement of the tube.

Further Reading:

Anonymous. Loculated hemopneumothorax. *Chest*. 1991;99(4):1054-1055.

Burns BJ, Aguirrebarrena G. Occult traumatic loculated tension pneumothorax—a sonographic diagnostic dilemma. *Prehosp Emerg Care*. 2013;17(1):92-94.

Case 4-21

A loaded handgun

Patient Presentation: A 19-year-old man was involved in a high-speed motor vehicle crash. He was initially awake with pain in his foot and pelvis.

Clinical Features: The patient presented with increasing respiratory distress. Subcutaneous emphysema was palpable along most of the anterior chest wall.

Differential Dx:

- Multiple blunt traumatic injuries, especially to the thorax

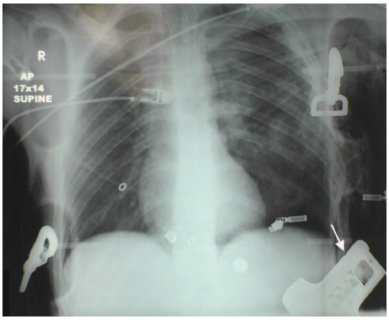

Figure 4-34. Chest x-ray. WA = loaded handgun located in the clothing of trauma patient

Emergency Care: An immediate portable chest radiograph demonstrated bilateral pneumothoraces. Of note, a loaded gun was visualized on the chest x-ray, concealed in the patient's clothing. Bilateral thoracostomies were placed. The patient was admitted for further care.

Outcome: The patient's thoracic injuries resolved without complication, and his pelvis and foot fractures were treated with open reduction and internal fixation. The patient was discharged without complication.

Key Learning Points:

- All critically ill blunt and penetrating trauma patients must have all clothing removed for appropriate diagnostic assessment.
- Weapons can be carried into the work setting deliberately or inadvertently. Unless the work setting has a weapons detection program, it is important to have a policy and process of handling weapons that are discovered.

Further Reading:

Kowalenko T, Walters BL, Khare RK, Compton S; Michigan College of Emergency Physicians Workplace Violence Task Force. Workplace violence: a survey of emergency physicians in the state of Michigan. *Ann Emerg Med*. 2005;46(2):142-147.

Rose AW. Pistol-packin' patients. What to know about legally armed patients and handling handguns safely. *EMS Mag*. 2009;38(3):60-61.

Simon HK, Khan NS, Delgado CA. Weapons detection at two urban hospitals. *Pediatr Emerg Care*. 2003;19(4):248-251.

Case 4-22

Pediatric coarctation of the aorta

Patient Presentation: A 2-month-old presented for evaluation of dehydration. The patient had been seen the previous day at an outside facility and diagnosed with a respiratory syncytial virus (RSV) infection.

Clinical Features: The infant was alert, afebrile, and had mild suprasternal retractions. The respiratory rate was 30 breaths/min. Lung auscultation revealed scattered end-expiratory wheezes, and oxygen saturation was 93% on room air.

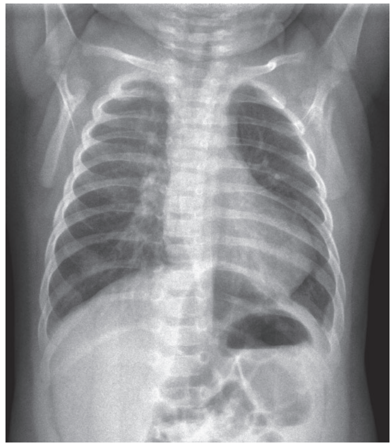

Figure 4-35. Chest x-ray. Streaky bilateral opacities

Differential Dx:

- RSV pneumonitis
- Bacterial pneumonia
- Dehydration
- Reactive airway disease
- Bronchiolitis
- Metabolic derangement

Emergency Care: Laboratory testing was performed, and IV fluids were administered. A chest radiograph showed streaky bilateral opacities compatible with atelectasis. Two hours after ED arrival, the patient developed sudden, severe respiratory distress and an altered mental status. Marked retractions were noted, and oxygenation saturation decreased to 82%.

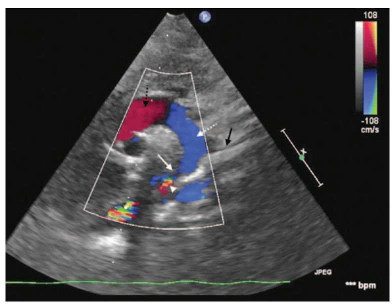

Figure 4-36. Pediatric cardiac ultrasound with color flow. BA = left subclavian artery, BDA = ascending aorta, WA = aortic coarctation, WAH = turbulent blood flow distal to coarctation, WDA = descending aorta

Bag-valve-mask ventilation was performed followed by rapid sequence intubation. Ketamine was administered for sedation. A bedside ED cardiac ultrasound revealed poor left ventricular function. A noncontrast head CT scan was unremarkable. Central venous and arterial catheters were inserted.

Outcome: The patient had an emergent cardiology ultrasound with color flow imaging. This revealed a severe coarctation of the aorta just distal to the left subclavian artery takeoff from the descending aorta. Relative directional aortic blood flow in the aortic arch results in red and blue colors, while local variability in color indicates high-velocity, turbulent blood flow. The aortic diameter at the coarctation was 4 mm.

The patient was started on IV alprostadil and milrinone infusions and was transferred to a tertiary pediatric cardiac care hospital for further management.

Key Learning Points:

- Coarctation of the aorta represents 5% to 7% of congenital heart disease, with an incidence of 0.3 to 0.4 per 1000 live births.
- Key diagnostic and physical examination findings for severe aortic coarctation include congestive heart failure and shock, occurring most notably at the time of ductus arteriosus closing. Hypertension in the upper extremities and diminished or delayed pulses in the lower extremities are also found.
- Operative mortality for repair of isolated coarctation of the aorta is 2%.
- Endovascular stenting or open operative repair are management options. A Cochrane review in 2012 determined there was insufficient evidence to favor one treatment option.

Further Reading:

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Case 4-23

Coarctation of the aorta in a pregnant patient

Patient Presentation: A 30-year-old presented complaining of a headache for several days. The patient was 8 weeks pregnant and had a history of hypertension. She stated she had heart problems during her last pregnancy necessitating a cesarean delivery and was supposed to have an operation after her delivery but did not because of insurance issues.

Clinical Features: Pleasant, well-appearing patient in mild painful distress. Unremarkable examination. Initial blood pressure was 197/90 mm Hg. The patient had a 3/6 holosystolic murmur.

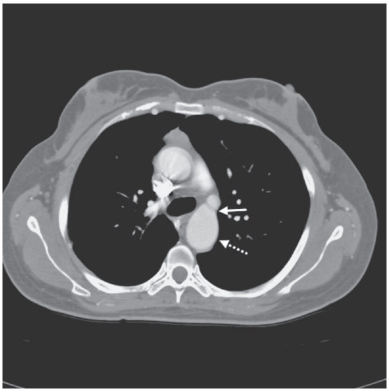

Figure 4-37. Contrast-enhanced chest CT scan. WA = coarctation of aorta, WDA = poststenotic dilation of descending aorta

Differential Dx:

- Per patient history, cardiac abnormality complicating pregnancy

Emergency Care: Records were obtained from an outside hospital. A contrast-enhanced chest CT scan had been previously performed before this pregnancy, showing a coarctation of the aorta with poststenotic dilation of the proximal descending aorta. The patient was admitted for hypertension management.

Outcome: The patient was started on labetalol with good control of her blood pressure. Options provided to the patient included continuing with the pregnancy with blood pressure management performed by cardiology, along with a planned early cesarean section delivery, or elective abortion. After much deliberation, the patient opted for an elective abortion at an outside facility.

Key Learning Points:

- High-risk pregnancies need to be managed early in the pregnancy by specialty obstetricians.
- Management of pregnant patients with significant coarctation of the aorta is complex. A multidisciplinary team including cardiologists, surgeons, and interventional radiologists is optimal as the condition can be managed medically, surgically, or endovascularly depending on the individual case circumstances.

Further Reading:

Assaidi A, Sbragia P, Fraisse A. Transcatheter therapy for aortic coarctation with severe systemic hypertension during pregnancy. *Catheter Cardiovasc Interv.* 2013;82(4):556-559.

Beauchesne LM, Connolly HM, Ammash NM, Warnes CA. Coarctation of the aorta: outcome of pregnancy. *J Am Coll Cardiol.* 2001;38(6):1728-1733.

Ruys TE, Bekkers JA, Duvekot JJ, Roos-Hesselink JW. A pregnant patient with native aortic coarctation and aneurysm. *Aorta (Stamford).* 2014;2(3):110-112.

Case 4-24

Unrecognized fatal adult coarctation of the aorta

Patient Presentation: A 26-year-old previously healthy patient presented in cardiac arrest from unknown etiology with no known trauma.

Clinical Features: The cardiac rhythm was asystole.

Differential Dx:
- Myocardial infarction
- Cardiac dysrhythmia
- Pulmonary disease such as asthma
- Pulmonary embolism
- Structural cardiac disease
- Prolonged QT syndrome
- Brugada syndrome, toxic ingestion
- Severe central nervous system event

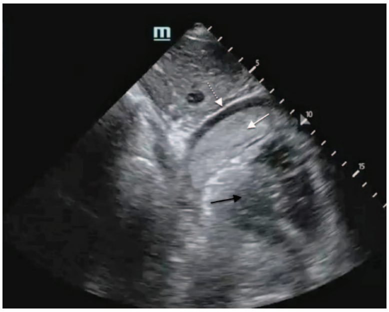

Figure 4-38. Cardiac ultrasound. BA = heart, WA = predominantly clotted hemopericardium, WDA = pericardium

Emergency Care: The patient was orotracheally intubated, and advanced cardiac life support resuscitation was continued. A bedside cardiac ultrasound revealed a large predominantly clotted pericardial effusion with the pericardium and cardiac structures clearly delineated. An ED thoracotomy was performed, with a massive bloody pericardial effusion released via pericardiotomy. The patient never regained a perfusing rhythm.

Outcome: An autopsy revealed a previously undiagnosed coarctation of the aorta, with a large proximal aortic aneurysm that had ruptured into the pericardial sac.

Key Learning Points:
- Hemorrhagic pericardial tamponade without trauma in a previously healthy patient is very unusual.
- Undiagnosed coarctation of the aorta in an adult leading to sudden death from a ruptured proximal aortic aneurysm into the pericardial sac is rare.

Further Reading:

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Latson L, Levsky JM, Haramati LB. Adult congenital heart disease: a practical approach. *J Thorac Imaging*. 2013;6:332-344.

Lawson RA, Fenn A. Dissection of an aneurysmal ascending aorta in association with coarctation of the aorta. *Thorax*. 1979;34(5):606-611.

Leetmaa TH, Nørgaard BL, Mølgaard H, Jensen JM. Severe aortic coarctation in an adult patient with normal brachial blood pressure. *J Clin Imaging Sci*. 2014;4:41.

Ludman P, Yacoub M, Dancy M. Mitral valve prolapse and occult aortic coarctation. *Postgrad Med J*. 1990;66(780):834-837.

Lunch MJ, Woodford NF, Dodd MJ. Sudden death due to aortic rupture complicating undiagnosed coarctation of the aorta in a teenager—a case report and review of the literature. *J Forensic Leg Med*. 2008;7:443-446.

Case 4-25

May-Thurner syndrome

Patient Presentation: A 48-year-old presented with a 3-day history of increasing swelling and discoloration in her left lower leg. The patient complained of intermittent shortness of breath without chest pain.

Clinical Features: The patient was alert with mild pain. Her left lower extremity was markedly swollen with purplish discoloration but intact distal pulses. Her examination was consistent with phlegmasia cerulea dolens (PCD).

Differential Dx:

- Deep vein thrombosis (DVT)
- Pulmonary embolism
- Arterial occlusion

Emergency Care: A lower extremity ultrasound diagnosed DVT of the left external iliac and popliteal veins. The patient was started on a heparin infusion. A transient decrease in oxygen saturation to 90% was concerning for pulmonary embolism. A CT pulmonary angiogram with venous runoff demonstrated no pulmonary embolism but did reveal a thrombus within the inferior vena cava as well as a thrombus within the left internal iliac vein. The right iliac artery was noted to be compressing the left iliac vein as it traversed over the vein. This was consistent with May-Thurner syndrome.

Outcome: The patient underwent endovascular aspiration thrombectomy following a 16-mg bolus of alteplase injected directly onto the clot and placement of an inferior vena cava filter. The patient had daily endovascular thrombolysis for 3 days with a gradual decrease in clot burden as noted on repeat venograms. The patient was discharged on anticoagulation.

Figure 4-39. CT pulmonary angiogram with venous runoff. WA = thrombosis in the inferior vena cava, WDA = inferior vena cava

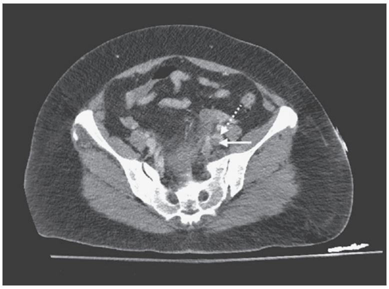

Figure 4-40. CT pulmonary angiogram with venous runoff. WA = thrombosis in the left internal iliac vein, WDA = left internal iliac vein

Figure 4-41. CT pulmonary angiogram with venous runoff reconstruction. WA = left internal iliac vein, WDA = right internal iliac artery

Key Learning Points:

- May-Thurner syndrome is caused by compression of the left iliac vein against the fifth lumbar vertebra by the right iliac artery as it traverses over the vein.
- PCD is a massive clot in the iliofemoral veins associated with significant morbidity.
- Patients with PCD present with sudden and severe pain, swelling, cyanosis, and edema that can progress to compartment syndrome.
- PCD is an indication for catheter-directed thrombolysis and thrombolectomy.

Further Reading:

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Erdoes LS, Ezell JB, Myers SI, Hogan MB, LeSar CJ, Sprouse LR 2nd. Pharmacomechanical thrombolysis for phlegmasia cerulea dolens. *Am Surg*. 2011;77(12):1606-1612.

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Case 4-26

Alpha-1-antitrypsin deficiency

Patient Presentation: A 57-year-old with severe emphysema secondary to alpha-1-antitrypsin deficiency (AATD) presented with increasing cough and sputum production.

Clinical Features: The patient was tachypneic and in mild to moderate respiratory distress. He had an oxygen saturation of 96% on 3 L of supplemental oxygen.

Differential Dx:

- Pneumonia
- Pneumothorax
- Pulmonary embolism
- Bronchitis
- Emphysema exacerbation

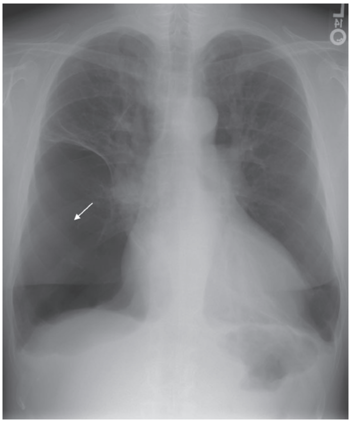

Figure 4-42. Chest x-ray. WA = large right lower lobe pulmonary bulla

Emergency Care: A chest radiograph demonstrated a large lower lobe pulmonary bulla from his AATD. The patient was given several β-agonist nebulization treatments, as well as prednisone, and was admitted for further management.

Outcome: The patient was treated with IV antibiotics and recovered well. As a side note, this patient had multiple episodes of pulmonary infections from *Xanthomonas*, atypical *Mycobacterium* spp., *Pseudomonas*, *Aspergillus*, and methicillin-resistant *Staphylococcus aureus*.

Key Learning Points:

- AATD is an uncommon, multisystem inherited disease.
- Alpha-1-antitrypsin is an inhibitor that protects lung tissue from proteolytic damage.
- Cigarette smoking and other environmental exposures worsen the disease.
- Definitive diagnosis is based on laboratory testing on serum levels, genotyping, and phenotyping.

Further Reading:

Anzueto A. Alpha-1 antitrypsin deficiency-associated chronic obstructive pulmonary disease: a family perspective. *COPD*. 2015;12(4):462-467.

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Case 4-27

Cardiac epithelioid angiosarcoma

Patient Presentation: A 27-year-old presented with a 3-day history of increasing shortness of breath. There was no prior significant medical history.

Clinical Features: The patient had an oxygen saturation of 93% on room air. He was tachypneic but did not have overt respiratory distress. Breath sounds were markedly diminished.

Differential Dx:
- Pulmonary infection
- Reactive airway disease
- Pulmonary embolism
- Cardiac disease

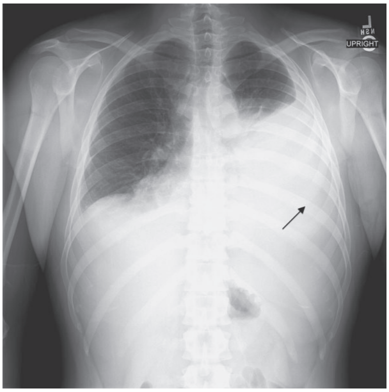

Figure 4-43. Chest x-ray. BA = left pleural effusion

Emergency Care: A chest radiograph revealed a large left pleural effusion. A thoracostomy tube was placed that drained 1,500 mL of serosanguinous fluid. The patient was admitted to the hospital.

Outcome: The patient developed a constrictive pericardial process and had a radical pericardiectomy performed. Biopsy at the time of surgery revealed a high-grade cardiac epithelioid angiosarcoma. The patient subsequently died.

Key Learning Points:
- Cardiac angiosarcoma, although rare, is the most common primary malignant tumor of the heart.
- Only 6% of all primary cardiac tumors are malignant.

Further Reading:

Ambrus N, Havasi K, Kalapos A, et al. Primary cardiac angiosarcoma: a case report. *Echocardiography*. 2018;35(2):267-271.

Matzke LM, Knowling MA, Grant D, et al. A rare cardiac neoplasm: case report of cardiac epithelioid angiosarcoma. *Cardiovasc Pathol.* 2011;20(5):e197-e201.

Wang J, Wang B, Hu Y, et al. Clinicopathologic features and outcomes of primary cardiac tumors: a 16-year-experience with 212 patients at a Chinese medical center. *Cardiovasc Pathol.* 2018;33:45-54.

Case 4-28

Multiloculated empyema

Patient Presentation: A 94-year-old woman presented with respiratory distress and chest pain. The patient had fallen 2 months prior and sustained a left-sided rib fracture.

Clinical Presentation: The patient was tachypneic, hypoxemic, and in mild respiratory distress but otherwise had stable vital signs. On lung auscultation, left-sided breath sounds were markedly reduced.

Differential Dx:
- Pneumoniapulmonary edema
  - Pneumonia
  - Pulmonary edema
- Pneumothorax
- Hemothorax
- Empyema

Emergency Care: A chest radiograph revealed a large left pleural effusion. A bedside ED ultrasound demonstrated a large, multiloculated complex fluid structure. A chest CT scan confirmed the ultrasound findings of a loculated pleural collection and collapsed lung pulled by adhesions. A thoracostomy tube was placed with 750 mL of purulent fluid drained, consistent with an empyema. The patient was given vancomycin and piperacillin/tazobactam and admitted to the hospital.

Outcome: Cultures grew streptococcus intermedius, and the patient was switched to ceftriaxone. A persistent loculated empyema remained despite continued modest drainage. Alteplase was injected via pigtail catheter into the loculated portions of the empyema. Following the alteplase injection, the purulent drainage markedly increased over the next 48 hours, with significant improvement in her clinical condition. She was discharged home on levofloxacin.

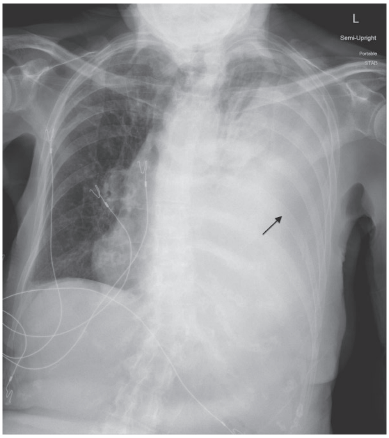

Figure 4-44. Chest x-ray. BA = left pleural effusion

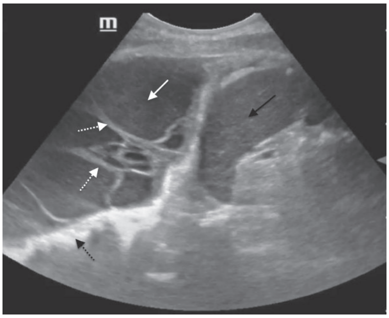

Figure 4-45. Thoracic ultrasound. BA = spleen, BDA = diaphragm, WA = loculated fluid, WDA = fibrous septations

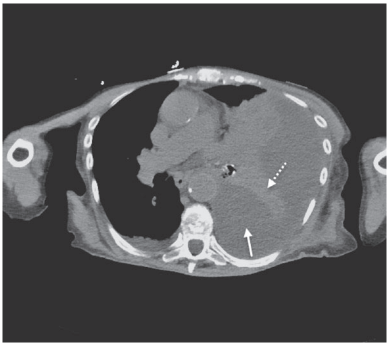

Figure 4-46. Chest CT scan. WA = loculated fluid, WDA = fibrous septations

Key Learning Points:

- Management for thoracic empyema varies according to clinical circumstances and the complexity of the empyema. Antibiotics, thoracostomy tube drainage, fibrinolytic agents, mucolytic agents, thorascopic or open debridement, and decortication are selectively utilized.

Further Reading:

Aleman C, Porcel JM, Alegre J, et al. Intrapleural fibrinolysis with urokinase versus alteplase in complicated parapneumonic pleural effusions and empyemas: a prospective randomized study. *Lung*. 2015;193(6):993-1000.

Janda S, Swiston J. Intrapleural fibrinolytic therapy for treatment of adult parapneumonic effusions and empyemas: a systematic review and meta-analysis. *Chest*. 2012;142(2):401-411.

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Case 4-29

Deactivation of automatic internal cardiac defibrillator

Patient Presentation: A middle-aged male presented after his automated internal cardiac defibrillator (AICD) had fired numerous times.

Clinical Features: The patient was awake, anxious, but not ill appearing. He had stable vital signs.

Differential Dx:
- Shockable cardiac arrhythmia
- Electrolyte abnormality
- Malfunctioning AICD

Emergency Care: The AICD fired several times upon presentation to the ED. Ventricular tachycardia was the rhythm the AICD was treating. The AICD was deactivated by placing a donut magnet directly over the AICD as shown on the chest radiograph, and the ventricular tachycardia was terminated with IV lidocaine.

Outcome: The AICD was interrogated and was found to have fired 37 times prior to deactivation. The patient was admitted for observation.

Key Learning Points:
- The AICD responses to placement of a magnet depend on the device as well as the particular model.
- No change in the AICD pacing mode occurs with magnet application. Although the general response of AICDs to magnet application is suspension of all antitachycardia therapies, this response is programmable depending on the model.
- In some instances, magnet removal may not reenable antitachycardia therapy, so it is best to consult with the device manufacturer or clinical electrophysiologist in these cases.

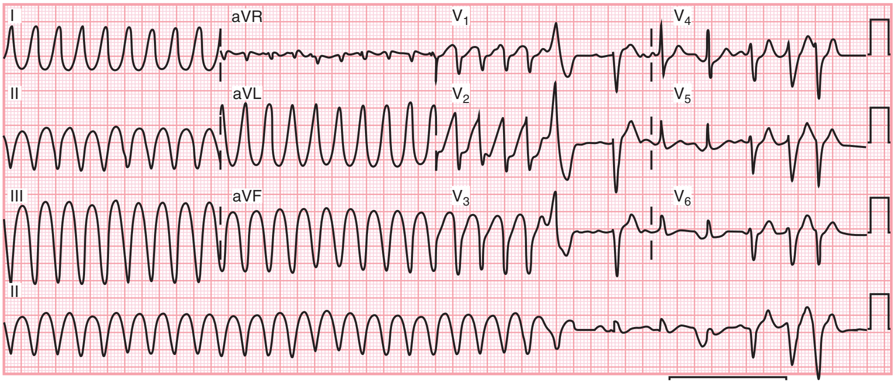

Figure 4-47. Electrocardiogram. Ventricular tachycardia

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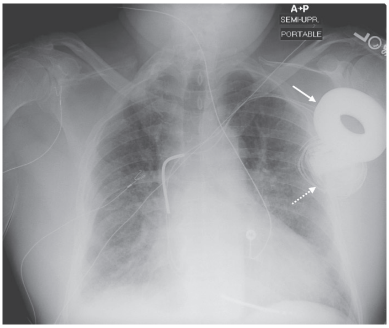

Figure 4-48. Chest x-ray. WA = donut magnet, WDA = AICD

Case 4-30

Right atrial myxoma

Patient Presentation: A 58-year-old presented with shortness of breath, abdominal pain, and peripheral edema. He denied chest pain.

Clinical Features: The patient was well appearing without painful or respiratory distress. Lungs were clear, and the patient had 2+ lower extremity pitting edema.

Differential Dx:

- New-onset pitting edema can have a cardiac, renal, or hepatic etiology. Abdominal pain and shortness of breath have innumerable diagnostic possibilities.

Emergency Care: A chest radiograph and electrocardiogram (EKG) were unremarkable. The patient had a mildly elevated NT ProBNP (3160 pg/mL) and D-dimer (587 ng/mL). Hepatic and renal function lab tests were unremarkable. A bedside ED cardiac ultrasound demonstrated a small pericardial effusion and a large echogenic mass in the right atrium that extended across the tricuspid valve into the right ventricle. The differential at this point was an atrial myxoma versus clot. A contrast-enhanced chest CT scan revealed this to be an atrial myxoma prolapsing into the right ventricle.

Outcome: The atrial myxoma was resected, and the patient had an uncomplicated hospital course.

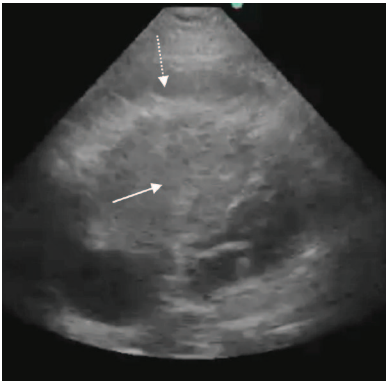

Figure 4-49. Cardiac ultrasound. WA = large echogenic mass involving the right atrium and right ventricle, WDA = pericardial effusion

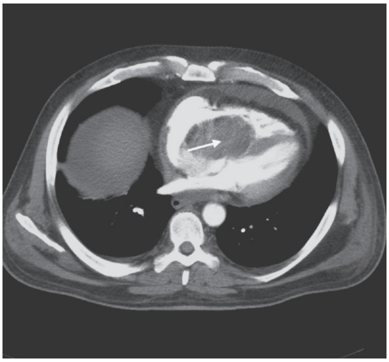

Figure 4-50. Contrast-enhanced chest CT scan. WA = atrial myxoma prolapsing into the right ventricle

Key Learning Points:

- The scope and utility of point-of-care ultrasound is remarkable. An argument for obtaining a bedside cardiac ultrasound in all patients in which a cardiac or pulmonary etiology is possible could easily be made.

Further Reading:

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Case 4-31

Umbilical artery and vein catheterization

Patient Presentation: A newborn required intensive care including placement of umbilical artery and umbilical vein catheters. Specific details of this case are unavailable.

Outcome: A chest radiograph demonstrated an umbilical artery catheter in the correct position, but the umbilical vein catheter exited the right atrium into the left atrium through a patent foramen ovale.

Key Learning Points:

- It is important to definitively image the location of both umbilical vein and umbilical artery catheters before using them for medications or monitoring.

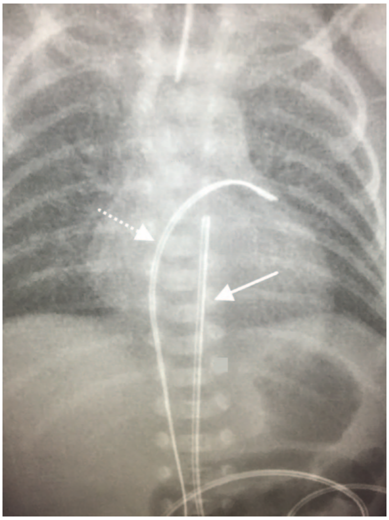

Figure 4-51. Chest x-ray. WA = umbilical artery catheter, WDA = umbilical vein catheter exiting the right atrium into the left atrium via a patent foramen ovale

Further Reading:

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Verheij GH, te Pas AB, Smits-Wintjens VE, Šràmek A, Walther FJ, Lopriore E. Revised formula to determine the insertion length of umbilical vein catheters. *Eur J Pediatr*. 2013;172(8):1011-1015.

Yigiter M, Arda IS, Hicsonmez A. Hepatic laceration because of malpositioning of the umbilical vein catheter: case report and literature review. *J Pediatr Surg*. 2008;43(5):E39-E41.

Case 4-32

Multiple pulmonary blebs

Patient Presentation: A 60-year-old patient with chronic obstructive pulmonary disease (COPD) presented with shortness of breath.

Clinical Features: The patient was in moderate respiratory distress with a prolonged expiration to inspiration ratio. Breath sounds were markedly diminished bilaterally with wheezes present.

Differential Dx:
- COPD exacerbation
- Pulmonary infection such as pneumonia or bronchitis

Emergency Care: The patient was treated with multiple β-agonist nebulizations and prednisone. A chest radiograph revealed impressive blebs but no change from baseline chest radiographs.

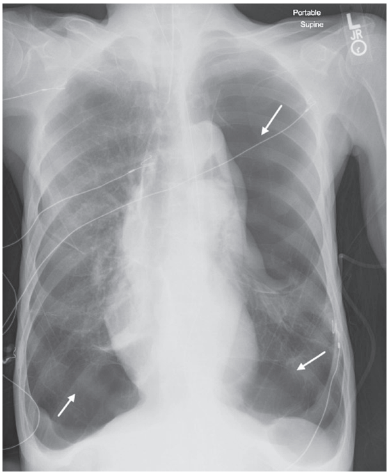

Figure 4-52. Chest X-ray. WA = pulmonary blebs

Outcome: The patient was treated for a COPD exacerbation with the addition of antibiotic therapy with levofloxacin.

Key Learning Points:
- Antibiotics are indicated in COPD exacerbations for a new infiltrate, or if there is increased dyspnea associated with increased sputum production or a change in sputum appearance indicative of purulence. There is evidence that C-reactive protein could predict the presence of bacterial infection in these patients.
- The decision to admit or discharge a patient with a COPD exacerbation can be difficult. Using the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria to determine severity of the exacerbation can be helpful.

Further Reading:

Gallego M, Pomares X, Capilla S, et al. C-reactive protein in outpatients with acute exacerbation of COPD: its relationship with microbial etiology and severity. *Int J Chron Obstruct Pulmon Dis*. 2016;11:2633-2640.

Merinopoulou E, Raluy-Callado M, Ramagopalan S, MacLachlan S, Khalid JM. COPD exacerbations by disease severity in England. *Int J Chron Obstruct Pulmon Dis*. 2016;11:697-709.

Montserrat-Capdevila J, Godoy P, Marsal JR, Barbé F. Predictive model of hospital admission for COPD exacerbation. *Respir Care*. 2015;60(9):1288-1294.

Case 4-33

Hepatic abscess causing pericardial tamponade

Patient Presentation: A 52-year-old transferred from an outside hospital. The patient had a recent diagnosis of hepatic cancer. He developed respiratory distress and was intubated. A coronal image from a contrast-enhanced chest CT scan showed a large pericardial effusion and a large hepatic fluid filled lesion.

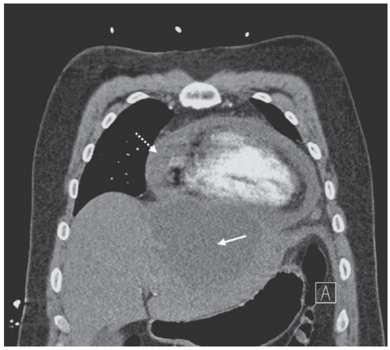

Figure 4-53. Contrast-enhanced chest CT scan. WA = hepatic abscess, WDA = pericardial effusion

Clinical Features: The patient arrived intubated and sedated with stable vital signs.

Differential Dx:

- Hepatic abscess
- Hepatic hemorrhage
- Pericardial effusion from reactive inflammatory, purulent, or transudative etiology

Emergency Care: A bedside ultrasound demonstrated a large pericardial effusion, a collapsing right ventricle anterior wall, and a small left ventricle. Shortly after this ED ultrasound was performed, the patient became hemodynamically unstable with a systolic blood pressure of 80 mm Hg. An emergent, ultrasound-guided pericardiocentesis was performed, and 450 cc of purulent fluid was aspirated. This resulted in immediate return of hemodynamic stability. The patient was admitted to the hospital.

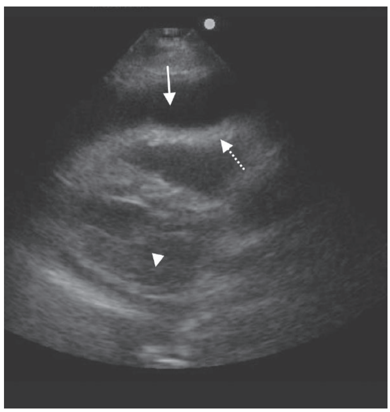

Figure 4-54. Cardiac ultrasound. WA = pericardial effusion, WAH = small left ventricle, WDA = collapsing free right ventricular wall

Outcome: This patient had a hepatic abscess from a subacute ruptured appendicitis. The hepatic abscess was drained by interventional radiology. The hepatic abscess communicated with the pericardium causing the purulent pericardial effusion and tamponade. The patient had a complicated hospital stay but was eventually discharged on prolonged antibiotic therapy.

Key Learning Points:

- It is important to be able to recognize the cardiac ultrasound features of hemodynamic compromise due to a pericardial effusion. Collapse of the free right ventricular wall, septal bowing, and small cardiac chambers representing poor filling are all indications that the pericardial effusion is causing the hemodynamic instability.

- Pericardiocentesis guided by real-time cardiac ultrasound is the safest method to perform this procedure.

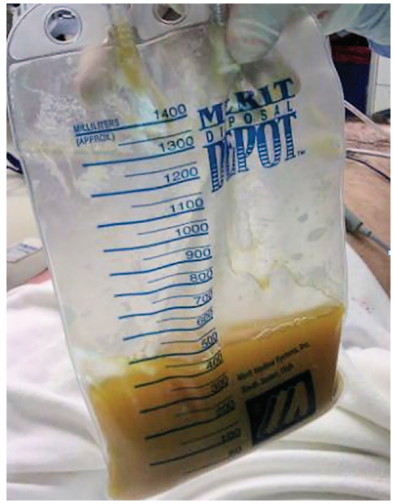

Figure 4-55. Purulent drainage obtained from pericardiocentesis

Further Reading:

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Case 4-34

Pulmonary edema associated with subarachnoid hemorrhage

Patient Presentation: A 34-year-old presented with a sudden altered mental status. There was no prior complaint of headache.

Clinical Features: The patient was agitated, confused, and not following commands. He was moving all extremities and had normal pupillary light reaction. The patient was febrile to 38.8°C (102°F).

Differential Dx:

- Central nervous system (CNS) pathology including infection, trauma, subarachnoid hemorrhage (SAH), ischemic or hemorrhage stroke, and toxicologic, endocrine, or metabolic abnormality
- Presence of fever concerning for meningitis or encephalitis

Figure 4-56. Noncontrast head CT scan. WA = subarachnoid hemorrhage

Emergency Care: The patient's agitation precluded providing supportive care as well as performing diagnostic testing. He underwent rapid sequence intubation followed by deep sedation. He was given antibiotics for concern of CNS infection, and a noncontrast head CT scan was obtained. This showed a large subarachnoid hemorrhage, and subsequent head CT angiogram demonstrated 6 mm anterior communicating artery aneurysm. Nicardipine was used to control blood pressure. A chest radiograph demonstrated bilateral infiltrates consistent with noncardiogenic pulmonary edema.

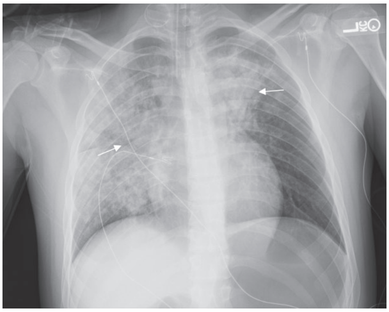

Figure 4-57. Chest x-ray. WA = noncardiogenic pulmonary edema

Outcome: The patient had a complicated hospital course but eventually regained consciousness with an intact neurologic examination. He did develop hydrocephalus subsequent to the initial hospitalization that required a ventriculoperitoneal shunt.

Key Learning Points:

- The sensitivity of head CT scan for diagnosis of subarachnoid hemorrhage is nearly 100% in the first 6 hours after symptoms and declines over the next several days.

- There is varying opinion as to whether a lumbar puncture is needed if the head CT scan is negative within 6 hours of the onset of symptoms. The experience of the individual reading the CT scan plays a role in the sensitivity of the initial CT scan, as does the presence of minor hemorrhages or atypical presentations.
- Noncardiogenic pulmonary edema is a known consequence of SAH. Noncardiogenic pulmonary edema is more likely to develop in the higher grades of SAH. Patients with high-grade SAH who develop pulmonary edema have a much worse prognosis than patients with high-grade SAH who do not develop pulmonary edema.

Further Reading:

Chen W, Chang SH, Chen JH, Tai HC, Chan CM, Wang YC. Heart rate variability predicts neurogenic pulmonary edema in patients with subarachnoid hemorrhage. *Neurocrit Care*. 2016;25(1):71-78.

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Case 4-35

Flail chest

Patient Presentation: This young adult patient had been involved in a high-speed motor vehicle crash.

Clinical Features: The patient was in moderate painful and respiratory distress from an obvious right chest injury. He was hemodynamically stable. He had an impressive flail chest. There was a contused and erythematous flail segment of the right upper chest wall. The axial image of a contrast-enhanced chest CT scan reveals the defect in the chest wall and the air bubble immediately under the bowed chest wall.

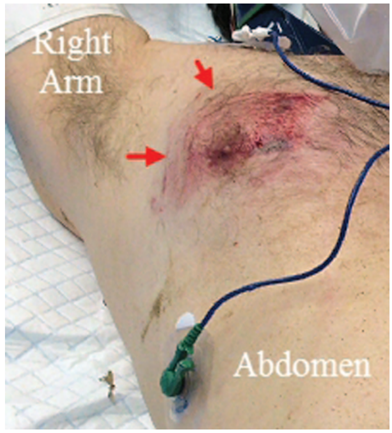

Figure 4-58. RA = contusion with a flail segment bowing outward in expiration

Differential Dx:
- Pulmonary contusion
- Pneumothorax
- Hemothorax
- Great vessel injury

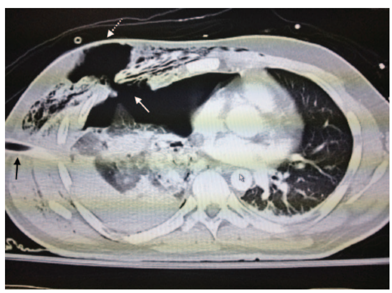

Figure 4-59. Contrast-enhanced chest CT scan. WA = defect in chest wall, WDA = large pocket of subcutaneous air underlying the flail segment

Emergency Care: Bedside sliding lung signs by ultrasound demonstrated a pneumothorax on the right. A thoracostomy tube was placed. The patient was admitted to the hospital.

Outcome: The patient never required mechanical ventilation. He resolved his pneumothorax and had an uncomplicated hospital course.

Key Learning Points:
- The most common definition of a flail chest is three or more contiguous ribs fractured in at least two places on each rib.
- The chest tube in this patient was somewhat difficult to place as the site had no bony support. The chest wall had to be supported from within using a finger to counter balance the pressure needed to push the tube into the right pleural space.
- These patients have multiple rib fractures, with resultant sharp bony edges. The physician needs to be careful not to sustain a puncture injury and to double glove or utilize gloves resistant to puncture.
- Flail chest can also be managed by operative fixation in an attempt to decrease pain and pulmonary complications such as pneumonia. The long-term utility of operative fixation remains unclear, as patient selection plays a key role.

- Continuous delivery of local anesthetic, such as ropivacaine, using a temporary implanted delivery device can greatly reduce the need for systemic pain medication and improves pulmonary function.

Further Reading:

Caragounis E, Fagevik-Olsen M, Pazooki D, Granhed H. Surgical treatment of multiple rib fractures and flail chest in trauma: a one-year follow-up study. *World J Emerg Surg*. 2016;11:27.

Fagevik-Olsen M, Slobo M, Klarin L, Caragounis EC, Pazooki D, Granhed H. Physical function and pain after surgical or conservative management of multiple rib fractures—a follow-up study. *Scand J Trauma Resusc Emerg Med*. 2016;24(1):128.

Senekjian L, Nirula R. Rib fracture fixation: indications and outcomes. *Crit Care Clin*. 2017;33(1):153-165.

Case 4-36

Massive pericardial effusion

Patient Presentation: A 48-year-old man presented with shortness of breath and a non-productive cough but denied fever or chest pain. He has worked as an asbestos remover for 9 years.

Clinical Features: The patient was mildly diaphoretic with an irregular heart rate of 144 beats/min. He was in mild respiratory distress with faint pulmonary wheezes. Oxygen saturation was 93% on room air.

Differential Dx:

- Pneumonia
- Pulmonary edema
- Congestive heart failure
- COPD
- Reactive airway disease
- Pulmonary embolism
- Pulmonary tumor
- Pleural effusion

Emergency Care: An initial EKG demonstrated atrial fibrillation with a rapid ventricular response, and chest x-ray demonstrated a markedly enlarged cardiac silhouette.

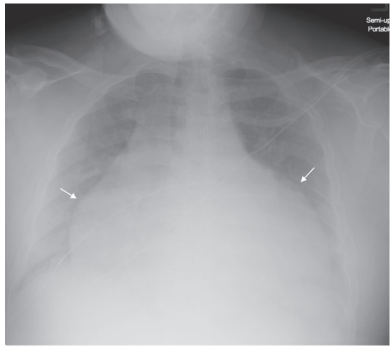

Figure 4-60. Chest x-ray. WA = large cardiac silhouette from a pericardial effusion

Figure 4-61. Contrast-enhanced chest CT scan. WA = large pericardial effusion

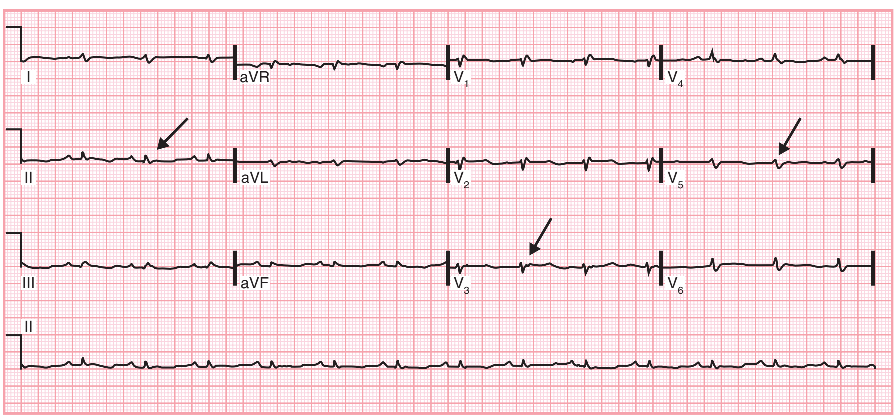

Figure 4-62. Electrocardiogram post-cardioversion. BA = markedly decreased QRS amplitude

A bedside ED cardiac ultrasound revealed a large pericardial effusion without tamponade appearance. A chest CT scan demonstrated the large pericardial effusion without any other cardiovascular or pulmonary pathology visualized. The patient was administered oxygen with improvement in his shortness of breath.

Outcome: The patient underwent cardioversion. A post-cardioversion EKG demonstrated a sinus rhythm with a marked decrease in QRS voltage secondary to the large pericardial effusion. A video-assisted pericardial window was performed with greater than 2 L of serosanguinous fluid drained. Extensive analysis of the pericardial fluid revealed no evidence for cancer or bacterial or fungal infection. Final diagnosis was viral pericarditis, and the patient was discharged home on colchicine.

Key Learning Points:

- An effusion this large had to have been slow in its accumulation to allow for accommodation and the absence of cardiac tamponade physiology.
- Pericarditis, trauma, malignancy, renal failure, autoimmune disease, post myocardial infarction, aortic dissection, and certain medications are the leading etiologies for pericardial effusion.
- History is often important in diagnosing the cause of a pericardial effusion.
- Gram stain, bacterial and fungal cultures, cytology, and AFB stain with mycobacterial culture are important studies on the pericardial fluid in this presentation.

Further Reading:

Goodman A, Perera P, Mailhot T, Mandavia D. The role of bedside ultrasound in the diagnosis of pericardial effusion and cardiac tamponade. *J Emerg Trauma Shock*. 2012;5(1):72-75.

Hoit BD. Pericardial effusion and cardiac tamponade in the new millennium. *Curr Cardiol Rep*. 2017;19(7):57.

Perez-Casares A, Cesar S, Brunet-Garcia L, Sanchez-de-Toledo J. Echocardiographic evaluation of pericardial effusion and cardiac tamponade. *Front Pediatr*. 2017;5:79.

Schairer JR, Biswas S, Keteyian SJ, Ananthasubramaniam K. A systematic approach to evaluation of pericardial effusion and cardiac tamponade. *Cardiol Rev*. 2011;19(5):233-238.

Vakamudi S, Ho N, Cremer PC. Pericardial effusions: causes, diagnosis, and management. *Progr Cardiovasc Dis*. 2017;59(4):380-388.

Case 4-37

Lemierre syndrome

Patient Presentation: A 20-year-old presented with fever, sore throat, cough, and shortness of breath. The patient had previously been seen twice at an outside facility. She was initially diagnosed with pharyngitis and treated with azithromycin. Symptoms continued to worsen, and she was treated with ceftriaxone, omnicef, and decadron for pneumonia. Four days later she presented for her initial ED visit.

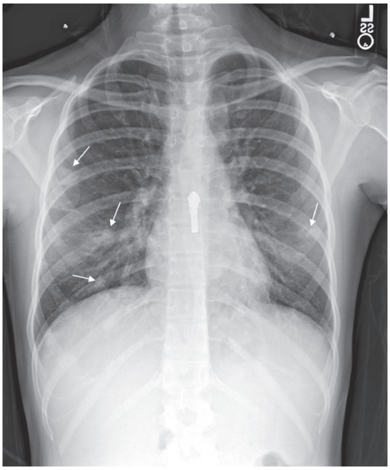

Figure 4-63. Chest x-ray. WA = multiple small pulmonary nodules

Clinical Features: The patient was febrile and in no painful or respiratory distress despite the coughing. Her posterior oropharynx was erythematous without exudate. She had tender anterior left-sided cervical adenopathy, and her lungs were clear to auscultation. No cardiac murmurs were appreciated.

Differential Dx:
- Pharyngitis
- Pneumonia
- Inflammatory or autoimmune pulmonary disease
- Sepsis
- Endocarditis

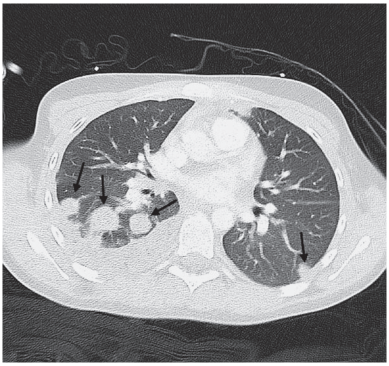

Figure 4-64. Contrast-enhanced chest CT scan. BA = multiple nodular pulmonary lesions

Emergency Care: A chest radiograph revealed multiple small nodular lesions. A contrast-enhanced chest CT scan in lung windows further delineated these peripheral nodular lesions. These findings raised the concern for septic emboli compatible with either right-sided endocarditis or Lemierre syndrome. A bedside ED vascular ultrasound of the neck demonstrated thrombosis in the internal jugular vein, compatible with Lemierre syndrome. The patient was admitted to the hospital.

Outcome: The patient was penicillin allergic and was treated initially with clindamycin and levofloxacin but later switched to ertapenem for a 5-week outpatient course. Blood cultures had no growth, likely due to the antibiotics previously administered. She recovered without complications.

Key Learning Points:

- It is important for the emergency medicine physician to expand the differential diagnoses in the setting of apparent failure of treatment.
- Lemierre syndrome is a septic thrombophlebitis of the internal jugular vein, typically caused by *Fusobacterium necrophorum*, a gram-negative anaerobe. It is usually preceded by pharyngitis with tonsillar or peritonsillar involvement.

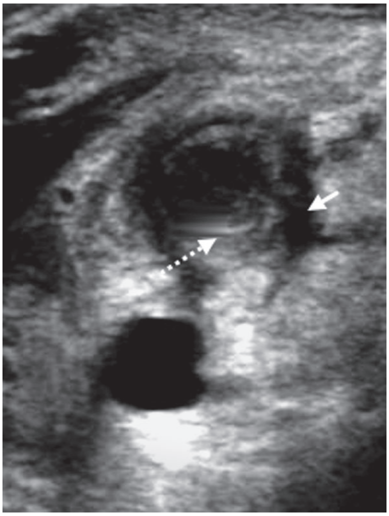

Figure 4-65. Vascular neck ultrasound. WA = internal jugular vein, WDA = thromobosis

Further Reading:

Noy D, Rachmiel A, Levy-Faber D, Emodi O. Lemierre's syndrome from odontogenic infection: review of the literature and case description. *Ann Maxillofac Surg*. 2015;5(2):219-225.

Righini CA, Karkas A, Tourniaire R, et al. Lemierre syndrome: study of 11 cases and literature review. *Head Neck*. 2014;36(7):1044-1051.

Weeks DF, Katz DS, Saxon P, Kubal WS. Lemierre syndrome: report of five new cases and literature review. *Emerg Radiol*. 2010;17(4):323-328.

Case 4-38

Pulmonary embolism postpartum

Patient Presentation: A 29-year-old woman presented in severe respiratory distress. She was 5 weeks postpartum from a normal vaginal delivery.

Clinical Presentation: The patient presented awake and in clinical shock with cyanosis and hypoperfusion with a systolic blood pressure of 80 mm Hg. Oxygen saturation was 75% on 100% oxygen. Shortly after arrival, the patient became unresponsive.

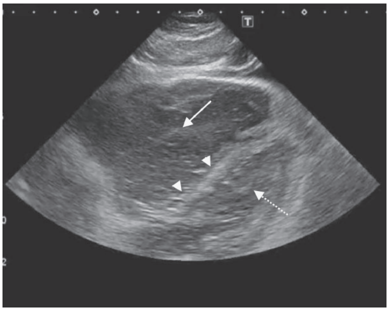

Figure 4-66. Cardiac ultrasound. WA = the white arrow is in the middle of a markedly dilated right ventricular chamber, WAH = bowing septum, WDA = the white dashed arrow is in the middle of the small left ventricular chamber

Differential Dx:
- Pulmonary embolism
- Myocardial infarction
- Aortic dissection
- Infectious pulmonary disease
- Sepsis
- Congestive heart failure

Figure 4-67. Contrast-enhanced chest CT scan. WA = bilateral pulmonary artery emboli

Emergency Care: Immediately after becoming unresponsive, a tibial intraosseous line was placed and used to facilitate rapid sequence intubation. A bedside cardiac ultrasound demonstrated massive right ventricular dilation and septal bowing with a small left ventricle. The patient was given a 50-mg bolus of alteplase and started on an alteplase infusion of 50 mg over the next hour. A pulmonary CT angiogram obtained after alteplase administration confirmed the diagnosis of pulmonary emboli. Lower extremity ultrasound did not reveal any additional potential clot burden.

Outcome: The patient's hemodynamic instability rapidly resolved in the ED. The patient was admitted and had an uncomplicated hospital course.

Key Learning Points:
- Point-of-care ultrasound is invaluable in rapidly determining a cause of clinical shock, eg, cardiogenic, hypovolemic, or distributive. Assessing cardiac function and chamber size, inferior vena cava diameter, presence or absence of pericardial tamponade or pneumothorax, presence or absence of lung "B" lines, and completing the FAST examination can quickly point to an etiology.
- Life-threatening pulmonary embolism needs to be aggressively managed with thrombolytic therapy.

Further Reading:

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Ha Y, Toh H. Clinically integrated multi-organ point-of-care ultrasound for undifferentiated respiratory difficulty, chest pain, or shock: a critical analytic review. *J Intensive Care*. 2016;4:54.

Perera P, Mailhot T, Riley D, Mandavia D. The RUSH exam: Rapid Ultrasound in Shock in the evaluation of the critically ill. *Emerg Med Clin North Am*. 2010;28(1):29-56.

Case 4-39

Pulmonary embolism with cardiac arrest

Patient Presentation: A 57-year-old presented with shortness of breath and hypotension.

Clinical Features: The patient was moderately ill appearing and in moderate respiratory distress. She was hypotensive, tachycardic, and hypoxemic.

Differential Dx:

- Pulmonary embolism
- Pneumonia
- Pneumothorax
- Hemothorax
- Pulmonary edema
- Cardiac disease
- Pulmonary disease such and asthma or COPD

Emergency Care: The patient was started on bilevel positive airway pressure (BiPaP), which improved her respiratory status. A bedside ED cardiac ultrasound demonstrated an enlarged right ventricle relative to the left ventricle. Bedside ED lower extremity ultrasound demonstrated large clot located within her femoral vein. The patient was started on a heparin infusion and a CT pulmonary angiogram was performed demonstrating a saddle pulmonary embolus. Two separate cardiac arrests then occurred, each responding to advanced cardiac life support medications and chest compressions. A 40-mg bolus of alteplase was given, followed by an infusion of an additional 50 mg.

Outcome: The patient had a prolonged hospital course but made a complete neurologic and cardiopulmonary recovery. An inferior cava filter was placed prior to discharge, and no prothrombotic disease was discovered on diagnostic evaluation.

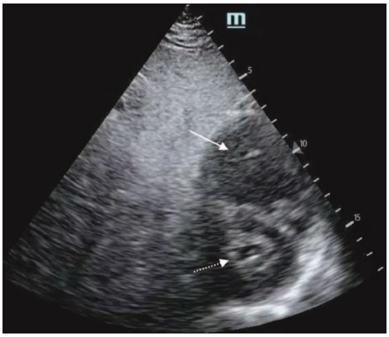

Figure 4-68. Cardiac ultrasound. WA = enlarged right ventricle, WDA = smaller left ventricle

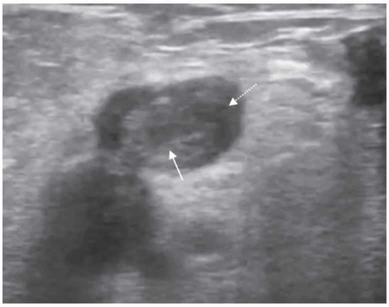

Figure 4-69. Femoral vascular ultrasound. WA = thrombosis in femoral vein, WDA = femoral vein

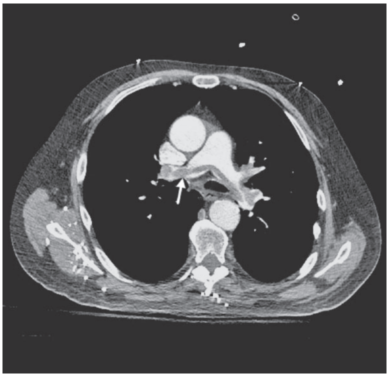

Figure 4-70. CT pulmonary angiogram. WA = saddle pulmonary embolism

Key Learning Points:

- Persistent hypotension or clinical shock is currently considered the primary indication for IV thrombolysis in the management of pulmonary embolism.
- In the setting of right ventricular dysfunction as evidenced by a dilated or hypokinetic right ventricle without clinical shock, the use of thrombolytic agents is controversial.
- Additional clot burden, cardiopulmonary resuscitation, worsening right ventricular dysfunction, and free floating atrial or ventricular thrombus are additional factors that may indicate a need for emergent thrombolytic therapy.
- Several thrombolytic agents and dosing regimens have been successfully utilized.

Further Reading:

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Rush B, Wiskar K, Berger L, Griesdale DE. The use of thrombolysis for acute pulmonary embolism in the United States: national trends and patient characteristics from 2006 to 2011. *J Emerg Med*. 2017; 52(5):615-621.

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Case 4-40

Pulmonary embolism presenting as a seizure

Patient Presentation: A 40-year-old patient with a history of traumatic brain injury, seizures, and pulmonary emboli was found by the paramedics with an altered mental status.

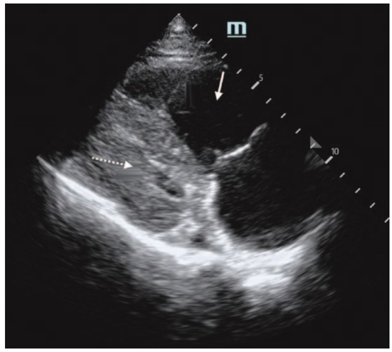

Figure 4-71. Cardiac ultrasound. WA = dilated right ventricle, WDA = collapsed left ventricle

Clinical Features: On ED arrival, the patient was awake and conversant with stable vital signs. However, shortly after arrival the patient had a generalized seizure.

Differential Dx:

- Breakthrough seizure activity
- Metabolic, endocrine, trauma, tumor, or infectious etiology

Emergency Care: Administration of 2 mg IV lorazepam terminated the seizure activity. A bedside ED ultrasound demonstrated a dilated right ventricle and a completely collapsed left ventricle, concerning for pulmonary embolism. During the cardiac ultrasound examination, the patient had a bradycardic cardiac arrest, and CPR was performed. He was administered 50 mg of IV alteplase with continued CPR. A dose of epinephrine was given, and repeat cardiac ultrasound demonstrated a smaller right ventricle and improved filling of the left ventricle. A pulse and monitor check revealed atrial fibrillation with a rapid ventricular response. Synchronized cardioversion resulted in sinus tachycardia. A subsequent CT pulmonary angiogram revealed a saddle embolus. The patient underwent therapeutic hypothermia and was admitted to the hospital.

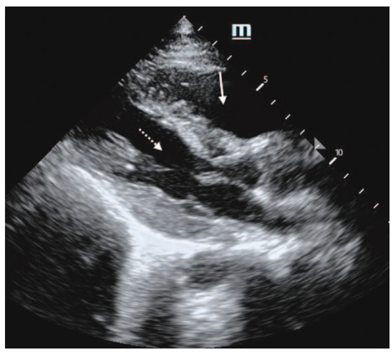

Figure 4-72. Cardiac ultrasound posttreatment with alteplase. WA = decreased size of right ventricle, WDA = improved filling of left ventricle

Outcome: The patient had a relatively uncomplicated hospital stay and was discharged with anticoagulation.

Key Learning Points:

- This patient clinically presented with a seizure. A bedside cardiac ultrasound fortuitously performed prior to the cardiac arrest led to the diagnosis of pulmonary embolism. Bedside cardiac ultrasound is extremely valuable in increasing suspicion for significant pulmonary embolism and in making rapid decisions regarding thrombolytic therapy. The relationship of the seizure activity to the pulmonary embolism is unclear but could be related to decreased cerebral perfusion.

- The combination of bedside cardiac ultrasound and lower extremity ultrasound results in a highly sensitive and specific diagnostic strategy in patients with suspected pulmonary embolism.

Further Reading:

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Nishigami K. Point-of-care echocardiography for aortic dissection, pulmonary embolism and acute coronary syndrome in patients with killer chest pain: EASY screening focused on the assessment of effusion, aorta, ventricular size and shape and ventricular asynergy. *J Echocardiography*. 2015;13(4):141-144.

Taylor RA, Davis J, Liu R, Gupta V, Dziura J, Moore CL. Point-of-care focused cardiac ultrasound for prediction of pulmonary embolism adverse outcomes. *J Emerg Med*. 2013;45(3):392-399.

Case 4-41

Anemia diagnosed with a chest CT scan

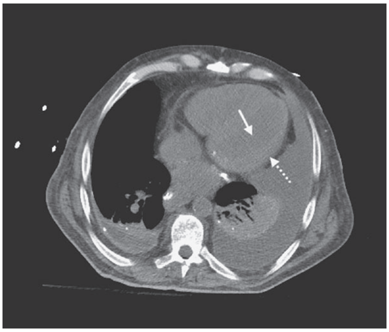

Figure 4-73. Noncontrast chest CT scan. WA = blood in left ventricle, WDA = left ventricular myocardium

Patient Presentation: A 55-year-old end-stage renal disease patient presented with markedly altered mental status and clinical shock.

Clinical Features: The patient was extremely ill appearing and not protecting his airway. Systolic blood pressure was 60 to 80 mm Hg.

Differential Dx:
- Cardiogenic, hypovolemic, or distributive shock

Emergency Care: The patient was endotracheally intubated using rocuronium due to a concern for hyperkalemia. Blood was seen in his posterior oropharynx. He remained extremely hypotensive and was started on norepinephrine. An orogastric tube aspiration revealed blood in his stomach. Labs results included an INR of 10 and a hemoglobin of 3.3 g/dL. He was given packed red blood cells, pantoprazole, and prothrombin complex concentrate. A noncontrast chest CT scan demonstrated a difference in density of left ventricular myocardium and the blood in the left ventricle cavity. When the attenuation of the myocardium and the intraventricular blood can be differentiated on chest CT scan, severe anemia (hemoglobin usually less than 6 g/dL) often exists.

Outcome: The patient had a very long and complex hospital course but eventually recovered and was discharged home.

Key Learning Points:
- Many medical imaging studies provide subtle information that may not be visualized or appreciated.

Further Reading:

Doppman JL, Rienmuller R, Lissner J. The visualized interventricular septum on cardiac computed tomography: a clue to the presence of severe anemia. *J Comput Assist Tomogr*. 1981;5(2):157-160.

Case 4-42

Acute bacterial endocarditis

Patient Presentation: A 23-year-old IV drug user presented with a headache and fever. The patient had a prior history of endocarditis and was status post tricuspid and mitral valve replacements.

Clinical Features: The patient was awake, nontoxic appearing, and in mild painful distress. Systolic blood pressure was 95 mm Hg, and heart rate was 133 beats/min with a temperature of 37.6°C (99.7°F). No cardiac murmurs were appreciated, but there were Janeway lesions on her hands.

Differential Dx:

- Sepsis
- Endocarditis
- Meningitis
- Encephalitis

Emergency Care: The patient had a lumbar puncture showing 200 nucleated cells on initial cell count. She was treated with vancomycin and cefepime, as well as IV fluids, and admitted to the hospital. Chest x-ray and chest CT show multiple peripheral nodular and ground-glass opacities, several of which are cavitary, consistent with pulmonary septic emboli. Axial diffusion-weighted image from a brain magnetic resonance imaging (MRI) shows numerous punctate bilateral brain infarcts. Abdominal CT scan with contrast shows a large splenic infarct.

Outcome: Cultures were positive for methicillin-sensitive *Staphylococcus aureus* (MSSA). Cardiac ultrasound demonstrated mitral valve vegetation with severe mitral stenosis, and an aortic annular ring abscess. She was not thought to be a candidate for repeat valve surgery. Despite aggressive supportive care and antibiotic therapy, she had a difficult hospital course and died 6 days later.

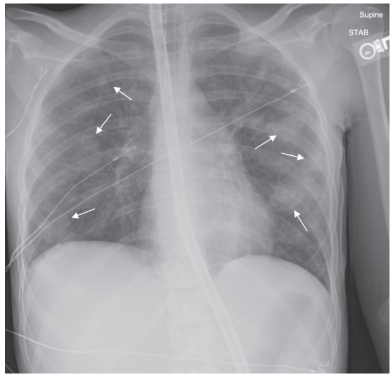

Figure 4-74. Chest x-ray. WA = numerous pulmonary nodules

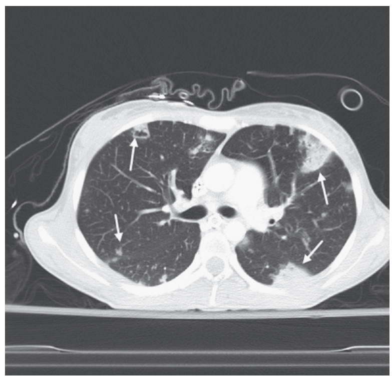

Figure 4-75. Contrast-enhanced chest CT scan. WA = multiple pulmonary nodules

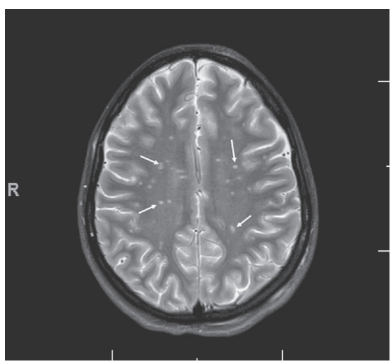

Figure 4-76. Brain MRI. WA = numerous bilateral punctate infarcts

Key Learning Points:

- Fever and cardiac murmur are the most common physical findings in acute endocarditis, although a murmur was absent in this case.
- Additional physical findings highly suggestive of endocarditis include Janeway lesions, splinter hemorrhages of the nail beds, Osler nodes, and Roth spots.
- Echocardiography is the mainstay in the medical imaging diagnosis of endocarditis.

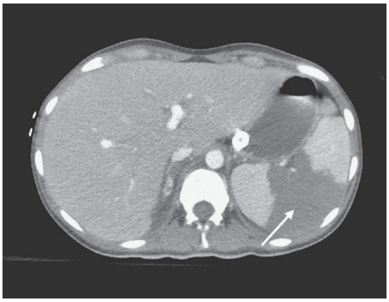

Figure 4-77. Contrast-enhanced abdominal CT scan. WA = splenic infarct

Further Reading:

Cox, M, Li Z, Desai V, et al. Acute nontraumatic splenic infarctions at a tertiary-care center: causes and predisposing factors in 123 patients. *Emerg Radiol*. 2016;23(2):155-160.

Georgescu AM, Azamfirei L, Szalman K, Szekely E. Fatal endocarditis with methicilin-sensible *Staphylococcus aureus* and major complications: rhabdomyolysis, pericarditis, and intracerebral hematoma: a case report and review of the literature. *Medicine*. 2016;95(41):e5125.

Schauer SG, Pfaff JA, Cuenca PJ. Emergency Department Management of acute infective endocarditis. *Emerg Med Pract*. 2014;16(11):1-17.

Case 4-43

Toxic inhalation injury from a binary explosive device

Patient Presentation: A 47-year-old walked into the ED complaining of shortness of breath. The patient had been confined in a spelunking cave for 5 hours after a binary explosive device prematurely detonated causing a cloud of smoke and dust. The explosion occurred approximately 20 hours prior to ED presentation.

Figure 4-78. Chest x-ray. Diffuse alveolar infiltrates

Clinical Features: The patient was tachycardic and tachypneic with severe respiratory distress. Pulmonary rales were auscultated, and room air O_2 saturation was 71%.

Differential Dx:
- Blast injury
- Inhalation injury

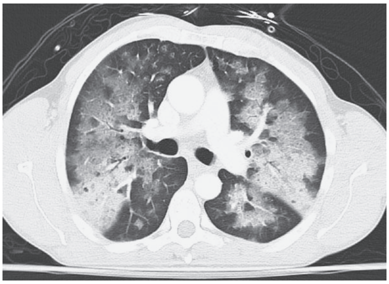

Figure 4-79. Contrast-enhanced chest CT scan. Severe and extensive pulmonary injury

Emergency Care: Modest clinical improvement occurred with 100% oxygen administration. A chest radiograph demonstrated diffuse alveolar infiltrates consistent with acute respiratory distress syndrome (ARDS). Given the patient's clinical appearance, persisting hypoxia, and concerning radiographic findings, the patient underwent rapid sequence intubation. A contrast-enhanced chest CT scan demonstrated the severe and extensive pulmonary injury. The extracorporeal membrane oxygenation team was notified.

Outcome: The patient was treated with antibiotics and steroids. He remained on the ventilator for 4 days and recovered.

Key Learning Points:
- A binary explosive device mixes two individually nonexplosive compounds together to create an explosive mixture.
- In this case, ammonium nitrate and nitromethane were mixed together. Combustion bi-products include nitrogen dioxide. Nitrogen dioxide has low water solubility and can reach the alveoli without significant upper airway irritation, which normally would be a noxious warning sign to retreat from the area of exposure.

- Symptoms from nitrogen dioxide inhalation are typically delayed 10 hours or more as the free radical injury to the alveoli occurs leading to ARDS.
- Treatment includes aggressive supportive critical care.
- The binary explosive device utilized in this case was the same type of device used in the deadly Oklahoma City bombing in 1995. This bomb is also loosely known as a "fertilizer bomb" as ammonium nitrate is a commonly used fertilizer.
- This patient suffered an inhalation injury of nitrogen dioxide, not a primary pulmonary blast injury.

Further Reading:

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Centers for Disease Control and Prevention. Exposure to nitrogen dioxide in an indoor ice arena—New Hampshire, 2011. *MMWR*. 2012;61(8):139-142.

Weiss SM, Lakshminarayan S. Acute inhalation injury. *Clin Chest Med*. 1994; 15(1):103-116.

Yim ES, Horn ER, Hegedus A, Tibbles CD. Cough and hemoptysis in athletes of an ice hockey team. *J Emerg Med*. 43(1):107-110.

Case 4-44

Cardiac thrombus-in-transit

Patient Presentation: A 60-year-old man with a history of alcohol abuse presented with palpitations.

Clinical Features: The patient had an unremarkable physical examination except for atrial fibrillation with a ventricular rate response of 120 beats/min.

Differential Dx:

- Atrial fibrillation, age unknown
- Structural cardiac disease
- Valvular disease
- Alcohol-induced "holiday heart" hyperthyroidism
- Cardiomyopathy

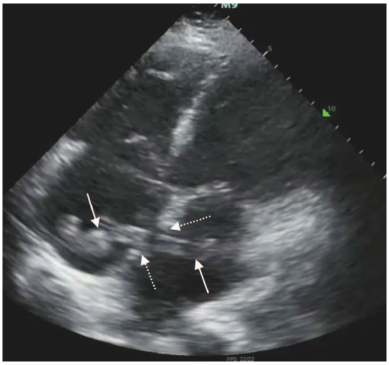

Figure 4-80. Cardiac ultrasound. WA = thrombus sliding between the left and right atria, WDA = edges of a patent foramen ovale

Emergency Care: The patient had an unremarkable cardiac workup in the ED except for the bedside cardiac ultrasound. An elongated thrombus was sliding in and out of the right and left atria via a patent foramen ovale. The patient was started on heparin and was admitted to the hospital.

Outcome: The patient was lost to follow-up.

Key Learning Points:

- Yet another reason for the emergency medicine physician to perform a bedside cardiac ultrasound if cardiac disease is in the differential diagnosis.
- Paradoxical embolic strokes through a patent foramen ovale are relatively common. However, capturing a thrombus-in-transit through a patent foramen ovale or atrial septal defect on imaging is rare.
- Emergent thrombolytic therapy for thrombus-in-transit should be considered to prevent a stroke.
- Case reports describe surgical removal of a thrombus-in-transit.
- Anticoagulation is a mainstay of treatment.

Further Reading:

Baydoun H, Barakat I, Hatem E, Chalhoub M, Mroueh A. Thrombus in transit through patent foramen ovale. *Case Rep Cardiol.* 2013; 2013:395879.

Carcagni A, Di SciascioI G. Echocardiography in patent foramen ovale [in Italian]. *G Ital Cardiol (2006)*. 2006;7(8):516-522.

Case 4-45

Pericardial tamponade with metastatic cancer

Patient Presentation: A 66-year-old patient with a history of metastatic adenocarcinoma of the lung presented with increasing weakness. The patient had a recent cerebral sinus thrombosis and was anticoagulated with warfarin.

Clinical Features: This patient was extremely fatigued, cachectic, dehydrated, and very ill appearing. Systolic blood pressure was 115 mm Hg with a pulse of 80 beats/min. He was in new onset atrial fibrillation.

Differential Dx:

- Electrolyte or metabolic abnormality
- Anemia
- Central nervous system metastatic disease
- Dehydration
- Structural cardiac disease

Emergency Care: Laboratory data revealed an INR >10 and a lactate >14 units/L. Chest x-ray revealed a large left pleural effusion and a small right pleural effusion. A bedside ED ultrasound demonstrated a large pericardial effusion, reduced right and left ventricular filling, and a collapsed free right ventricular wall. His noninvasive tissue oximetry (StO2) was 55%, indicating poor tissue perfusion despite a stable pulse and blood pressure. A pericardial drain was placed under ultrasound guidance with 250 cc of serosanguinous fluid removed. Additionally, the patient had a left pleural drain placed and underwent rapid sequence intubation for respiratory failure. The StO2 improved to 75%, and the cardiac ultrasound post pericardiocentesis demonstrated markedly improved right and left ventricular filling, normal free right ventricular wall motion, and significant decrease in the size of the pericardial effusion.

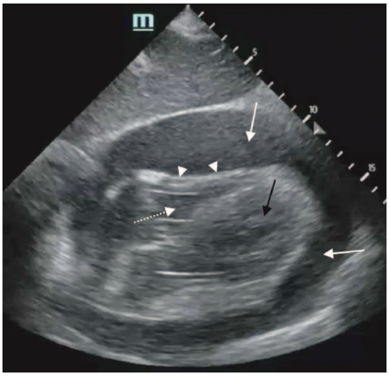

Figure 4-81. Cardiac ultrasound. BA = decreased left ventricular filling, WA = pericardial effusion, WAH = collapsed free right ventricular wall, WDA = compressed right ventricle

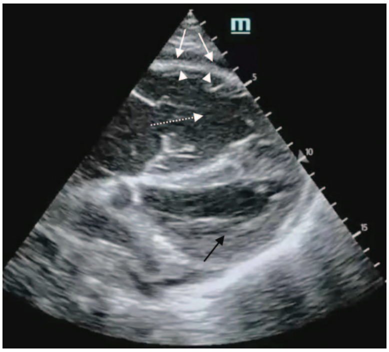

Figure 4-82. Cardic ultrasound post pericardiocentesis. BA = improved filling of left ventricle, WA = reduced pericardial, WAH = normal right ventricular free wall, WDA = increased size of right ventricle

Outcome: The patient had a very complicated 5-week hospital course that ended in hospice care.

Key Learning Points:

- Tissue oximetry (StO2) is a method to assess tissue perfusion, and more research is needed to examine its utility. It is thought to be a more accurate indicator of tissue perfusion than either heart rate or blood pressure. Normal value is generally >70%.
- Acute pericardial tamponade occurs in trauma, aortic dissection, or cardiac rupture and requires a smaller amount of acute hemorrhage for the tamponade physiology to develop as compared to medical diseases that cause subacute tamponade.
- Subacute pericardial tamponade develops in days to weeks and is caused by infection, inflammatory disease, and malignancy; it is usually associated with larger amounts of pericardial fluid.
- Clinical findings include hypotension, tachycardia, clinical shock, jugular venous distension, and shortness of breath.
- Cardiac ultrasound easily rules in a pericardial effusion, and it can be used to determine if tamponade physiology is present by noting right free ventricular wall collapse, septal bowing, and a reduced left ventricular chamber size.
- Patients who present with a large pericardial effusion without hemodynamic compromise are at risk for subsequent cardiac tamponade. The decision for timing of drainage in these cases can be difficult.

Further Reading:

Epstein CD, Haghenbeck KT. Bedside assessment of tissue oxygen saturation monitoring in critically ill adults: an integrative review of the literature. *Crit Care Res Pract*. 2014;2014:709683.

Green MS, Sehgal S, Tariq R. Near-infrared spectroscopy: the new must have tool in the intensive care unit? *Semin Cardiothorac Vasc Anesthes*. 2016;20(3):213-224.

Halpern DG, Argulian E, Briasoulis A, Chaudhry F, Aziz EF, Herzog E. A novel pericardial effusion scoring index to guide decision for drainage. *Crit Pathw Cardiol*. 2012;11(2):85-88.

Schairer JR, Biswas S, Keteyian SJ, Ananthasubramaniam K. A systematic approach to evaluation of pericardial effusion and cardiac tamponade. *Cardiol Rev*. 2011;19(5):233-238.

Case 4-46

Pediatric pneumonia with chest wall erythema

Patient Presentation: A pediatric patient presented with a fever and cough.

Clinical Features: The patient was febrile with a cough and mild tachypnea but was not in respiratory distress. Examination of the patient's lateral chest wall showed an area of erythema and warmth.

Differential Dx:
- Pneumonia
- Bronchitis

Emergency Care: A chest radiograph revealed a right middle lobe infiltrate indicative of pneumonia. The radiograph correlated well with the unusual physical finding of erythema and warmth of the chest wall. The child was treated on an outpatient basis with antibiotics.

Outcome: No further follow-up was noted in the medical chart.

Key Learning Points:
- The external skin finding of erythema and warmth correlating with the presence of pneumonia is an unusual and rare finding.
- This finding did not represent an extension of infection into the chest wall, but rather represented local inflammatory response.

Figure 4-83. Pediatric patient with a right middle lobe pneumonia. RA = erythematous chest wall

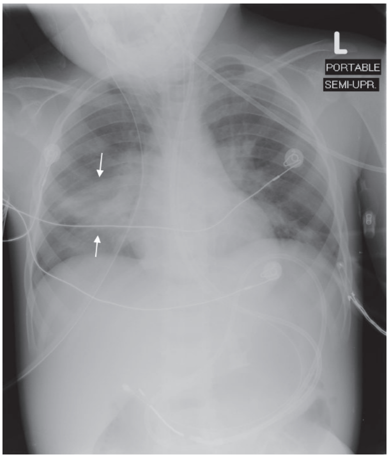

Figure 4-84. Chest x-ray. WA = a right middle lobe infiltrate

Further Reading:

McCullum RJ, Patel K. Recent developments in pediatric community-acquired pneumonia. *Curr Infect Dis Rep*. 2016;18(5):14.

Parikh K, Biondi E, Nazif J, et al. Value in Inpatient Pediatrics Network Quality Collaborative For Improving Care In Community Acquired Pneumonia. A multicenter collaborative to improve care of community acquired pneumonia in hospitalized children. *Pediatrics*. 2017;139(3). pii: e20161411.

Qin Q, Shen K. Community-acquired pneumonia and its complications. *Indian J Pediatr*. 2015;82(8):745-751.

Seear M, Awasthi S, Gowraiah V, et al. Predictive accuracy of chest radiographs in diagnosing tachypneic children. *Indian J Pediatr*. 2016;83(9):930-936.

Shaughnessy EE, Stalets EL, Shah SS. Community-acquired pneumonia in the post 13-valent pneumococcal conjugate vaccine era. *Curr Opin Pediatr*. 2016;28(6):786-793.

CHAPTER 5

Obstetrics and Gynecology

Case 5-1

Rupture of 26-week-old uterine cornu ectopic pregnancy

Patient Presentation: A 27-year-old female who was 26 weeks pregnant presented to an outside institution with sudden onset of shortness of breath followed by syncope. She was tachycardic and diaphoretic. A computed tomography (CT) pulmonary angiogram was performed that was negative for pulmonary embolus but did show a hemoperitoneum on the inferior CT images. The patient was transferred to our facility with 2 units of packed red blood cells transfusing.

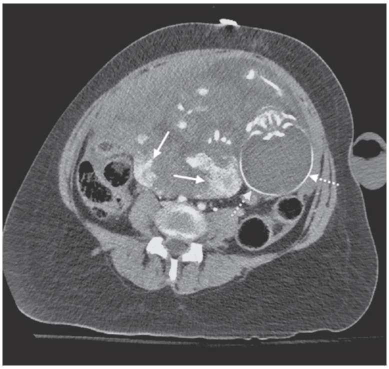

Figure 5-1. Contrast-enhanced abdominal CT scan. WA = contrast extravasation indicating active hemorrhage, WDA = fetal head

Clinical Features: The patient was pale but awake and in mild painful distress. She remained hypotensive and tachycardic. Her abdomen was gravid with the uterus palpable above the umbilicus.

Differential Dx:

- Heterotopic pregnancy
- Placenta abruption
- Uterine rupture
- Ectopic pregnancy
- Trauma with liver and/or spleen hemorrhage
- Aortic or other large vessel catastrophe

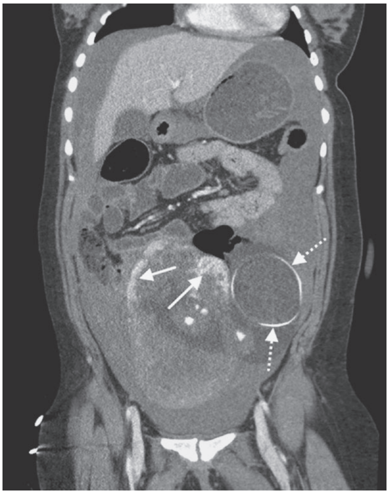

Figure 5-2. Contrast-enhanced abdominal CT scan. WA = contrast extravasation indicating active hemorrhage, WDA = fetal head

Emergency Care: Bedside abdominal ultrasound demonstrated a very large hemoperitoneum and a fetal heart rate of 140 bpm. The massive transfusion protocol was instituted. The patient was given a dose of dexamethasone for fetal lung maturity and 4 g of magnesium for neuroprotection. The patient, despite her hypotension and tachycardia, appeared clinically stable. Given her clinical appearance, known hemoperitoneum, and the lack of a diagnosis, the patient had a contrast-enhanced abdominal CT scan that demonstrated a large hemoperitoneum with active hemorrhage and what was initially interpreted as an intrauterine pregnancy with possible placental abruption. The patient was taken to the operating room.

Outcome: Upon entering the peritoneal cavity, there was a large hemoperitoneum with the fetus found floating freely within the abdominal cavity and a ruptured uterus. The placenta was attached to the uterine cornu. Apgar scores were 4, 7, and 8 at 1, 5, and 10 minutes, respectively. The infant subsequently had multiple clinical issues related to prematurity.

The images for this case demonstrate, in retrospect, a ruptured uterus with significant extravasation of contrast indicative of active hemorrhage, with the fetal head outside of the uterine cavity.

Key Learning Points:

- Uterine cornu ectopic pregnancies compose 1% to 3 % of all ectopic pregnancies. They can be difficult to distinguish from an intrauterine pregnancy with pelvic ultrasound and frequently present with uterine rupture and significant life-threatening hemorrhage.

Further Reading:

Alkatout I, Honemeyer U, Strauss A, Tinelli A, Malvasi A, Jonat W, Mettler L, Schollmeyer T. Clinical diagnosis and treatment of ectopic pregnancy (review). *Obstet Gynecol Surv.* 2013;68(8):571-581.

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Chan LY, Fok WY, Yuen PM. Pitfalls in diagnosis of interstitial pregnancy. *Acta Obstet Gynecol Scand.* 2003;82(9):86.

Idama TO, Tuck CS, Ivory C, Ellerington MC, Travis S. Survival of cornual (interstitial) pregnancy. *Eur J Obstet Gynecol Reprod Biol.* 1999;84(1):103-105.

Case 5-2

Uterine fibroids (two patients)

Patient Presentation: These are two patients with uterine fibroids. The first patient presented with abdominal pain and lower extremity peripheral edema and had a large anterior abdominal wall hernia. It should be noted that the inferior vena cava was being compressed by these fibroids, causing the lower extremity edema. The second patient had calcified uterine fibroids as an incidental finding on the pelvis x-ray taken for evaluation hip pain.

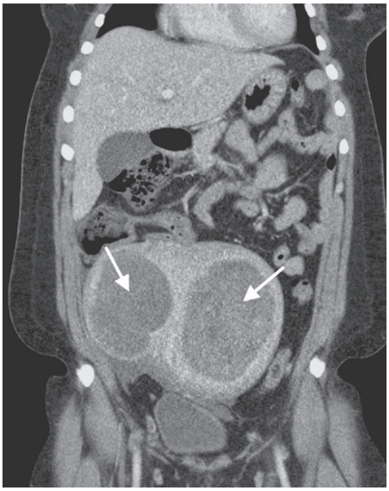

Figure 5-3. First patient. Noncontrast abdominal CT scan. WA = two large uterine fibroids

Outcome: The first patient was admitted and had a total abdominal hysterectomy and ventral hernia repair. The second patient had no intervention for these asymptomatic uterine fibroids.

Key Learning Points:

- Uterine fibroids are benign lesions. They are the most common pelvic tumor in women, and the incidence increases as women grow older, following the life cycle changes of the reproductive hormones estrogen and progesterone.
- Medical, surgical, and minimally invasive management options exist for women with symptoms attributable to uterine fibroids.

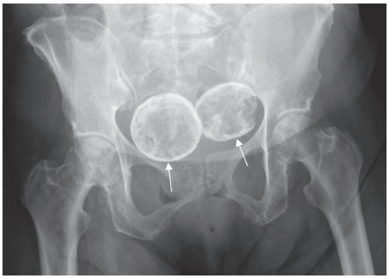

Figure 5-4. Second patient. Pelvic x-ray. WA = two calcified uterine fibroids

Further Reading:

Chen J, Chen W, Zhang L, Li K, Peng S, He M, Hu L. Safety of ultrasound-guided ultrasound ablation for uterine fibroids and adenomyosis: a review of 9988 cases. *Ultrason Sonochem*. 2015;27:671-676.

Chittawar PB, Kamath MS. Review of nonsurgical/minimally invasive treatments and open myomectomy for uterine fibroids. *Curr Opin Obstet Gynecol*. 2015;27(6):391-397.

Gurusamy KS, Vaughan J, Fraser IS, Best LM, Richards T. Medical therapies for uterine fibroids —a systematic review and network meta-analysis of randomised controlled trials. *PLoS One*. 2016;11(2):e0149631.

Wise LA, Laughlin-Tommaso SK. Epidemiology of uterine fibroids: from menarche to menopause. *Clin Obstet Gynecol*. 2016;59(1):2-24.

Case 5-3

Ovarian torsion with a dermoid cyst

Patient Presentation: A 36-year-old female presented with abdominal pain. She was seen at an outside institution 1 day prior and had an abdominal and pelvic CT scan that demonstrated a right dermoid cyst with a calcified component, likely odontogenic, and was treated symptomatically. She presented to the emergency department (ED) with continued pain.

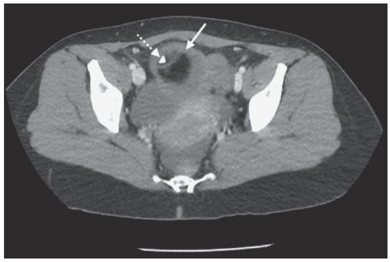

Figure 5-5. Contrast-enhanced pelvic CT scan. WA = dermoid cyst, WDA = calcified lesion (odontogenic)

Clinical Features: The patient was in moderate painful distress. Abdominal examination revealed moderate focal tenderness to palpation in the right lower quadrant. A pelvic examination was not performed.

Differential Dx:

- Appendicitis
- Ovarian cyst or rupture
- Ovarian torsion
- Renal stone
- Ectopic pregnancy

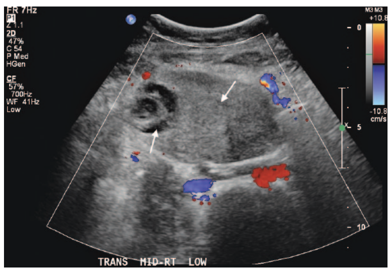

Figure 5-6. Pelvic ultrasound. WA = dermoid cyst with poor arterial flow visualization

Emergency Care: The urinary pregnancy test was negative. A transvaginal ultrasound revealed a complex 7 × 7 cm mass in the right ovary consistent with a dermoid cyst. There was normal venous flow and suboptimal visualization of arterial flow secondary to abnormal ovarian position in the pelvis.

Outcome: The patient was taken directly to the operating room where a right ovarian torsion was visualized via laparoscopy and a right oophorectomy was performed.

Key Learning Points:

- Dermoid cysts are a risk factor for ovarian torsion. Ovaries larger than 5 cm from ovarian masses are at especially increased risk for torsion.
- Moderate or severe pain in a patient with a dermoid cyst should be a red flag for possible ovarian torsion.
- The most sensitive ultrasound findings in torsion are an increase in ovarian size or abnormal ovarian position in the pelvis.
- Normal arterial and venous blood flow does not rule out the possibility of torsion. Clinical presentation is crucial in helping make this difficult diagnosis.

Further Reading:

Oltmann SC, Fischer A, Barber R, Huang R, Hicks B, Garcia N. Cannot exclude torsion—a 15-year review. *J Pediatr Surg*. 2009;44(6):1212-1216.

Rey-Bellet Gasser C, Gehri M, Joseph JM, Pauchard JY. Is it ovarian torsion? a systematic literature review and evaluation of prediction signs. *Pediatr Emerg Care*. 2016;32(4):256-261.

Sasaki KJ, Miller CE. Adnexal torsion: review of the literature. *J Minim Invas Gynecol*. 2014;21(2):196-202.

Case 5-4

Ectopic pregnancy diagnosed with transvaginal ultrasound

Patient Presentation: A young female presented with abdominal pain without vaginal bleeding.

Clinical Presentation: Vital signs were stable. Mild to moderate left lower quadrant tenderness was present. Pelvic examination revealed no vaginal bleeding or discharge, but the patient did have left adnexal tenderness to palpation.

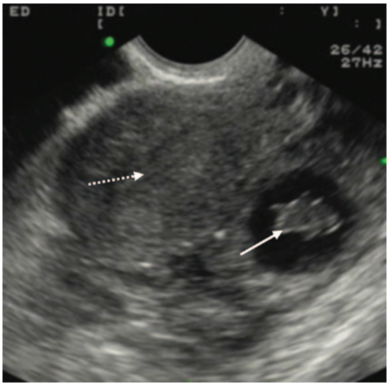

Figure 5-7. Pelvic ultrasound. WA = ectopic pregnancy, WDA = empty uterus

Differential Dx:

- Ectopic pregnancy
- Ovarian torsion
- Pelvic inflammatory disease
- Renal colic
- Ovarian cyst or rupture of ovarian cyst
- Threatened spontaneous abortion
- Diverticulitis

Emergency Care: A bedside transvaginal ED ultrasound, performed prior to obtaining urine pregnancy test results, demonstrated an ectopic pregnancy with an empty uterus, both readily visualized in the same ultrasonographic plane of view. There was minimal free pelvic fluid present.

Outcome: The patient was taken to the operating room for management but was lost to follow-up postoperatively.

Key Learning Points:

- Seeing an empty uterus and ectopic pregnancy on the same ultrasonographic plane of view is unusual and fortuitous.
- Use of discriminatory β-hCG levels between 1000 mIU/mL to 3000 mIU/mL can be used to heighten suspicion of an ectopic pregnancy in the setting of an empty uterus. The probability of an ectopic pregnancy is substantially increased with an empty uterus and higher BHCG levels, particularly if the level is higher than 3000 mIU/ mL.
- However, the negative predictive value of an empty uterus and elevated β-hCG representing a pregnancy definitively outside of the uterus is less than 100%, making clinical decision-making and the use of serial β-hCG measurements important.

Further Reading:

Doubilet PM, Benson CB, Bourne T, et al. Diagnostic criteria for nonviable pregnancy early in the first trimester. *N Engl J Med* 2013;369(15):1443-1451.

Knez J, Day A, Jurkovic D. Ultrasound imaging in the management of bleeding and pain in early pregnancy. *Best Pract Res Clin Obstet Gynaecol*. 2104;28(5):621-636.

Rodgers SK, Chang C, DeBardeleben JT, Horrow MM. Normal and abnormal US findings in early first-trimester pregnancy: review of the Society of Radiologists in Ultrasound 2012 Consensus Panel Recommendations. *Radiographics*. 2015;35(7):2135-2148.

Case 5-5

Molar pregnancy

Patient Presentation: A 35-year-old female presented with vaginal bleeding. The patient had a positive urine pregnancy test with estimated gestational age of 9 weeks by last menstrual period.

Clinical Presentation: The patient had mild lower abdominal tenderness to palpation and mild vaginal bleeding on pelvic examination.

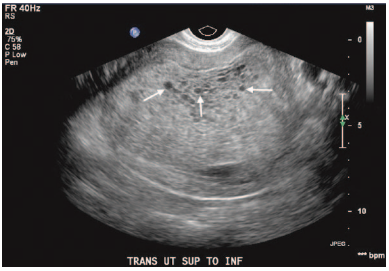

Figure 5-8. Pelvic ultrasound. WA = "cluster of grapes" appearance of a molar pregnancy

Differential Dx:

- Threatened spontaneous abortion
- Ectopic pregnancy

Emergency Care: A beside ED ultrasound show a typical "cluster of grapes" appearance consistent with a molar pregnancy.

Outcome: The patient was immediately referred to obstetrics and gynecology and was lost to follow-up.

Key Learning Points:

- Molar pregnancy is part of group of diseases called gestational trophoblastic disease.
- β-hCG levels are higher than normal pregnancies of the same gestational age.
- β-hCG levels greater than 100,000 mIU/mL are typically seen in patients with a complete molar pregnancy, and any patient with a β-hCG level greater than 100,000 mIU/mL should have a pelvic ultrasound performed.

Further Reading:

Al-Talib AA. Clinical presentation and treatment outcome of molar pregnancy: ten years' experience at a tertiary care hospital in Dammam, Saudi Arabia. *J Family Community Med.* 2016;23(3):161-165.

Berkowitz RS, Goldstein DP. Current management of gestational trophoblastic diseases. *Gynecol Oncol.* 2009;112(3):654-662.

Murphy R, Jahnke K, Houry D. Characteristics of patients who present to the emergency department with molar pregnancy. *South Med J.* 2008;101(8):797-799.

Case 5-6

Endometrioma hemorrhage from blunt trauma

Patient Presentation: A 40-year-old female fell three stories from a window.

Clinical Presentation: The patient was awake but agitated, in mild to moderate pain, and in respiratory distress. She had a visible flail chest on the right and was hypotensive.

Differential Dx:

- Multiple traumatic injuries
- Clinical examination concerning for possible tension pneumothorax

Figure 5-9. Contrast-enhanced abdominal CT scan. WA = endometrioma, WDA = contrast extravasation from active hemorrhage

Emergency Care: A bedside ultrasound revealed lack of sliding lung sign on the right. Given her agitation, the need for a significant diagnostic evaluation, and her respiratory distress, the patient was endotracheally intubated, and a right thoracostomy tube was placed. Abdominal ultrasound revealed free intraperitoneal fluid. The patient maintained a systolic blood pressure of 90 mm Hg and had an abdominal CT scan performed.

Outcome: The contrast-enhanced abdominal CT scan showed a 13 cm × 28 cm × 32 cm mass with active extravasation from hemorrhage. This was thought to be an endometrioma that had previously been judged nonoperable from an outside institution because of underlying hepatic disease with ascites. The patient required multiple blood transfusions over the next 24 to 36 hours but became hemodynamically stable. Repeat abdominal CT scan at 72 hours showed cessation of active hemorrhage involving the endometrioma. The patient had a long and complicated hospital course and was eventually discharged to a long-term care facility requiring ventilator support.

Key Learning Points:

- Thoracic sliding lung sign evaluation using ultrasound is more sensitive than a supine chest x-ray for the detection of pneumothorax. It has the disadvantage of evaluating only a focused window of the pleura, so it can miss focal pneumothoraces if it is not directly viewing the area affected.
- Intraperitoneal fluid discovered during a FAST examination is not diagnostic for hemorrhage, as both preexisting ascites and urine from a ruptured bladder can be visualized as a nonspecific finding of intraperitoneal fluid by ultrasound. However, in the setting of trauma, intraperitoneal hemorrhage should be assumed to be the etiology of intraperitoneal fluid on ultrasound examination until proven otherwise.

- Hounsfield units (HU) can be used to differentiate ascites or urine from blood on the abdominal CT scan. Transudative ascites is around 0 HU (water density), urine −5 to +15 HU, while blood is approximately 40 HU.

Further Reading:

Blaivas M, Lyon M, Duggal S. A prospective comparison of supine chest radiography and bedside ultrasound for the diagnosis of traumatic pneumothorax. *Acad Emerg Med.* 2005;12(9):844-849.

Kaponis A, Taniguchi F, Azuma Y, et al. Current treatment of endometrioma. *Obstet Gynecol Surv*. 2015;70(3):183-195.

Case 5-7

Pelvic varicosities

Patient Presentation: A 24-year-old female presented with lower abdominal and pelvic pain as well as a vaginal discharge.

Clinical Presentation: The patient was afebrile and in mild painful distress. She had lower abdominal tenderness to palpation. Pelvic examination revealed a white vaginal discharge, bilateral adnexal tenderness to palpation, and cervical motion tenderness.

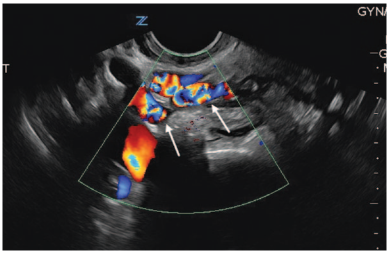

Figure 5-10. Pelvic ultrasound. WA = color flow within extensive pelvic varicosities

Differential Dx:

- Pelvic inflammatory disease
- Tubo-ovarian abscess
- Cervicitis
- Appendicitis
- Inflammatory bowel disease
- Urinary tract infection

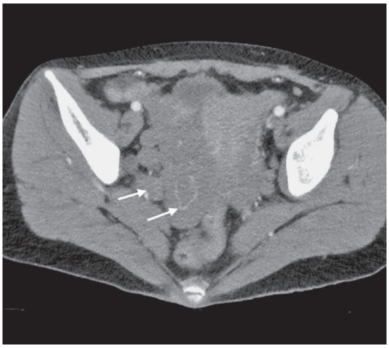

Figure 5-11. Contrast-enhanced pelvic CT scan. WA = pelvic varicosities

Emergency Care: The white blood cell count was modestly elevated at 14,000 mm^3. A bedside ED ultrasound showed a normal uterus, ovaries not well visualized, no free pelvic fluid, and what appeared to be dilated and prominent blood vessels. An abdominal and pelvic CT scan showed inflammatory changes consistent with pelvic inflammatory disease. However, the patient also had extensive pelvic varicosities as noted on the ED ultrasound.

Outcome: The patient was treated on an outpatient basis for her pelvic inflammatory disease.

Key Learning Points:

- Pelvic varicosities are dilated uterine and ovarian veins that have a reduced blood flow and are seen in pelvic congestion syndrome in some patients with chronic pelvic pain. This may be seen with or without vulvar varicosities.
- There is limited data that medical management might be beneficial.
- Patients that fail medical therapy may try embolization or sclerotherapy.

Further Reading:

Borghi C, Dell'atti L. Pelvic congestion syndrome: the current state of the literature. *Arch Gynecol Obstet*. 2016;293(2):291-301.

Daniels JP, Champaneria R, Shah L, Gupta JK, Birch J, Moss JG. Effectiveness of embolization or sclerotherapy of pelvic veins for reducing chronic pelvic pain: a systematic review. *J Vasc Intervent Radiol*. 2016;27(10):1478-1486.e8.

Hansrani V, Abbas A, Bhandari S, Caress AL, Seif M, McCollum CN. Trans-venous occlusion of incompetent pelvic veins for chronic pelvic pain in women: a systematic review. *Eur J Obstet Gynecol Reprod Biol*. 2015;185:156-163.

Knuttinen M, Xie K, Jani A, Palumbo A, Carrillo T, Mar W. Pelvic venous insufficiency: imaging diagnosis, treatment approaches, and therapeutic issues. *AJR Am J Roentgenol*. 2015;204(2):448-458.

Case 5-8

Large ovarian mass

Patient Presentation: A 52-year-old female presented with increasing abdominal pain and distention.

Clinical Features: Vital signs were normal, and the patient was in mild painful distress. Her abdomen was extremely distended and tense and mildly to moderately tender to palpation.

Differential Dx:
- Bowel obstruction
- Mass or tumor
- Ascites
- Ruptured viscous

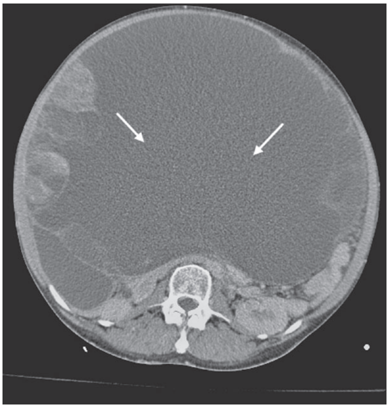

Figure 5-12. Contrast-enhanced abdominal CT scan. WA = large ovarian mass

Emergency Care: Contrast-enhanced abdominal CT scan demonstrated a large cystic lesion with solid enhancing peripheral components. The radiographic differential diagnosis included ovarian cystadenocarcinoma, ovarian cystadenoma, and pseudomyxoma peritonei.

Outcome: The patient was transferred to another facility for definitive management of this mass, and final pathologic diagnosis is unknown. It should be noted that this patient did return to our health care facility 12 years after this event for an unrelated clinical problem and had a normal abdominal examination.

Key Learning Points:
- There should be a high index of suspicion for ovarian cancer in postmenopausal women with an adnexal mass, slowly increasing abdominal distension, or new onset ascites. At least 30% of ovarian masses in women over age 50 are malignant neoplasms.

Further Reading:

Katke RD. Giant mucinous cystadenocarcinoma of ovary: a case report and review of literature. *J Midlife Health*. 2016;7(1):41-44.

Vang R, Shih I, Kurman RJ. Ovarian low-grade and high-grade serous carcinoma: pathogenesis, clinicopathologic and molecular biologic features, and diagnostic problems. *Adv Anat Pathol*. 2009;16(5):267-282.

Zaino RJ, Brady MF, Lele SM, Michael H, Greer B, Bookman MA. Advanced stage mucinous adenocarcinoma of the ovary is both rare and highly lethal: a Gynecologic Oncology Group study. *Cancer*. 2011;117(3):554-562.

Case 5-9

Blunt trauma in pregnancy

Patient Presentation: A young female who was 38 weeks pregnant was involved in a motor vehicle crash with significant damage to the car. She presented complaining of back pain.

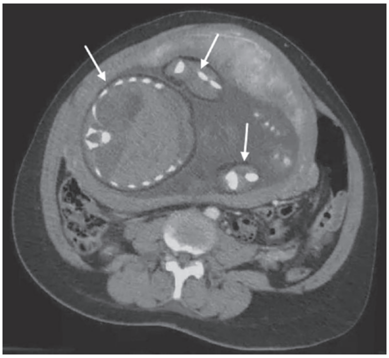

Figure 5-13. Abdominal CT scan. WA = fetus

Clinical Features: The patient was hemodynamically stable and in moderate painful distress. The abdomen was gravid and nontender to palpation. Fetal cardiac activity was normal. The patient had midline tenderness to palpation of her lumber spine.

Differential Dx:
- Multiple traumatic injuries are possible given the high energy mechanism.
- Injuries related to the pregnancy such as placental abruption or uterine rupture are considerations.

Emergency Care: The patient underwent a CT scan that demonstrated two lumbar transverse process fractures. No other injuries were noted.

Outcome: The patient was admitted for observation, and no complications developed. The transverse process fractures were treated symptomatically.

Key Learning Points:
- Pregnant women seen for evaluation of injuries after a significant mechanism of trauma present a difficult dilemma, ie, full diagnostic evaluation while minimizing radiation risk to the fetus.
- Performing an eFAST ultrasound exam of the mother and fetus as initial medical imaging is critical in these patients.
- In major trauma, the relative radiation risk to the fetus is small compared to the risk of a missed or delayed diagnosis of a significant injury to the mother.
- CT scanning does provide data about the state of the placenta.
- Fetal radiation dose can be decreased if the abdominal CT scan is limited to the top of the iliac crests and does not include the pelvis.

Further Reading:

Corwin MT, Seibert JA, Fananapazir G, Lamba R, Boone JM. JOURNAL CLUB: quantification of fetal dose reduction if abdominal CT is limited to the top of the iliac crests in pregnant patients with trauma. *AJR Am J Roentgenol*. 2016;206(4):705-712.

Hansen W, Moshiri M, Paladin A, Lamba R, Katz DS, Bhargava P. Evolving practice patterns in imaging pregnant patients with acute abdominal and pelvic conditions. *Curr Prob Diagn Radiol*. 2017;46(1):10-16.

Kopelman T, Bogert JN, Walters JW, et al. Computed tomographic imaging interpretation improves fetal outcomes after maternal trauma. *J Trauma Acute Care Surg.* 2016;81(6):1131-1135.

Raptis CA, Mellnick VM, Raptis DA, et al. Imaging of trauma in the pregnant patient. *Radiographics.* 2014;34(3):748-763.

Sadro C, Berstein MP, Kanal KM. Imaging of trauma: part 2, abdominal trauma and pregnancy—a radiologist's guide to doing what is best for the mother and baby. *AJR Am J Roentgenol.* 2012;199(6):1207-1219.

Shakerian R, Thomson BN, Judson R, Skandarajah AR. Radiation fear: impact on compliance with trauma imaging guidelines in the pregnant patient. *J Trauma Acute Care Surg.* 2015;78(1):88-93.

Case 5-10

Pregnancy with an intrauterine device

Patient Presentation: A 30-year-old female presented with vaginal bleeding. The patient had a copper intrauterine device (IUD) in place for 7½ years.

Clinical Features: This patient was in no painful distress and was hemodynamically stable. Abdominal examination was benign, and the vaginal vault contained a minimal amount of blood.

Differential Dx:
- Ectopic pregnancy
- Intrauterine pregnancy
- Menstrual period
- Uterine infection
- Uterine bleeding
- IUD complication such as uterine perforation

Emergency Care: The patient had a positive pregnancy test. Transvaginal ultrasound demonstrated a living fetus within the uterus as well as an IUD positioned within the uterine cavity. Obstetrics and gynecology was consulted.

Outcome: Despite the presence of an IUD, this was a desired pregnancy. The IUD string could not be visualized precluding simple IUD removal. Instead of a more invasive IUD removal procedure, the patient elected for expectant management. Unfortunately, the patient suffered a spontaneous abortion at 12 weeks of age and had subsequent IUD removal at that time.

Key Learning Points:
- The long-term cumulative failure rate of an IUD is 1% to 2% and is dependent on the age of women and IUD location.
- In the setting of a desired pregnancy, the IUD can be removed if the strings are

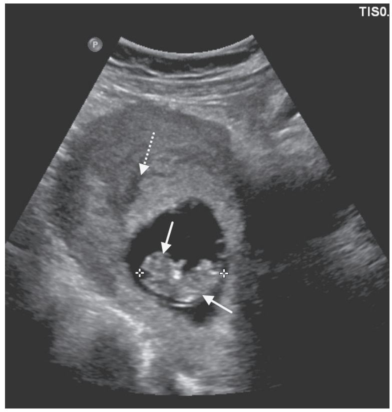

Figure 5-14. Pelvic ultrasound. WA = fetus, WDA = uterus

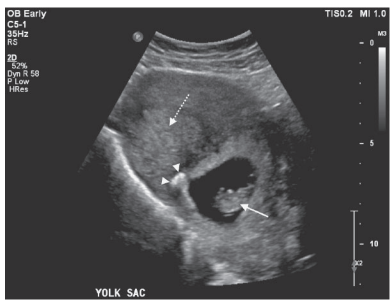

Figure 5-15. Pelvic ultrasound. WA = fetus, WAH = intrauterine device, WDA = uterus

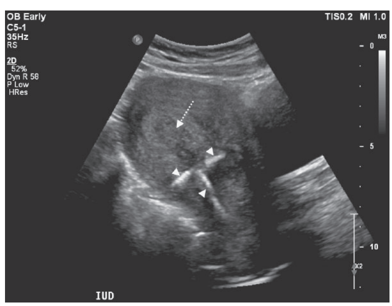

Figure 5-16. Pelvic ultrasound. WAH = intrauterine device, WDA = uterus

visible. If the strings are not visible, the IUD can still be removed with forceps under ultrasound guidance.

- There is a 37% adverse outcome rate of pregnancies when the IUD is removed vs a 63% adverse outcome rate if the IUD is left in place during the pregnancy.

Further Reading:

Brahmi D, Steenland MW, Renner RM, Gaffield ME, Curtis KM. Pregnancy outcomes with an IUD in situ: a systematic review. *Contraception*. 2012;85(2):131-139.

Chaim W, Mazor M. Pregnancy with an intrauterine device in situ and preterm delivery. *Arch Gynecol Obstet*. 1992;252(1):21-24.

Ozgu-Erdinc AS, Tasdemir UG, Uygur D, Aktulay A, Tasdemir N, Gulerman HC. Outcome of intrauterine pregnancies with intrauterine device in place and effects of device location on prognosis. *Contraception*. 2014;89(5):426-430.

Rowe P, Farley T, Peregoudov A, et al. Safety and efficacy in parous women of a 52-mg levonorgestrel-medicated intrauterine device: a 7-year randomized comparative study with the TCu380A. *Contraception*. 2016;93(6):498-506.

Thonneau P, Goulard H, Goyaux N. Risk factors for intrauterine device failure: a review. *Contraception*. 2001;64(1):33-37.

Wu JP, Porch E, Womack JP. Successful retrieval of an intrauterine device with "missing strings" using a manual vacuum aspirator in a desired early pregnancy: case report. *J Minim Invas Gynecol*. 2011;18(2):254-256.

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CHAPTER 6 Foreign Body

Case 6-1

Swallowed flashing toy ambulance

Patient Presentation: A 23-month-old presented to the emergency department (ED) after his mother noted a red light flashing in his stomach 45 minutes prior. The mother thought the child had swallowed a very small ambulance toy car with a small battery-powered flashing red light. The child was in no distress.

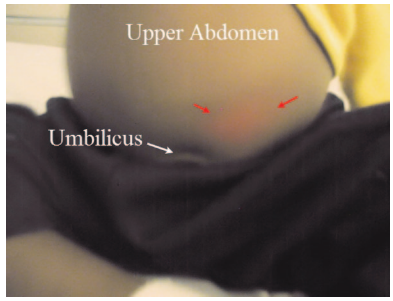

Figure 6-1. RA = a flashing red light from a swallowed toy ambulance

Clinical Features: With the examination room lights turned off, a red light flashing at a rate of 1 per second could clearly be seen. Every flash elicited a giggle from the toddler. Abdominal examination was completely benign.

Differential Dx:

- The diagnosis of an ingested toy with a battery powered red light was obvious.
- The clinical location of the foreign body was past the esophagus and in either the stomach or the small bowel.

Figure 6-2. Abdominal x-ray. WA = toy ambulance in the stomach

Emergency Care: A supine abdominal radiograph revealed the toy to be in the stomach, correlating with physical examination findings. The foreign body did not appear radiographically to have any sharp edges that might impede transit through the gastrointestinal system. The regional poison center was contacted for concern regarding dangers associated with battery ingestions. Since the battery was past the esophagus, and thought to be fully encased without direct exposure to the gastrointestinal wall lining, the decision was made to allow an opportunity for the foreign body to pass through the patient's gastrointestinal tract.

Outcome: The toddler was discharged home and followed up 24 hours later for a repeat radiograph, which demonstrated significant passage of the toy into the distal colon. The toddler never returned to the ED, with presumptive passage of the foreign body without complication.

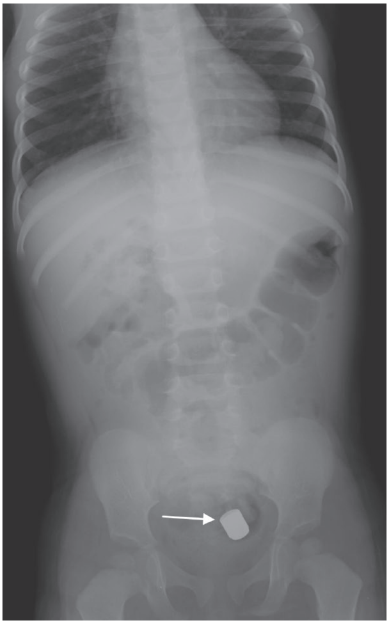

Figure 6-3. Abdominal x-ray. WA = toy ambulance has passed into distal colon

Key Learning Points:

- Button battery and cylindrical battery ingestion can cause serious gastrointestinal injury. Diagnostic and therapeutic management decisions are complex and depend on patient age, location of the battery in the gastrointestinal tract, size and type of battery ingested, the presence of a co-ingested magnet, and the length of time since ingestion. The National Battery Ingestion Hotline is a good resource for management decisions.

Further Reading:

Kramer RE, Lerner DG, Lin T, et al. Management of ingested foreign bodies in children: a clinical report of the NASPGHAN Endoscopy Committee. *J Pediatr Gastroenterol Nutr.* 2015;60(4):562.

National Capital Poison Center. NBIH Button Battery Ingestion Triage and Treatment Guideline. Available at: http://www.poison.org/battery/guideline. Accessed May 24, 2018.

Case 6-2

Swallowed pencil

Patient Presentation: A 24-year-old presented after ingesting a pencil in an attempt to harm himself.

Clinical Features: The patient was well appearing and in no painful distress. The abdominal examination was benign.

Differential Dx:

- Retained foreign body in unknown anatomic location with the possibility of complications

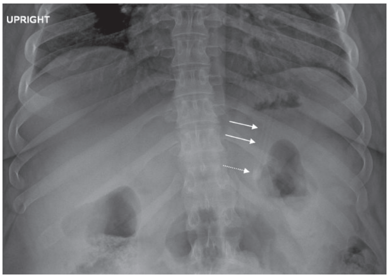

Figure 6-4. Abdominal x-ray. WA = body of the pencil, WDA = pencil eraser head

Emergency Care: An abdominal radiograph demonstrated the location of the pencil in the stomach.

Outcome: The foreign body was removed from the stomach without complication using upper endoscopy under conscious sedation. He was transferred to the psychiatric service.

Key Learning Points:

- The vast majority of foreign bodies located in the esophagus or stomach can be removed endoscopically.
- Endoscopic retrieval of esophageal and gastric foreign bodies should be performed as soon as possible to decrease the chances of complication, including ulcer formation and perforation, as well as to increase the success rate of endoscopic removal.

Further Reading:

Birk M, Bauerfeind P, Deprez PH, et al. Removal of foreign bodies in the upper gastrointestinal tract in adults: European Society of Gastrointestinal Endoscopy (ESGE) Clinical Guideline. *Endoscopy*. 2016;48(5):489-496.

Geraci G, Sciume C, Di Carlo G, Picciurro A, Modica G. Retrospective analysis of management of ingested foreign bodies and food impactions in emergency endoscopic setting in adults. *BMC Emerg Med*. 2016;16(1):42.

Hong KH, Kim YJ, Kim JH, Chun SW, Kim HM, Cho JH. Risk factors for complications associated with upper gastrointestinal foreign bodies. *World J Gastroenterol*. 2015;21(26):8125-8131.

Khan K, Siddique K, Anwar S, Shiwani MH. Spectacles in stomach: a case of successful endoscopic removal. *J Nepal Health Res Counc*. 2015;13(30):163-165.

Obinwa O, Cooper D, O'Riordan JM. An ingested mobile phone in the stomach may not be amenable to safe endoscopic removal using current therapeutic devices: a case report. *Int J Surg Case Rep*. 2016;22:86-89.

Ribas Y, Ruiz-Luna D, Garrido M, Bargalló J, Campillo F. Ingested foreign bodies: do we need a specific approach when treating inmates? *Am Surg*. 2014;80(2):131-137.

Case 6-3

Swallowed spoon

Patient Presentation: A middle-aged male presented with a history of significant gastroparesis on total parenteral nutrition; he was not supposed to take any food orally. He stated that he ate a piece of chicken that got stuck in the back of his throat. He asked a friend to try and retrieve the piece of chicken with a spoon and then accidentally swallowed the spoon.

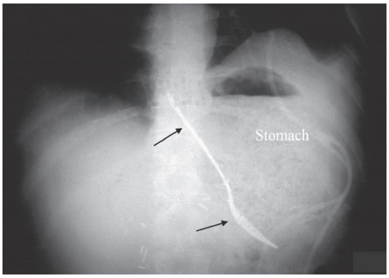

Figure 6-5. Abdominal x-ray. BA = spoon in the stomach

Clinical Features: The patient was well appearing and in no respiratory or painful distress.

Differential Dx:

- Foreign body (chicken and/or spoon) in esophagus or stomach

Emergency Care: An abdominal radiograph demonstrated the spoon in the stomach, which was distended with mottled contents.

Outcome: The patient underwent upper endoscopy with retrieval of the spoon without any complication, and he was discharged home.

Key Learning Points:

- Frequent symptoms of gastroparesis include nausea and vomiting, abdominal pain, bloating, and early satiety. In severe cases such as this patient, weight loss can occur and may require total parenteral nutrition.
- Diabetes is the most common etiology for gastroparesis.
- Medical management of gastroparesis includes metoclopramide as the first-line treatment, followed by erythromycin.
- The case reports listed in the Further Reading section indicate swallowing a spoon is a rare but reproducible event.

Further Reading:

Beldholm BR, Lee AU. Simple endoscopic technique for retrieving a long foreign body from the stomach. *ANZ J Surg.* 2007;77(7):560-561.

Rygl M, Pycha K. Perforation of the stomach by a foreign body in a girl with anorexia nervosa—case report [in Czech]. *Rozhl Chir.* 2002;81(12):628-630.

Watanabe T, Aoyagi K, Tomioka Y, Ishibashi H, Sakisaka S. Endoscopic removal of a tablespoon lodged within the duodenum. *World J Gastroenterol.* 2015;21(16):5096-5098.

Case 6-4

Transorbital intracranial impalement

Patient Presentation: A 44-year-old suffered a penetrating eye injury with a round wooden shovel handle from an unclear mechanism of injury.

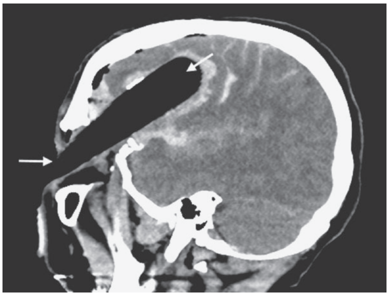

Figure 6-6. Noncontrast head CT scan. WA = large foreign body with transorbital entrance into the cranium

Clinical Features: The patient was alert and oriented with stable vital signs. Neurologic examination was nonfocal.

Differential Dx:

- Ocular and intracranial injury

Emergency Care: Shortly after ED arrival, the patient had a decreasing level of consciousness. He started vomiting and was not protecting his airway. The patient underwent rapid sequence intubation with ketamine and rocuronium. Fentanyl, levetiracetam, hydralazine, and 5% saline were administered. A sagittal image of a noncontrast head CT scan revealed deep penetration of the wood with frontal and parietal hemorrhage. The patient was taken to the operating room.

Outcome: The patient underwent a craniotomy with removal of the intracranial portion of the foreign body. Ophthalmology removed the orbital section of the wood. There were extensive and complex eyelid lacerations requiring repair and lateral canthoplasty. A hyphema was present, but the globe itself was intact. An antibiotic regimen for prevention of infection was maintained. A cerebral spinous fluid leak resolved. Visual acuity 7 days post accident was 20/200 from the injured eye.

Key Learning Points:

- The emergency physician must adhere to the basics of initial management of critically injured patients.
- It is a pitfall to become distracted from a dramatic and viscerally stimulating injury.
- Intracranial penetration via the superior orbit is a common injury and can be missed in subtle cases involving small foreign bodies.
- Head CT scans can fail to detect small intracranial or orbital wooden foreign bodies.

Further Reading:

Hansen JE, Gudeman SK, Holgate RC, Saunders RA. Penetrating intracranial wood wounds: clinical limitations of computerized tomography. *J Neurosurg*. 1988;68(5):752-756.

Liu H, Qiu E, Zhang TM, Zhao JW, Song WX, Fu JD. Neurosurgical therapy of transorbital intracranial foreign bodies: review of 28 cases [in Chinese]. *Zhonghua Yi Xue Za Zhi*. 2008;88(25):1737-1741.

Sanli AM, Kertmen H, Yilmaz ER, Sekerci Z. A retained wood penetrating the superior orbital fissure in a neurologically intact child. *Turk Neurosurg*. 2012;22(3): 393-397.

Smely C, Orszagh M. Intracranial transorbital injury by a wooden foreign body: re-evaluation of CT and MRI findings. *Br J Neurosurgery*. 1999;13(2): 206-211.

Case 6-5

Sponge bezoar in the stomach

Patient Presentation: A young male presented after ingesting several large sponges. He reportedly cut up several large sponges into pieces and then consumed them.

Clinical Features: The patient was well appearing and in mild painful distress. Abdominal examination revealed a soft abdomen with tenderness to palpation in the left upper quadrant.

Differential Dx:

- Gastric outlet obstruction
- Small bowel obstruction
- Stomach or bowel perforation

Emergency Care: An abdominal radiograph revealed a distended stomach that appeared to be full of mottled bubbly material, ie, the ingested sponges.

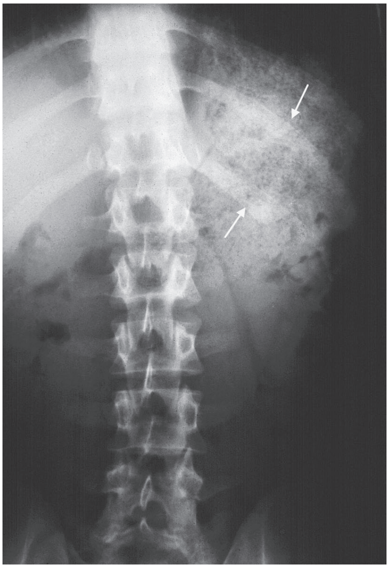

Figure 6-7. Abdominal x-ray. WA = stomach filled with loose radiodense material

Outcome: The patient went initially to endoscopy, but the sponge had formed a very large bezoar that could not be removed with the endoscope. The patient underwent exploratory laparotomy with removal of the bezoar from the stomach.

Key Learning Points:

- Most foreign bodies in the stomach that have indications for removal can be retrieved with endoscopy.
- Laparoscopic gastrotomy can also be utilized and is less invasive than exploratory laparotomy.

Further Reading:

Chin EH, Hazzan D, Herron DM, Salky B. Laparoscopic retrieval of intraabdominal foreign bodies. *Surg Endosc*. 2007;21(8):1457.

McAlinden MG, Potts SR. Sponge bezoar: a rare cause of abdominal pain. *Ulster Med J*. 1999;68(1):36-37.

Case 6-6

Swallowed eyeglasses and action figure doll

Patient Presentation: A young adult with significant psychiatric disease presented for evaluation after ingesting multiple foreign bodies.

Clinical Features: The patient was well appearing and in no painful or respiratory distress with an unremarkable abdominal examination.

Differential Dx:

- Multiple foreign body ingestion with unknown anatomic location and the potential for gastrointestinal complications

Emergency Care: An abdominal radiograph was performed and revealed multiple foreign bodies. The foreign bodies included a pair of eyeglasses, an action figure doll toy, several clips, and the stand base for the action figure doll toy.

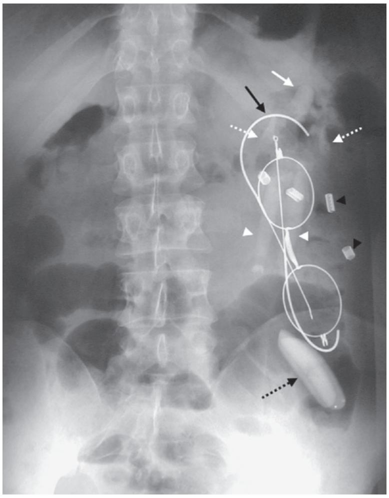

Figure 6-8. Abdominal x-ray. BA = eyeglasses, BAH = clips, BDA = stand base for action figure doll, WA = head of action figure doll, WAH = legs of action figure doll, WDA = arms of action figure doll

Outcome: The initial management plan called for upper endoscopic removal, but the final disposition and outcome are unknown.

Key Learning Points:

- *"Truth is stranger than Fiction, but it is because Fiction is obliged to stick to possibilities; Truth isn't."* This quote is attributed to Mark Twain.

Further Reading:

Gilchrist BF, Valerie EP, Nguyen M, Coren C, Klotz D, Ramenofsky ML. Pearls and perils in the management of prolonged, peculiar, penetrating esophageal foreign bodies in children. *J Pediatr Surg*. 1997;32(10):1429-1431.

Glasbrenner K. Giving visibility to accidentally swallowed toy. *JAMA*. 1984;252(3):323-324.

Hayek G, D'Assignies G. Images in clinical medicine. An unknowingly swallowed inedible toy. *N Engl J Med*. 2013;369(26):2535.

Khan K, Siddique K, Anwar S, Shiwani MH. Spectacles in stomach: a case of successful endoscopic removal. *J Nepal Health Res Counc*. 2015;13(30):163-165.

Morioka WT, Maisel RH, Smith TW, Cantrell RW. Unexpected radiographic findings related to foreign bodies. *Ann Otol Rhinol Laryngol*. 1975;84(5 Pt 1):627-630.

Case 6-7

Swallowed batteries and tweezers (two patients)

Patient Presentation: These are two separate patients who presented after swallowing foreign bodies. The first patient, a 38-year-old swallowed two AA-size batteries. The second patient, a 35-year-old swallowed tweezers.

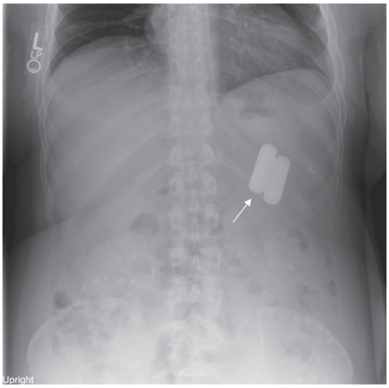

Figure 6-9. First patient. Abdominal x-ray. WA = swallowed batteries in the stomach

Clinical Features: Both patients were well appearing and in no painful distress with a normal abdominal examination.

Differential Dx:

- Foreign body
- Stomach and bowel obstruction or perforation
- Ulceration

Emergency Care: Both patients underwent conscious sedation and removal of their respective foreign bodies via endoscopy.

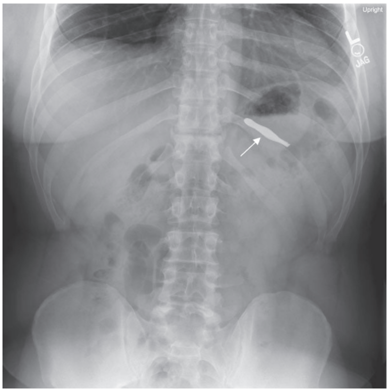

Figure 6-10. Second patient. Abdominal x-ray. WA = swallowed tweezers in the stomach

Outcome: Both patients tolerated the sedation and endoscopic removal of their foreign body well.

Key Learning Points:

- Button battery and cylindrical battery ingestion can cause serious gastrointestinal injury. Diagnostic and therapeutic management decisions are complex and depend on the patient's age, the location of the battery in the gastrointestinal tract, the size and type of battery ingested, the presence of a co-ingested magnet, and the length of time since ingestion. The National Battery Ingestion Hotline is a good resource for management decisions.

Further Reading:

National Capital Poison Center. NBIH button battery ingestion triage and treatment guideline. Available at: http://www.poison.org/battery/guideline. Accessed May 25, 2018.

Oztuna F, Bulbul Y, Celik I, Ozsu S, Ozlu T. Tweezers in the right bronchial system. *Respiration*. 2007;74(2):214.

Case 6-8

Cocaine body packing

Patient Presentation: A 39-year-old presented with a foreign body sensation in his throat and difficulty speaking 21 hours after swallowing 34 bags of cocaine.

Clinical Features: The patient was anxious appearing and unable to speak above a whisper, but he was controlling his secretions. There was no stridor, and the patient was not in respiratory distress.

Differential Dx:
- Foreign body in airway or esophagus
- Airway injury
- Esophageal injury

Emergency Care: A soft tissue lateral of the neck revealed marked prevertebral swelling and subcutaneous emphysema. Noncontrast abdominal CT scan revealed a stomach filled with multiple bags, presumably packed with cocaine.

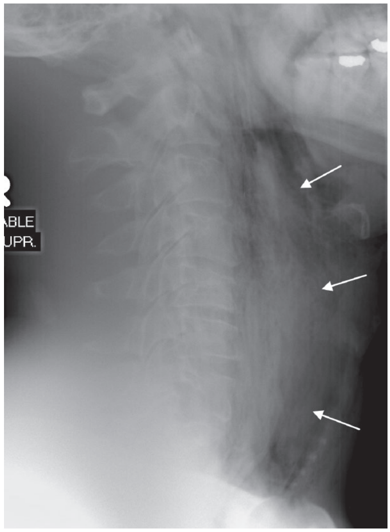

Figure 6-11. Soft tissue lateral neck x-ray. WA = marked prevertebral swelling and subcutaneous emphysema

Outcome: The patient underwent an emergent laparotomy and removal of the bags of cocaine. Esophagoscopy and gastrograffin esophagram did not reveal any visible tears or leaks in his esophagus. The patient had a prolonged and complicated hospital course that included tracheotomy and acute renal failure, but he made a full recovery.

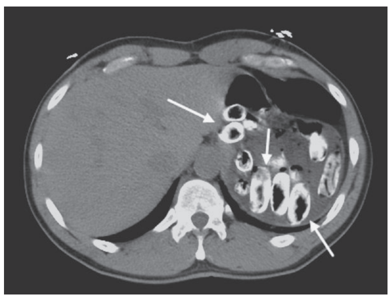

Figure 6-12. Noncontrast abdominal CT scan. WA = multiple foreign bodies in the stomach

Key Learning Points:
- Body packing is the intracorporeal placement of large amounts of illegal drugs in durable containers for the purposes of smuggling for profit. Body stuffing is the intracorporeal placement of illegal drugs during the process of being arrested to hide the contraband. Body stuffing usually involves smaller amounts in containers less durable and prone to leakage.
- Body packers/stuffers exhibiting toxicologic signs or symptoms of absorption of the illicit substance should undergo removal of the packed bags. Body packers/stuffers without signs or symptoms can be conservatively managed and await transit through the gastrointestinal tract.

Further Reading:

Aissa J, Kohlmeier A, Rubbert C, et al. Diagnostic value of CT-localizer and axial low-dose computed tomography for the detection of drug body packing. *J Forensic Leg Med*. 2016;37:55-60.

Cappelletti S, Aromatario M, Bottoni E, et al. Drug-related deaths with evidences of body packing: two case reports and medico-legal issues. *Leg Med (Tokyo)*. 2016;20(23-26).

Cappelletti S, Piacentino D, Sani G, et al. Systematic review of the toxicological and radiological features of body packing. *Int J Leg Med*. 2016;130(3):693-709.

Covarelli P, Burini G, Castellani E. Therapeutic options for body packers: surgical or conservative treatment? A single center experience and review of literature. *Ann Ital Chi*. 2015;86(4):371-377.

Esterson YB, Patel V, Nicastro J, Friedman B. Plain radiography may underestimate the burden of body packer ingestion: a case report. *Clin Imag*. 2017;44:57-60.

Glovinski PV, Lauritsen ML, Bay-Nielsen M, Brandstrup B, Bisgaard T. Asymptomatic body packers should be treated conservatively. *Danish Med J*. 2013;60(11):A4723.

Shields LE, Rolf CM, Hunsaker JC. Sudden death due to acute cocaine toxicity-excited delirium in a body packer. *J Forensic Sci*. 2015;60(6):1647-1651.

Case 6-9

Spring in the esophagus

Patient Presentation: A 5-month-old presented to the ED in respiratory distress that started 5 days prior. The patient had been seen in a clinic on two separate visits for this illness and was diagnosed with upper viral illness with new onset reactive airway disease.

Clinical Features: The patient was febrile and had audible inspiratory and expiratory stridor, along with chest wall retractions. The infant was not hypoxic but appeared ill.

Differential Dx:
- Supraglottitis
- Bacterial tracheitis
- Viral croup
- Reactive airway disease
- Foreign body

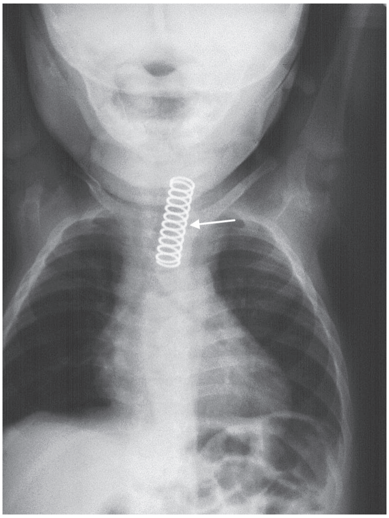

Figure 6-13. Chest x-ray. WA = spring in the esophagus

Emergency Care: A chest radiograph revealed a spring located in the esophagus.

Outcome: The patient was taken to the operating room with successful endoscopic removal of the spring, which measured 3.5 cm long and 0.9 cm diameter. The infant recovered uneventfully.

Key Learning Points:
- There are two medical axioms that still apply as demonstrated in this case: "*All that wheezes is NOT asthma*" and "*First time wheezing is an indication for a chest radiograph.*"
- A 5-month-old infant can ingest or aspirate large foreign bodies.

Further Reading:

Cruz CI, Patel D. Impacted button-battery masquerading as croup. *J Emerg Med.* 2013;45(1):30-33.

Cuestas G, Rodríguez V, Doormann F, Bellia Munzón P, Bellia Munzón G. Foreign body in the esophagus as a cause of respiratory symptoms in children. Clinical cases [in Spanish]. *Arch Argent Pediatr*. 2017;115(2):e126-e130.

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Jafari SA, Khalesi M, Partovi S, Kiani M, Ahanchian H, Kianifar H. Ingested foreign bodies removed by flexible endoscopy in pediatric patients: a 10-year retrospective study (corrected). *Iran J Otorhinolaryngol*. 2014;26(76):175-179.

Russell R, Lucas A, Johnson J, et al. Extraction of esophageal foreign bodies in children: rigid versus flexible endoscopy. *Pediatr Surg Int*. 2014;30(4):417-422.

Sink JR, Kitsko DJ, Mehta DK, Georg MW, Simons JP. Diagnosis of pediatric foreign body ingestion: clinical presentation, physical examination, and radiologic findings. *Ann Otol Rhinol Laryngol*. 2016;125(4):342-350.

Case 6-10

Dental bridge in the esophagus

Patient Presentation: Elderly male presented for evaluation of an altered mental status after falling while intoxicated.

Clinical Features: The patient was clinically intoxicated, and facial contusions were present. The patient was in no painful or respiratory distress. A cervical collar had been placed for cervical spine protection.

Differential Dx:
- Altered mental status secondary to alcohol intoxication
- Closed head trauma
- Facial injury

Emergency Care: A cervical spine radiograph series was performed looking for traumatic injury. A partial dental bridge was discovered in his esophagus.

Outcome: The patient had endoscopic removal of his dental bridge without difficulty.

Figure 6-14. Cervical spine x-ray. WA = partial dental bridge in the esophagus

Key Learning Points:
- Dental bridges can be aspirated into the upper airway and lodge in the supraglottic space, glottis, trachea, or mainstem bronchus.
- Dental bridges can be ingested and lodge in the esophagus, stomach, or pass into the small bowel.
- There is one case report of a patient suffering from a cardiac arrest and a good Samaritan performed mouth-to-mouth ventilation. The patient survived, and 6 days post cardiac arrest the patient began to experience fever and shortness of breath. The good Samaritan's own dental bridge had been introduced into the patient's mouth during ventilations and had become lodged in the patient's esophagus. It was removed with a good outcome.

Further Reading:

Bunni J, Youssef F. Swallowed dental bridge perforating the terminal ileum. *South Med J*. 2010;103(6):593-594.

Chawla A, Bosco J, Subramanian M, Chokkapan K, Shenoy J, Lim TC. Imaging findings of swallowed dentures: a case series. *Emerg Radiol*. 2015;22(6):717-721.

Mahmoud M, Imam S, Patel H, King M. Foreign body aspiration of a dental bridge in the left main stem bronchus. *Case Rep Med*. 2012;2012:798163.

Paulsen JM, Aragon GC, Jager DL, Borum ML. Unusual cause of upper gastrointestinal bleed: gastric ulceration and bleed secondary to ingested dental bridge. *Am J Gastroenterol*. 2009;104(2):535-537.
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Wong RK, Edelson JG, Sperling LC, Keegan MT, Johnson LF. Endoscopic foreign body retrieval through a gastrostomy feeding orifice. *Endoscopy*. 1982;14(6):232-234.

Case 6-11

Saw blade in the neck

Patient Presentation: A 23-year-old suffered an accidental impalement of a large saw blade into his neck. There was a significant amount of blood at the scene.

Clinical Features: The patient was alert and hemodynamically stable. The knife was firmly embedded with arterial bleeding noted along the knife's edge. There was no intraoral blood, and the patient had a normal voice. There were motor deficits to his right upper extremity.

Differential Dx:
- Vascular, airway, nerve, and esophageal injury

Emergency Care: The patient underwent rapid sequence intubation with etomidate and succinylcholine. The massive transfusion protocol was initiated. The initial hemoglobin was 11.1 g/dL. A contrast-enhanced head and neck CT scan did not reveal a significant vascular injury.

Outcome: The saw blade was removed in the operating room, and an injury to the right subclavian vein was repaired. Injuries were noted to multiple branches of the brachial plexus. The patient's wound healed well, but he continued to have significant motor deficits to his right upper extremity.

Figure 6-15. WA = large saw blade impaled in the neck (inferior view)

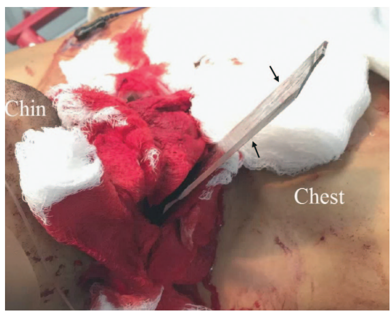

Figure 6-16. BA = large saw blade impaled in the neck (lateral view)

Key Learning Points:
- Objects impaled in regions with vascular structures at risk should be left in place and removed in the operating room. An exception is the presence of life-threatening exsanguinating hemorrhage or airway compromise requiring foreign body removal for successful management of the hemorrhage or airway compromise.
- It was prudent to manage this patient's airway early precluding possible airway compromise from expanding hematoma.

Further Reading:

Bullingham A, Hampson-Evans D, Palazzo M. An impaled neck. Management of difficult airway access. *Anaesthesia*. 1994;49(10):866-869.

Deshmukh S, Halwai O, Sharma A, Dabholkar J. Metallic foreign body in the neck: case report. *Otolaryngol Pol*. 2012;6(1):64-65.

Fama F, Cicciù M, Nastro-Siniscalchi E, et al. Nonfatal cervical-neck lesion with a wooden foreign body: diagnosis and management. *J Craniofac Surg*. 2016;27(1):175-176.

McCrary HC, Nielsen TJ, Goldstein SA. Penetrating neck trauma: an unusual case presentation and review of the literature. *Ann Otol Rhinol Laryngol*. 2016;125(8):682-686.

Melillo EP, Hawkins DJ, Lynch L, Macnamara A. Difficult airway management of a child impaled through the neck. *Paediatr Anaesthes*. 2001;11(5):615-617.

Parajuli R, Thapa S. Penetrating neck injury by a sickle. *Clin Case Rep*. 2017;5(3):363-365.

Case 6-12

Comb in the esophagus

Patient Presentation: A 33-year-old was using a hair comb to scratch the back of her throat when she accidentally swallowed the comb.

Clinical Features: The patient was agitated and tearful in moderate painful distress but without respiratory distress. There was no stridor, but the patient was gagging with occasional blood tinged saliva noted. Breath sounds and oxygen saturations were normal.

Differential Dx:
- Foreign body in upper airway or esophagus

Emergency Care: The patient was given intramuscular olanzapine to facilitate examination. The foreign body could not be visualized with direct oropharyngeal examination. A lateral soft tissue neck radiograph showed the comb to be in the upper esophagus exiting into the supraglottic area.

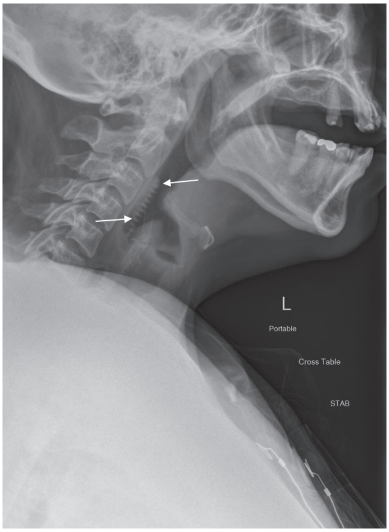

Figure 6-17. Soft tissue lateral neck x-ray. WA = comb in the esophagus

Outcome: Due to concern of possible esophageal perforation, the patient was taken to the operating room. The comb was visualized with direct laryngoscopy. It was sitting in the esophageal inlet and blocking the view of her vocal cords. A Magill forceps was utilized to remove the comb. The patient recovered uneventfully.

Key Learning Points:
- The upper esophageal sphincter as part of the cricopharyngeus muscle is a common location where foreign bodies become lodged.
- Most foreign bodies lodged in the esophageal inlet can be visualized with direct laryngoscopy and removed with a Magill forceps.
- Awake direct laryngoscopy can be facilitated by nebulized lidocaine (50 mg) and topical lidocaine cream (4%) generously applied to the tongue. Light sedation can also be added if necessary with ketamine 0.5 mg/kg IV generally preserving the patient's airway reflexes.

Further Reading:

Baral BK, Joshi RR, Bhattarai BK, Sewal RB. Removal of coin from upper esophageal tract in children with Magill's forceps under propofol sedation. *Nepal Med Coll J.* 2010;12(1):38-41.

Karaman A, Cavuşoğlu YH, Karaman I, Erdoğan D, Aslan MK, Cakmak O. Magill forceps technique for removal of safety pins in upper esophagus: a preliminary report. *Int J Pediatr Otorhinolaryngol*. 2004;68(9):1189-1191.

Villalonga A. Anesthesia under difficult conditions: use of an adult-size laryngoscope to remove a foreign body from a child's esophagus with Magill forceps [in Spanish]. *Rev Esp Anestesiol Reanim*. 2004;51(10):608-609.

Yalcin S Karnak I, Ciftci AO, Senocak ME, Tanyel FC, Büyükpamukçu N. Foreign body ingestion in children: an analysis of pediatric surgical practice. *Pediatr Surg Int*. 2007;23(8):755-761.

Case 6-13

Open safety pin in the small bowel

Patient Presentation: A 60-year-old presented with abdominal pain. Obtaining an accurate history was difficult due to psychiatric disease. The patient stated that he was having abdominal pain and bloating for 1 week and he swallowed an open safety pin to help alleviate his symptoms.

Clinical Features: The patient was febrile. Abdominal examination revealed a distended abdomen that was markedly tender to palpation with both rebound tenderness and guarding present.

Differential Dx:

- Bowel obstruction
- Bowel perforation

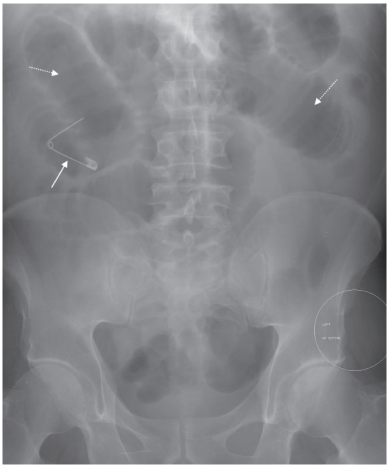

Figure 6-18. Abdominal x-ray. WA = open safety pin, WDA = small bowel obstruction

Emergency Care: An abdominal radiograph demonstrated disproportionate small bowel dilatation consistent with a small bowel obstruction with an open safety pin in the right lower quadrant. The patient was taken to the operating room.

Outcome: Exploratory laparotomy revealed the safety pin had perforated the ascending colon near the ileocecal valve. A right hemicolectomy was performed, and the patient made an uneventful recovery.

Key Learning Points:

- Children can accidentally ingest safety pins, while in adults this ingestion is more often intentional.
- Open safety pins tend to get lodged in the esophagus and stomach.
- Most open safety pins can be removed from both the esophagus and stomach safely with endoscopy.
- Amazingly, there is one documented case report of an open safety pin having closed on its own as a result of normal peristaltic bowel function.

Further Reading:

Altman AR, Gottfried EB. Intragastric closure of an ingested open safety pin. *Gastro Endosc*. 1978;24(6):294-295.

Andreasson L, Ingelstedt S, Tjernstrom O. Peristaltic closure of a safety pin—an unusual fate of a safety pin seen as a foreign body in the gastrointestinal tract. *J Laryngol Otol*. 1986;100(4):385-388.

Golz A, Netzer A, Gordin A, Westerman ST, Joachims HZ. Safe extraction of an impacted open safety pin from the esophagus: report of 9 cases. *Am J Otolaryngol*. 2006;27(6):413-417.

Kalayci A, Tander B, Kocak S, Rizalar R, Bernay F. Removal of open safety pins in infants by flexible endoscopy is effective and safe. *J Laparoendosc Adv Surg Tech A*. 2007;17(2):242-245.

Marsh BR. The problem of the open safety pin. *Ann Otol Rhinol Laryngol*. 1975; 84(5 Pt 1):624-626.

Sarihan H, Kaklikkaya I, Ozcan F. Pediatric safety pin ingestion. *J Cardiovasc Surg*. 1998;39(4):515-518.

Case 6-14

Open safety pin in the hypopharynx

Patient Presentation: A 12-month-old presented with the parents who were concerned that the child had ingested a foreign object. The actual event was not witnessed by the parents, but they stated there was a small amount of bleeding immediately after the event.

Clinical Features: The child was in no painful or respiratory distress. There was no blood in the oropharynx. There was no stridor, but the child was drooling when sitting upright.

Differential Dx:

- Foreign body ingestion or aspiration

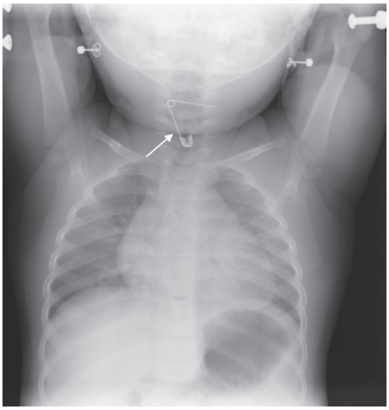

Figure 6-19. Chest x-ray. WA = open safety pin in the hypopharynx or esophagus

Emergency Care: A chest radiograph demonstrated an open safety pin in the hypopharynx or proximal esophagus.

Outcome: The patient was transferred to an outside facility for endoscopic removal.

Key Learning Points and Further Reading: Please see Case 6-13, Figure 6-18.

Case 6-15

Coin in the esophagus

Patient Presentation: A 4-year-old presented after his mother found the child gagging; she was concerned for a foreign body ingestion. The nature of the potential object was unknown to the mother.

Clinical Features: The child was in no respiratory distress but was intermittently gagging and drooling. There was no stridor.

Differential Dx:

- Foreign body or food ingestion into esophagus or trachea

Emergency Care: A chest radiograph demonstrated a coin located in the esophagus. Ketamine 40 mg and atropine 0.1 mg were administered IM. After topical anesthetic spray of the oropharynx, a laryngoscope was used to visualize the upper airway and esophageal inlet, but no foreign body was seen. A weighted bougie was passed into the esophagus using direct laryngoscopic visualization. A second chest radiograph demonstrated the coin had been pushed into the stomach.

Outcome: The patient recovered and was discharged home after a period of ED observation. The child was lost to follow-up, but presumably passed the coin successfully through the entirety of the gastrointestinal tract.

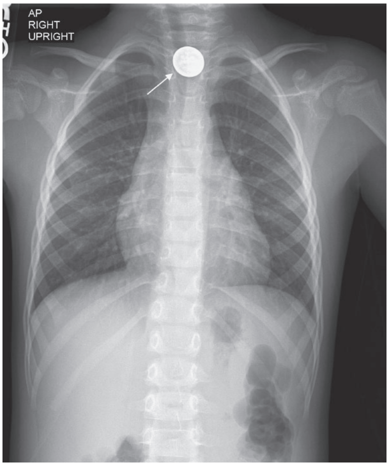

Figure 6-20. Chest x-ray. WA = coin in the esophagus

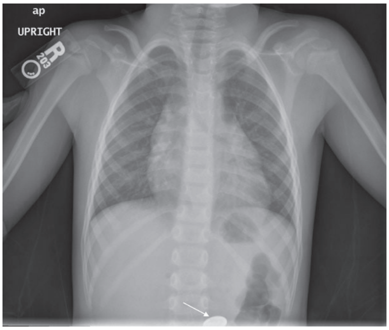

Figure 6-21. Chest x-ray. WA = coin pushed into the stomach

Key Learning Points:

- The classic teaching is that the orientation of the coin indicates where the coin is located. Coronal orientation of the coin indicates esophageal location, while sagittal orientation indicates a tracheal location. The reliability of determining location of a coin by its orientation has been called into question by at least one study.
- Several techniques have been used successfully for removal of esophageal coins in children. These include use of a balloon-tipped bladder catheter in which the balloon is partially inflated past the coin and pulled out of the esophagus along with the coin (this procedure, however, runs the risk of aspiration when the coin

clears the esophagus), a weighted bougie pushing the coin down the esophagus as described in this case (bougienage), sedation with direct laryngoscopy and grasping the coin using a Magill forceps, and upper endoscopy.

- Esophageal bougienage is effective and safe, with less recovery time and decreased cost when compared to endoscopic removal.
- Removal of coins from the upper esophagus under sedation by a Magill forceps is well described. The Magill forceps is placed and gently opened in the esophageal inlet to first visualize and then remove the coin. This is effective and safe in the hands of an experienced emergency physician.

Further Reading:

Baral BK, Joshi RR, Bhattarai BK, Sewal RB. Removal of coin from upper esophageal tract in children with Magill's forceps under propofol sedation. *Nepal Med Coll J*. 2010;12(1):38-41.

Bhargava R, Brown L. Esophageal coin removal by emergency physicians: a continuous quality improvement project incorporating rapid sequence intubation. *CJEM*. 2011;13(1):28-33.

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Case 6-16

Swallowed stolen ring

Patient Presentation: A young male presented in police custody for evaluation of a swallowed ring. The patient allegedly tried to steal an $18,000 ring at a jewelry store by swallowing it.

Clinical Features: The patient was well appearing and in no painful distress. Abdominal examination was benign.

Differential Dx:
- Retained foreign body in unknown location with potential for bowel pathology

Emergency Care: An abdominal radiograph demonstrated the position of the ring low in the gastrointestinal tract. The patient consented to undergo whole bowel irrigation with polyethylene glycol and electrolyte solution. The patient was observed in the ED until passage of the ring.

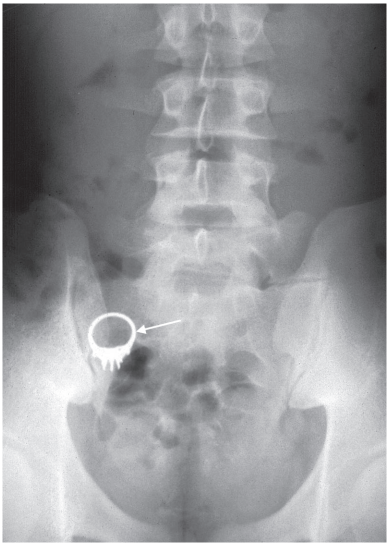

Figure 6-22. Abdominal x-ray. WA = stolen ring in the distal bowel

Outcome: The patient was discharged to jail after uneventful passage of the ring.

Key Learning Points:
- Whole bowel irrigation is effective in decreasing transit time of foreign bodies in the gastrointestinal tract.
- Whole bowel irrigation has been shown to be effective in "body packing," ie, the planned and deliberate packing of illicit drugs using packages such as condoms. However, it is not generally recommended in the management of the "body stuffer," ie, the impulsively ingested contraband as a result of impending law enforcement arrest, as there is no supporting literature.

Further Reading:

Jackson J, Randell KA, Knapp JF. Two year old with water bead ingestion. *Pediatr Emerg Care*. 2015;31(8):605-607.

Mowad E, Haddad I, Gemmel DJ. Management of lead poisoning from ingested fishing sinkers. *Arch Pediatr Adolesc Med*. 1998;152(5):485-488.

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Case 6-17

Swallowed water-filled balloon

Patient Presentation: A 34-year-old presented after ingesting four water-filled balloons.

Clinical Presentation: The patient was well appearing and in no painful distress. Abdominal examination was benign.

Differential Dx:

- Bowel obstruction
- Bowel perforation
- Retained foreign body

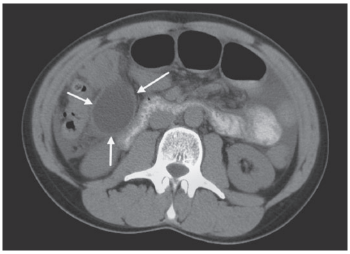

Figure 6-23. Noncontrast abdominal CT scan. WA = water-filled balloon in the small bowel

Emergency Care: A gastroenterologist was consulted.

Outcome: The patient underwent upper endoscopy with removal of three balloons from the stomach. The duodenum was also explored, and the fourth balloon was not visualized. Post endoscopy the patient was adamant he had swallowed four balloons. A noncontrast abdominal CT scan demonstrated a fluid-filled structure in the right midabdominal bowel. An endoscopic ultrasound was performed. This demonstrated extrinsic compression of the second portion of the duodenum, and ultrasound imaging revealed an anechoic structure causing the extrinsic compression. This structure was punctured with a needle using a transduodenal approach, with immediate collapse of the structure. Clear fluid was aspirated with the needle confirming needle placement into the water balloon. The patient recovered uneventfully with the collapsed balloon transiting the gastrointestinal tract.

Key Learning Points:

- Transduodenal fine-needle aspiration is utilized for biopsy of different anatomic lesions, including suspected pancreatic cancer.
- This technique was creatively utilized to deflate the water balloon in this patient.

Further Reading:

Bang JY, Ramesh J, Trevino J, Eloubeidi MA, Varadarajulu S. Objective assessment of an algorithmic approach to EUS-guided FNA and interventions. *Gastrointest Endosc*. 2013;77(5):739-744.

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Case 6-18

Swallowed toothbrushes in the small bowel

Patient Presentation: A 42-year-old man presented with abdominal pain associated with nausea and vomiting.

Clinical Features: The patient was in moderate painful distress with stable vital signs. Examination revealed a distended, tympanitic abdomen with moderate diffuse tenderness to palpation.

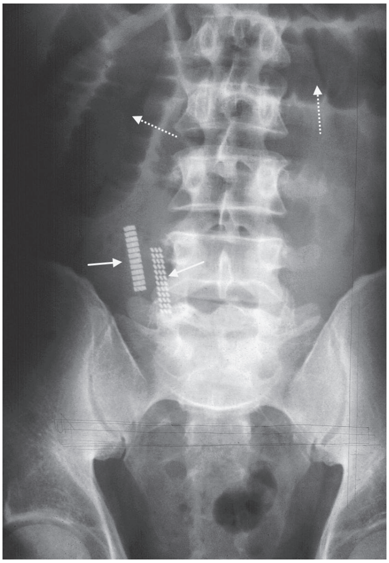

Figure 6-24. Abdominal x-ray. WA = two toothbrushes, WDA = small bowel obstruction

Differential Dx:

- Bowel obstruction
- Bowel perforation
- Infectious bowel disease
- Inflammatory bowel disease
- Vascular accident
- Appendicitis
- Gastroesophageal reflux disease
- Gastritis
- Ulcer disease
- Pancreatitis
- Gallbladder disease

Emergency Care: An abdominal radiograph revealed dilated small bowel loops consistent with obstruction as well as what appeared to be two foreign bodies. The patient was asked several times for a history of ingesting a foreign body, but he, initially, could not recall any such event. A short time later during his ED visit, the patient remembered that approximately 13 months prior to this ED presentation, while in jail, he had swallowed two toothbrushes "on a dare." He had forgotten all about them until this moment.

Outcome: The patient had an exploratory laparotomy and removal of the toothbrushes with resolution of his small bowel obstruction.

Key Learning Points:

- Most actions done "on a dare" turn out to be ill-advised.
- Review of the literature on swallowed toothbrushes reveals no toothbrush ever having passed successfully the entire length of the gastrointestinal tract.
- Most swallowed toothbrushes are retrieved in the esophagus or stomach.
- There is one case report of a swallowed toothbrush transiting to the colon before requiring removal.

Further Reading:

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Farahnak MR, Araghi S, Nikakhlagh S, Saki N. Toothbrush: a report of an unusual foreign body. *Iran J Otorhinolaryngol*. 2015:27(80):247-249.

Gupta M, Gupta P, Gupta M. Extraction of swallowed toothbrush in stomach by pneumatic insufflation and gastrotomy under local anesthesia: a rare occurrence. *J Res Med Sci*. 2014;19(5):472-473.

Jamal K, Shaunak S, Kalsi S, Nehra D. Successful laparoscopic removal of an ingested toothbrush. *J Surg Techn Case Rep*. 2013;5(2):99-102.

Kim Y, Cho SI, Do NY, Park JH. A case of pharyngeal injury in a patient with swallowed toothbrush: a case report. *BMC Res Notes*. 2014;7:788.

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Sewpaul A, Shaban F, Venkatasubramaniam AK, Tennant D, Kelly SB. The case of the forgotten toothbrush. *Int J Surg Case Rep*. 2012;3(5):184-185.

Case 6-19

Beer bottle in the rectum

Patient Presentation: Young male presented with abdominal and rectal pain. He stated he had rolled onto a bottle while he was sleeping.

Clinical Features: The patient was in mild painful distress but was otherwise well appearing. There was mild tenderness to palpation of the lower abdomen without peritoneal signs.

Differential Dx:
- Retained rectal glass foreign body
- Rectal or colon injury

Emergency Care: A plain abdominal radiograph demonstrated a large intact glass bottle in the rectal vault. There was also a small glass vial overlying the left mid-abdomen that was in the patient's clothing and contained amyl nitrate.

Outcome: The patient was taken to the operating room for sedation and removal. The patient was placed into a lithotomy position with delivery of a large glass beer bottle using suprapubic pressure to aid in its passage.

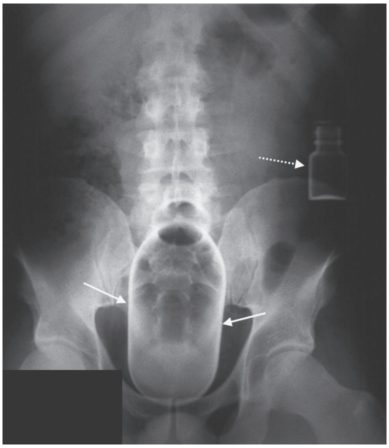

Figure 6-25. Abdominal x-ray. WA = glass bottle in rectum, WDA = bottle of amyl nitrate (in patient's clothing)

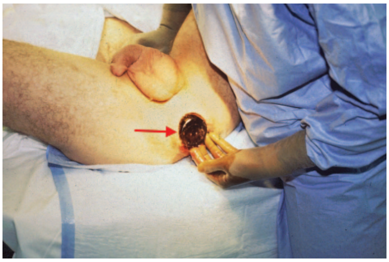

Figure 6-26. RA = glass beer bottle being removed from the rectum

Key Learning Points:
- The size, location, composition, and orientation of rectal foreign bodies is utilized to decide the tools and method of removal.
- The vast majority of rectal foreign bodies can be removed transanally.
- Perianal nerve block and/or conscious sedation facilitates removal and lessens patient discomfort.
- Anoscopes or vaginal speculums can be used to dilate the anus after anesthesia is achieved and allow for introduction of tools to remove the foreign body.
- Tenaculum forceps, ring forceps, obstetric forceps, balloon-tipped bladder catheters, spoons, and obstetric vacuum extractors have all been described in removing rectal foreign bodies.

Further Reading:

Akhtar MA, Arora PK. Case of unusual foreign body in the rectum. *Saudi J Gastroenterol*. 2009;15(2):131-132.

Coates W. Anorectal procedures. In: *Roberts & Hedges' Clinical Procedures in Emergency Medicine,* 6th ed. Philadelphia: Elsevier; 2013.

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Huang W, Jiang JK, Wang HS, et al. Retained rectal foreign bodies. *J Chin Med Assoc.* 2003;66(10):607-612.

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Yaman M, Deitel M, Burul CJ, Shani B, Hadar B. Foreign bodies in the rectum. *Can J Surg*. 1993;36(2):173-177.

Case 6-20

Migration of rectal vibrator

Patient Presentation: A 54-year-old man presented with a retained vibrator. The vibrator had been placed 2 days prior to presentation. He began to have bright red blood per rectum and was seen at an outside hospital where he was noted to have a 3 g/dL drop in hemoglobin. He received blood transfusions and was transferred to our facility.

Clinical Features: The patient was well appearing and in mild painful distress. Abdominal examination was reassuring with minimal tenderness to palpation. Rectal examination demonstrated large blood clots with continued active bleeding. The vibrator could not be palpated on rectal examination.

Differential Dx:

- Migrated rectal vibrator from rectal vault proximally
- Bowel obstruction
- Bowel perforation
- Vascular injury

Emergency Care: An abdominal radiograph and coronal image from a noncontrast abdominal CT scan demonstrate the vibrator had migrated into his sigmoid colon. No bowel perforation or obstruction was visualized.

Outcome: The patient had an exploratory laparotomy and removal of the vibrator with primary closure of his colon. Mucosal ulcerations were the cause of the bleeding. He required an additional blood transfusion and made an uneventful recovery.

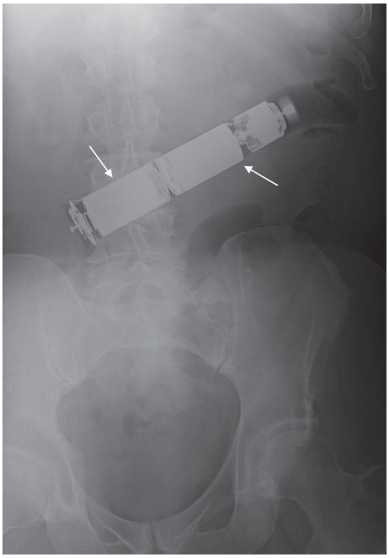

Figure 6-27. Abdominal x-ray. WA = vibrator in colon

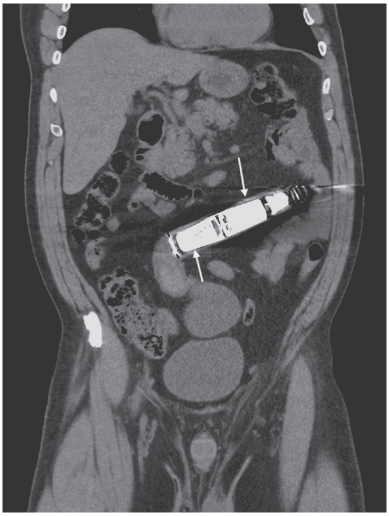

Figure 6-28. Noncontrast abdominal CT scan. WA = vibrator in colon

Key Learning Points:

- Retained rectal foreign bodies are common in emergency medicine.
- Rectal foreign bodies can migrate proximally within the bowel lumen, or they can perforate and migrate outside of the bowel. Migration can result in significant pathology.

Further Reading:

Chiu W, Hsiao CW, Kang JC, Feng JJ, Chao PC, Jao SW. Intrapelvic migration with long-term retention of a rectal thermometer: a case report. *Clin Pediatr*. 2007;46(7):636-638.

Rispoli G, Esposito C, Monachese TD, Armellino M. Removal of a foreign body from the distal colon using a combined laparoscopic and endoanal approach: report of a case. *Dis Colon Rectum*. 2000;43(11):1632-1634.

Yildiz SY, Kendirci M, Akbulut S, Ciftci A, Turgut HT, Hengirmen S. Colorectal emergencies associated with penetrating or retained foreign bodies. *World J Emerg Surg*. 2013;8(1):25.

Case 6-21

Rectal bezoar from sunflower seeds

Patient Presentation: A 6-year-old boy presented with abdominal pain and constipation and no bowel movement for several days.

Clinical Features: The patient was well appearing, in mild painful distress, and afebrile with normal vital signs. Abdominal examination revealed mild lower abdominal tenderness to palpation without peritoneal signs.

Differential Dx:
- Constipation
- Bowel obstruction
- Appendicitis
- Urinary tract infection
- Inflammatory bowel disease
- Retained foreign body

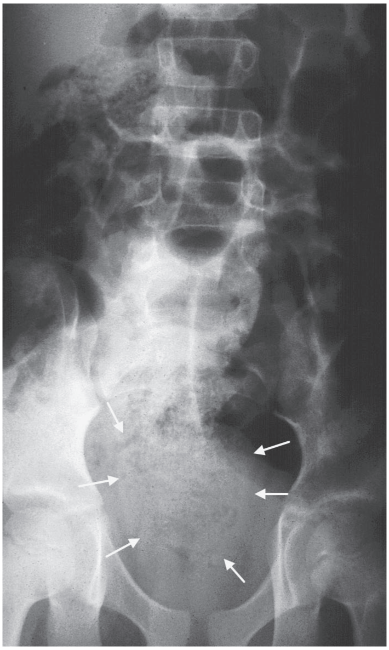

Figure 6-29. Abdominal x-ray. WA = large fecal mass in rectum

Emergency Care: An abdominal radiograph was obtained to look for radiographic signs of obstruction or constipation. A large fecal mass was noted in the rectal vault. Further questioning of this child and mother revealed that the child had ingested a large bag of sunflower seeds 3 days prior to presentation and the seeds were eaten without shell removal.

Outcome: A rectal examination was performed, and digital disimpaction of a rectal sunflower seed bezoar was performed. The child was sent home with a mild bowel regimen to promote bowel movements.

Key Learning Points:
- Phytobezoars result from ingestion of indigestible or poorly digested food.
- Rectal phytobezoars from prickly pear seeds, pomegranate seeds, acerola, watermelon seeds, pumpkin seeds, and sunflower seeds have been reported in the literature.
- Most rectal phytobezoars can be removed with manual disimpaction, although occasionally colonoscopy with mass fragmentation is required.

Further Reading:

Britton PN, Polon M. A case of impacted watermelon seed rectal bezoar in a 12-year-old girl. *J Paediatr Child Health*. 2011;47(1-2):68-69.

El-Majzoub N, Soweid A. Rectal impaction by pomegranate seeds. *Ann Saudi Med*. 2014;34(6):555.

Jao S, Wang LT, Wu CC, Hsiao CW. Removal of a giant rectosigmoid phytobezoar without laparotomy. *Indian J Surg*. 2015;77(suppl 1):69-71.

Manne JR, Rangu VM, Motapothula UM, Hall MC. A crunching colon: rectal bezoar caused by pumpkin seed consumption. *Clin Med Res*. 2012;10(2):75-77.

Marchese S, Bertucci B, Manti F, Berritto D, Roperto AG, Tamburrini S. Rectal impaction due to prickly pear seeds bezoar: a case report. *J Biol Regul Homeost Agents*. 2015;29(3):707-711.

Thing BA, Jorgensen H. Rectal bezoar caused by sunflower seeds [in Danish]. *Ugeskr Laeger*. 2010;172(42):2905-2906.

Case 6-22

Unusual case of repetitive body stuffing of the same object

Patient Presentation: A 40-year-old presented in police custody. The police were suspicious that the patient had placed a bag containing an illicit substance in his rectum during his arrest.

Clinical Features: The patient was well appearing with normal vital signs and in no painful distress.

Differential Dx:

- Cocaine or heroin in rectal bag with a concern for impending toxidrome

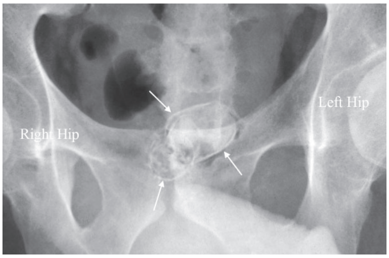

Figure 6-30. Abdominal x-ray (coned down into pelvis). WA = foreign body initially in the rectum

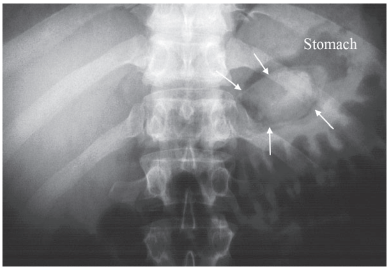

Figure 6-31. Abdominal x-ray (coned down into stomach). WA = same foreign body now in the stomach

Emergency Care: An abdominal radiograph revealed a rectal foreign body. This could not be palpated with digital rectal examination. The patient agreed to take polyethylene glycol orally to speed transit of the bag. A foreign body was not passed after several liquid stools. A second abdominal radiograph was obtained that revealed the foreign body was no longer located in the rectal vault but was now in the stomach. The patient had passed the bag per rectum containing the contraband and surreptitiously swallowed the bag for continued concealment.

Outcome: The patient continued to receive polyethylene glycol and had closer supervision of his stool passage until the bag was successfully passed and recovered.

Key Learning Points:

- A body stuffer is a person who in the process of being arrested quickly either ingests the contraband or places the contraband into the rectum or, in the case of females, the vagina. Often the container is not well sealed, leading to leaking of contraband contents and subsequent toxic symptoms.
- A body packer is a person who places contraband within the body in a deliberate and planned attempt to smuggle. There is usually a large amount of contraband involved. It is usually placed in well-sealed, layered latex containers coated with wax.
- Conservative management, including whole bowel irrigation, is safe and a viable alternative in the asymptomatic body packer. Invasive management, including

laparotomy, is indicated in the presence of bowel obstruction or significant symptoms related to absorption of the contraband.

Further Reading:

Alfa-Wali M, Atinga A, Tanham M, Iqbal Q, Meng AY, Mohsen Y. Assessment of the management outcomes of body packers. *ANZ J Surg*. 2016;86(10):821-882.

Gsell M, Perrig M, Eichelberger M, Chatterjee B, Stoll U, Stanga Z. Body-packer & body-stuffer—a medical challenge [in German]. *Praxis (Bern 1994)*. 2010;99(9):533-544.

Janczak JM, Beutner U, Hasler K. Body packing: from seizures to laparotomy. *Case Rep Emerg Med*. 2015;2015:208047.

Mandava N, Chang RS, Wang JH, et al. Establishment of a definitive protocol for the diagnosis and management of body packers (drug mules). *Emerg Med J*. 2011;28(2):98-101.

Sica G, Guida F, Bocchini G, Iaselli F, Iadevito I, Scaglione M. Imaging of drug smuggling by body packing. *Semin Ultrasound CT MR*. 2015;36(1):39-47.

Case 6-23

Handcuff key in the rectum

Patient Presentation: A 35-year-old prison inmate presented for evaluation of a foreign body in his rectal vault. He was brought in by correctional personnel who were concerned the patient had placed something in his rectum for hiding.

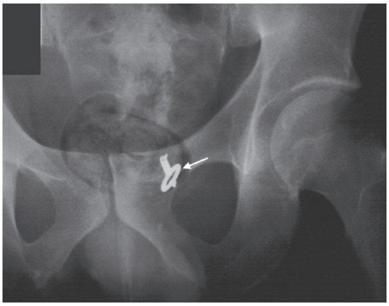

Figure 6-32. Abdominal x-ray (coned down into pelvis). WA = handcuff key

Clinical Features: The patient was in no painful distress with a benign abdominal examination. Rectal examination was unremarkable.

Differential Dx:
- Unknown rectal foreign body

Emergency Care: An abdominal radiograph revealed a key in his rectal vault.

Outcome: The patient had monitored bowel movements by police. This key was a key to unlock his handcuffs.

Key Learning Points:
- Amazingly, this scenario has been described before.
- The appearance of this key as a handcuff key is classic. The point on the ring end of the key is used to double-lock all major brands of handcuffs to prevent them from continuing to ratchet closed and get tighter on the prisoner once they are applied.

Further Reading:

Parlow JL. An unexpected benefit of pre-emptive rectal analgesic administration: the “key” to postoperative analgesia. *CMAJ*. 2000;163(12):1576-1577.

Case 6-24

Pliers in the rectum

Patient Presentation: A 58-year-old man presented to the ED complaining of being sexually assaulted 2 days previously and had a foreign object placed into his rectum.

Clinical Features: The patient was tachycardic and diaphoretic with hand tremors. Abdominal examination was benign. Rectal examination was negative without blood or foreign body palpated.

Differential Dx:

- Foreign body complication such as obstruction or perforation

Emergency Care: An abdominal radiograph revealed 8-in (20-cm) pliers in the rectal vault.

Figure 6-33. Abdominal x-ray. WA = pliers in rectal vault

Outcome: The patient underwent conscious sedation, and the pliers were removed via lower endoscopy without difficulty. The patient was admitted for significant alcohol withdrawal but eventually made a complete recovery.

Key Learning Points:

- Rectal screwdrivers as foreign bodies have been reported in the literature, but no cases of rectal pliers were noted in a literature search.

Further Reading:

Gruev I, Kapitanova K. Case of a foreign body (a screwdriver) pushed into the rectum via the anus and removed by laparotomy [in Bulgarian]. *Khirurgiia Sofiia*. 1977:30(6):525-526.

Spanager L, Mohr M. An unusual case of a screwdriver found in rectum [in Danish]. *Ugeskr Laeger*. 2011;173(49):3190-3191.

Case 6-25

Bullets in rectum

Patient Presentation: Unfortunately, the case history related to this figure is permanently missing. The reader is left to ponder how and why these bullets found their way into the rectal vault and descending colon of this patient.

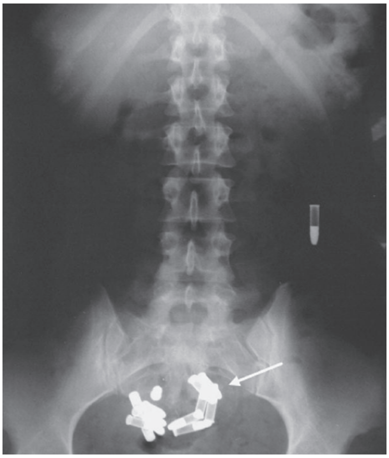

Figure 6-34. Abdominal x-ray. WA = bullets in rectal vault and distal colon

Case 6-26

Eyeglass case and metal shower head in the rectum (two patients)

Patient Presentation: These two patients are both 34-year-old men who presented requesting removal of foreign bodies from their rectum in unrelated incidents.

Clinical Features: Both patients had no painful or respiratory distress, and both had benign abdominal examinations.

Differential Dx

- Foreign body
- Bowel perforation
- Bowel obstruction

Emergency Care: The first patient had a retained eyeglass carrying case. This was palpable by rectal examination. It was removed in the ED without anesthesia as it was easy to reach up with a gloved hand and grab the container with little discomfort to the patient.

The second patient had a metallic shower head in the rectum. This was not palpable via rectal examination. The patient went to the operating room to have it removed under general anesthesia.

Outcomes: Both patients were discharged without complications.

Key Learning Points and Further Reading: Please see Case 6-19, Figures 6-25 and 6-26.

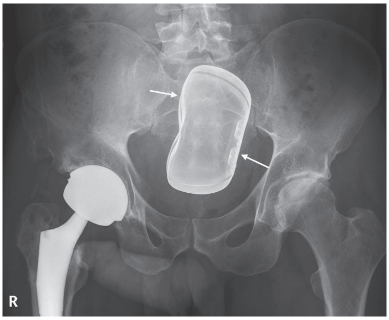

Figure 6-35. First patient. Pelvis x-ray. WA = eyeglass case in rectal vault

Figure 6-36. Second patient. Abdominal x-ray. WA = metallic shower head in rectal vault

Case 6-27

Inflated toy balloon in rectum

Patient Presentation: A young adult presented stating he had a toy balloon in his rectum and could not get it to pass.

Clinical Features: The patient was well appearing in mild painful distress. The balloon could not be visualized on inspection of the rectum or felt by digital examination.

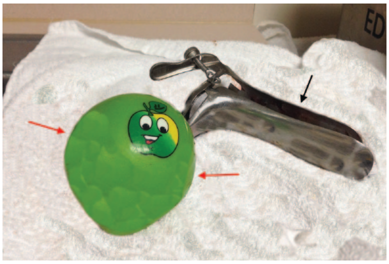

Figure 6-37. BA = vaginal speculum utilized, RA = partially deflated toy balloon post removal from the rectum

Reproduced with permission from Robinson EC, Roy D, Driver BE. Deflate to Extricate: A Technique for Rectal Foreign Body Removal of Inflatable Ball, *J Emerg Med.* 2018 Feb;54(2):e23-e25.

Differential Dx:
- Retained rectal foreign body
- Bowel perforation
- Bowel obstruction

Emergency Care: A vaginal speculum was inserted into the rectum and opened to visualize the inflated toy balloon. A bladder catheter with a 30-cc balloon was slipped past the toy balloon, inflated, and pulled back to move the toy balloon closer to the rectal opening. However, it became wedged and immovable as it approached the rectum. An 18-gauge needle was placed on a syringe, the toy balloon was punctured, and air was aspirated in order to deflate the balloon. The toy balloon was then grabbed with a hemostat and removed completely.

Outcome: The patient was discharged home.

Key Learning Points:
- The size, location, composition, and orientation of rectal foreign bodies is utilized to decide the tools and method of removal.
- The vast majority of rectal foreign bodies can be removed transanally.
- Perianal nerve block and/or conscious sedation facilitates removal and lessens patient discomfort.
- Anoscopes or vaginal speculums can be used to dilate the anus after anesthesia is achieved and allow for introduction of tools to remove the foreign body.
- Tenaculum forceps, ring forceps, obstetric forceps, balloon-tipped bladder catheters, spoons, and obstetric vacuum extractors have all been described in removing rectal foreign bodies.

Further Reading:

Akhtar MA, Arora PK. Case of unusual foreign body in the rectum. *Saudi J Gastroenterol.* 2009;15(2):131-132.

Coates W. Anorectal procedures. In: *Roberts & Hedges' Clinical Procedures in Emergency Medicine*, 6th ed. Philadelphia PA: Elsevier; 2013.

Coskun A, Erkan N, Yakan S, Yıldirim M, Cengiz F. Management of rectal foreign bodies. *World J Emerg Surg*. 2013;8(1):11.

Huang W, Jiang JK, Wang HS, et al. Retained rectal foreign bodies. *J Chin Med Assoc*. 2003;66(10):607-612.

Johnson SO, Hartranft TH. Nonsurgical removal of a rectal foreign body using a vacuum extractor. Report of a case. *Dis Colon Rect*. 1996;39(8):935-937.

Robinson EC, Roy D, Driver BE. Deflate to extricate: a technique for rectal foreign body removal of inflatable ball. *J Emerg Med*. 2018;54(2):e23-e25.

Yaman M, Deitel M, Burul CJ, Shani B, Hadar B. Foreign bodies in the rectum. *Can J Surg*. 1993;36(2):173-177.

Case 6-28

Car muffler impaled in the chest

Patient Presentation: A 32-year-old was working in an auto muffler shop when there was a poorly defined mechanism of trauma leading to impalement of his left upper anterior chest with a car muffler.

Clinical Features: The patient was in moderate painful and respiratory distress. Vital signs were stable. A large metallic muffler was embedded in his left anterior chest wall.

Differential Dx:

- Vascular, cardiac, pulmonary, and axial skeletal injury

Emergency Care: The patient underwent rapid sequence intubation and thoracostomy. A chest radiograph showed the position of the muffler.

Outcome: The patient was taken to the operating room where the muffler was wrapped in sterile gauze and removed from the thorax. There were no major vascular injuries. A pulmonary contusion and lung laceration were noted. Interestingly, a ballpoint pen, which had been in the patient's front shirt pocket, was found within the left thorax and removed. The patient made an uneventful recovery.

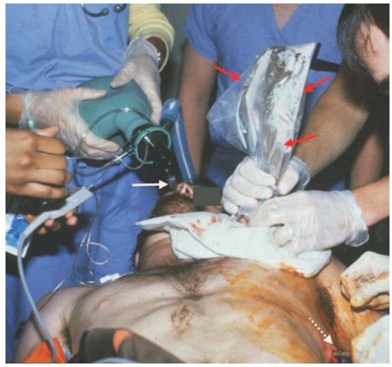

Figure 6-38. RA = muffler impaled into the chest, WA = endotracheal tube, WDA = thoracostomy tube

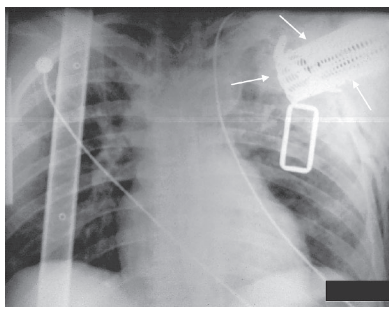

Figure 6-39. Chest x-ray. WA = muffler impaled into the chest

Key Learning Points:

- Impaled thoracic foreign bodies that may involve major vascular structures should be removed in the operating room under conditions where control of major hemorrhage can be attained.
- The impaled thoracic object should be stabilized ideally at the scene before patient transport or upon arrival in the ED. Procedures such as intubation and thoracostomy should be performed in the ED as indicated.
- In the setting of penetrating thoracic trauma in an intubated and sedated patient, control of the pleural space via thoracostomy performed in the ED is important to prevent the development of a tension pneumothorax.

Further Reading:

Edwin F, Tettey M, Sereboe L, et al. Impalement injuries of the chest. *Ghana Med J*. 2009;43(2):86-89.

Lunca S, Morosanu C, Alexa O, Pertea M. Severe thoracic impalement injury: survival in a case with delayed surgical definitive care. *Ulus Travma Acil Cerrahi Derg*. 2015;21(2):152-156.

Miura H, Ogata K, Nawa K, Konagai N, Kato H. Penetrating thoracic injury. *Kyobu Geka*. 2006;59(11):1013-1017.

Romero LH, Nagamia HF, Lefemine AA, Foster ED, Wysocki JP, Berger RL. Massive impalement wound of the chest. A case report. *J Thorac Cardiovasc Surg*. 1978;75(6):832-835.

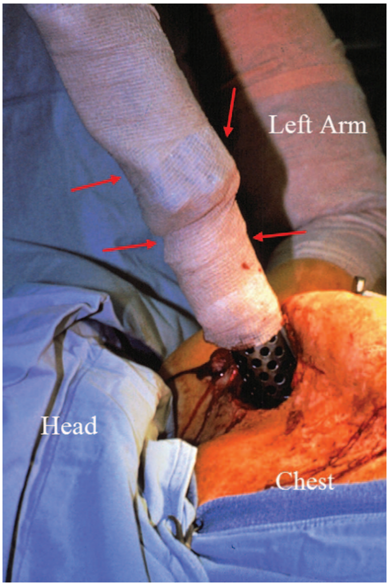

Figure 6-40. Intraoperative photo. RA = muffler impaled into the chest

Case 6-29

Metal pipe impaled in the chest

Patient Presentation: A 21-year-old presented for evaluation of injuries after a motor vehicle crash. The patient suffered impalement of a metal sign post.

Clinical Features: The patient presented with stable vital signs in severe painful distress. A metal pipe was embedded in his upper chest and neck just superior to his clavicle.

Differential Dx:

- Cardiovascular, pulmonary, and upper airway injury

Emergency Care: The patient underwent rapid sequence intubation followed by deep sedation. A thoracostomy tube and a nasogastric tube was placed. A chest radiograph demonstrated the position of the metal pipe.

Outcome: The patient was taken to the operating room, and the pipe was removed. The pipe measured 47 cm in length with a 4-cm diameter. There were no major nerve or vascular injuries. The patient recovered uneventfully.

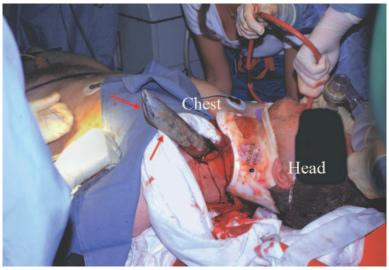

Figure 6-41. RA = end of metal pipe impaled into left chest wall

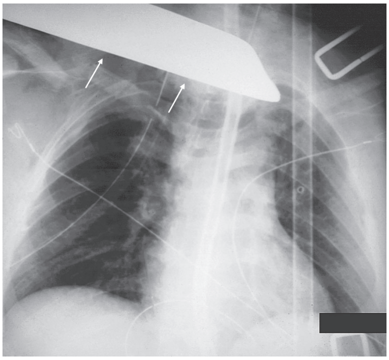

Figure 6-42. Chest x-ray. WA = metal pipe

Key Learning Points:

- In the prehospital setting, it often requires creative solutions to cut the impaled object down to a manageable size in a timely fashion and stabilize it for transport.
- Removal of impaled objects that may involve major vascular structures should be performed in the operating room. The exception to this is the presence of life-threatening exsanguinating hemorrhage with the impaled object still in place when there is not enough time to get to the operating room.

Further Reading:

Davis IC, Davis JW, Groom T. Thoracic plank impalement: an engineering perspective. *J Trauma*. 2003;54(5):1036.

Eder F, Meyer F, Huth C, Halloul Z, Lippert H. Penetrating abdomino-thoracic injuries: report of four impressive, spectacular and representative cases as well as their challenging surgical management. *Pol Przegl Chir*. 2011;83(3):117-122.

Foot CL, Naodoo P. Breaking the rules: a thoracic impalement injury. *Med J Austral*. 1999;171(11-12):676-677.
Isenburg S, Jackson N, Karmy-Jones R. Removal of an impaled knife under thoracoscopic guidance. *Can Respir J*. 2008;15(1):39-40.
Nott DB. Impalement injury of the thorax. *ANZ J Surgery*. 2001;71(2):126-128.
Wick JM. Case report: survival of a type I transthoracic impalement. *Int J Trauma Nurs*. 2001;3:88-92.

Case 6-30

Tree branch impaled in the chest

Patient Presentation: A 51-year-old man presented after a motor vehicle crash. The car the patient was driving drove off the road into a grove of trees. He was found inside his car with his left chest impaled by a 3-in (7.6-cm) diameter tree branch.

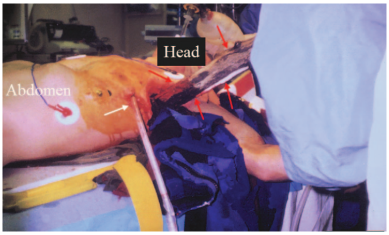

Figure 6-43. RA = large tree branch impaled into the left chest, WA = thoracostomy tube

Clinical Features: The patient was awake and talking in moderate painful and respiratory distress. He was hypotensive and tachycardic. The tree branch entered his left chest and was firmly impaled.

Differential Dx:
- Multiple blunt traumatic injuries

Emergency Care: The patient underwent rapid sequence intubation and sedation. A left thoracostomy was performed inferior to the entrance of the tree branch. The patient was taken to the operating room.

Outcome: The patient had a partial left pneumonectomy for a severe lung injury. He had an uneventful recovery.

Key Learning Points:
- Dramatic visual presentations of critically injured patients can be distracting and lead the emergency medicine physician away from the basics of trauma care.
- This patient, despite being awake and oriented, was critically ill with a life-threatening injury. The basics were quickly performed: rapid sequence intubation with sedation for airway control and thoracostomy for pleural space control before attention was directed to the impalement.

Further Reading:

Karger B, Teige K, Bajanowski T. Bizarre impalement fatalities—where is the implement? *J Forens Sci*. 2002;47(2):389-391.

Mouaffak Y, Elfadel B, Boutbaoucht M. A case of penetrating axillary trauma. *Rev Stomatol Chir Maxillofac*. 2011;112(6):369-371.

Tsang FF, Sihoe AL, Cheng L. Unusual retained foreign body in the lung: a tree branch. *Euro J Cardio-Thorac Surg*. 2007;31(2):309-310.

Case 6-31

Shotgun injury to the chest

Patient Presentation: A 55-year-old man presented with several respiratory complaints suggestive of pneumonia.

Clinical Features: The patient was well appearing and in no painful or respiratory distress.

Differential Dx:
- Pulmonary infection

Emergency Care: The patient had chest radiographs that demonstrated several dozen pellets from a previous gunshot wound years prior to this presentation. No other pulmonary pathology was visualized.

Outcome: The patient was treated symptomatically for his upper respiratory illness.

Key Learning Points:
- Judging by the number and location of these pellets, it is remarkable the patient survived his original gunshot wound injuries.
- Metallic foreign bodies may be present and asymptomatic for years, and their simple presence is not an indication for removal.
- Metallic foreign bodies can migrate over time into spaces that provide an indication for removal, such as vascular, joint, or central nervous system involvement.

Figure 6-44. Chest x-ray (PA view). Numerous pellets from old gunshot injury

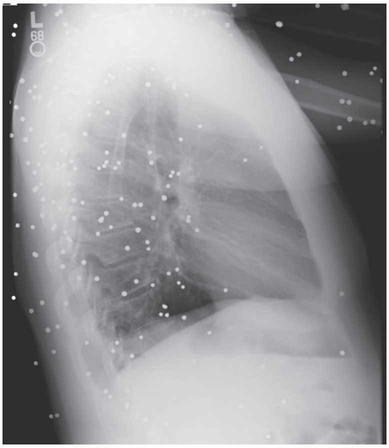

Figure 6-45. Chest x-ray (lateral view). Numerous pellets from old gunshot injury

Further Reading:

Centeno JA, Rogers DA, van der Voet GB, et al. Embedded fragments from U.S. military personnel—chemical analysis and potential health implications. *Int J Environ Res Public Health*. 2014;11(2):1261-1278.

Sersar SI, Albohiri KA, Abdelmohty H. Impacted thoracic foreign bodies after penetrating chest trauma. *Asian Cardiovasc Thorac Ann*. 2016;24(8):782-787.

Case 6-32

Cardiac gunshot injury with acute inferior myocardial infarction

Patient Presentation: An 18-year-old man presented for evaluation of injuries after a shotgun injury.

Clinical Features: The patient had several anterior circular small wounds over his abdomen and chest wall. His vital signs were stable, but he was in moderate to severe painful distress. His pain seemed to be out of proportion to his clinical condition.

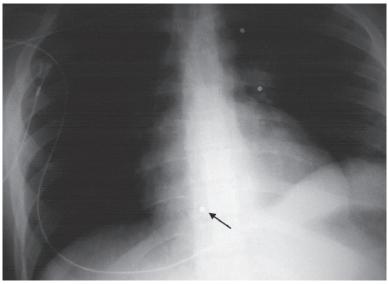

Figure 6-46. Chest x-ray. BA = pellet overlying cardiac silhouette

Differential Dx:

- Multiple diagnostic possibilities related to penetrating thoracic and abdominal trauma

Emergency Care: A chest radiograph was performed demonstrating several pellets within the thorax and over the mediastinum. An electrocardiogram demonstrated an inferoposterior ST-segment myocardial infarction. A diagnostic peritoneal lavage (case was before the advent of bedside ED ultrasound or readily available CT scan) was grossly positive, and the patient was taken to the operating room.

Outcome: Operative findings included hemoperitoneum with a mesenteric hematoma without penetrating bowel injury and a small liver laceration that was no longer bleeding. A pericardial window was performed, and there was a scant amount of normal-appearing, clear pericardial fluid.

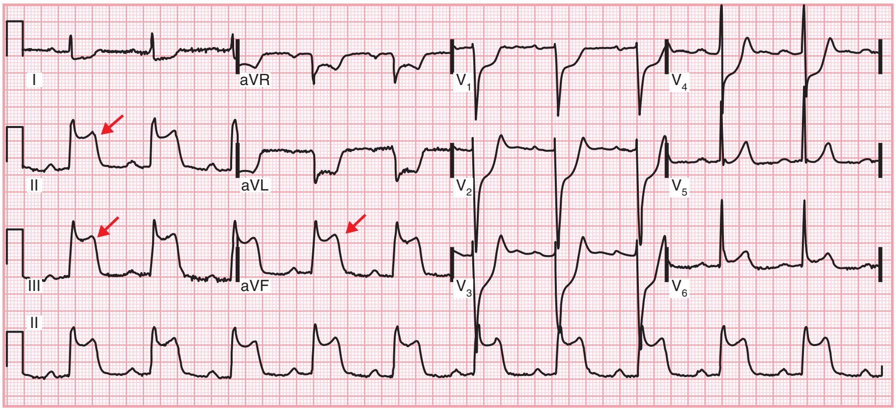

Figure 6-47. Electrocardiogram. RA = acute inferior myocardial infarction

Postoperatively, a transesophageal echocardiogram demonstrated an inferior wall motion abnormality with a 60% left ventricular ejection fraction. A subsequent coronary angiogram demonstrated clean coronary arteries except for 100% occlusion of the posterior descending artery.

The patient progressed to a full recovery.

Key Learning Points:

- How the pellet came to rest in the posterior descending artery is unclear. It could have lodged directly, or could have embolized hematogenously.
- A few case reports with similar presentations show that most were treated conservatively without emergent removal of the pellet.

Further Reading:

Bali HK, Vijayvergiya R, Banarjee S, Kumar N. Gunshot injury of the heart: an unusual cause of acute myocardial infarction. *Texas Heart Inst J*. 2003;30(2):158-160.

Bayir A, Soylu A, Kara H. Total right coronary artery obstruction related to penetrating injuries of the thorax caused by gunshot. *Acta Cardiol*. 2007;62(5):529-531.

La Vecchia L, Rubboli A, Paccanaro M, Varotto L, Fontanelli A. Acute total occlusion of the right coronary artery by a pellet. *Circulation*. 2001;104(8):E40.

Raisky O, Metton O, Henaine R, Salih C, Obadia JF, Ninet J. Coronary embolization in bullet wounds: role of perioperative coronary angiography. *Ann Thorac Surg*. 2007;84(1):274-276.

Case 6-33

Retained and hidden knife blade in the lumbar vertebra

Patient Presentation: A young male presented after being stabbed in the anterior abdomen.

Clinical Features: The patient had stable vital signs. There was a 2-cm (0.8-in) linear laceration to the anterior abdomen, but no foreign body was visualized. There was minimal tenderness to palpation of the abdomen.

Differential Dx:
- Solid viscous injury to liver or spleen
- Bowel injury
- Vascular injury

Emergency Care: Anterior/posterior and lateral abdominal radiographs demonstrated a retained metallic foreign body. The assailant had broken off the knife blade from the knife handle. The knife had deeply penetrated the anterior surface of the third lumbar vertebral body, with the tip of the knife almost completely through the vertebral body and entering the spinal canal. The patient was taken to the operating room for exploratory laparotomy.

Outcome: There were no significant vascular or bowel injuries found on abdominal exploration. Removal of the knife required significant withdrawal force.

Key Learning Points:
- The finding of a retained knife blade was quite unexpected. External wound appearance is not a good predictor of pathology below the skin surface.
- This patient had a benign abdominal examination and a surprising lack of actual injury at the time of surgery given the depth and location of the knife blade.

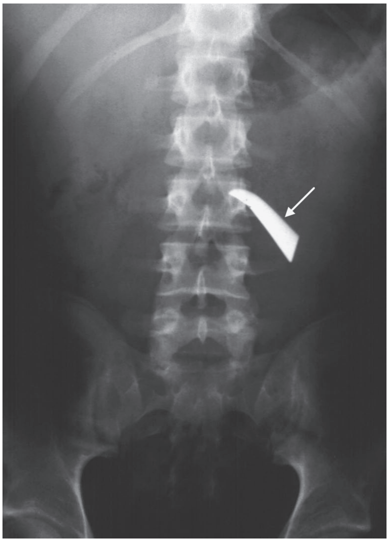

Figure 6-48. Abdominal x-ray (AP view). WA = concealed knife blade in the third lumbar vertebra

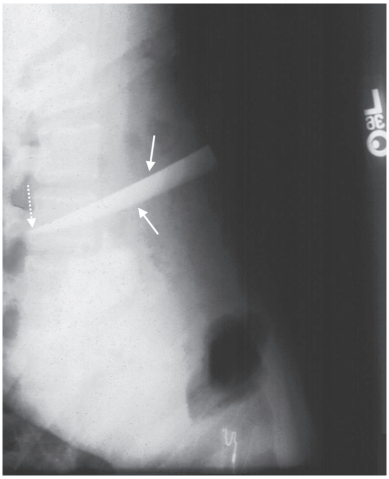

Figure 6-49. Abdominal x-ray (lateral view). WA = concealed knife blade in the third lumbar vertebra, WDA = tip of knife blade barely entering the spinal canal

- Nonoperative management for select patients with stab wounds to the anterior abdominal wall and negative CT scanning is feasible but was not done in this case.

Further Reading:

Biffl WL, Moore EE. Management guidelines for penetrating abdominal trauma. *Curr Opin Crit Care*. 2010;16(6):609-617.

Chiu WC, Shanmuganathan K, Mirvis SE, Scalea TM. Determining the need for laparotomy in penetrating torso trauma: a prospective study using triple-contrast enhanced abdominopelvic computed tomography. *J Trauma*. 2001;51(5):860-868.

Goin G, Massalou D, Bege T, et al. Feasibility of selective nonoperative management for penetrating abdominal trauma in France. *J Visc Surg*. 2016;154(3):167-174.

Inaba K, Okoye OT, Rosenheck R, et al. Prospective evaluation of the role of computed tomography in the assessment of abdominal stab wounds. *JAMA Surg*. 2013;148(9):810-816.

Plackett TP, Fleurat J, Putty B, Demetriades D, Plurad D. Selective nonoperative management of anterior abdominal stab wounds: 1992-2008. *J Trauma*. 2011;70(2):408-413.

Sanei B, Mahmoudieh M, Talebzadeh H, Shahabi Shahmiri S, Aghaei Z. Do patients with penetrating abdominal stab wounds require laparotomy? *Arch Trauma Res*. 2013;2(1):21-25.

Case 6-34

Retained and hidden knife blade in the right thorax

Patient Presentation: A 17-year-old was stabbed in the right chest during an assault. Paramedics reported air bubbling out of the chest wound.

Clinical Features: The patient was awake and hemodynamically stable. He had a laceration directly over his sternum, with no foreign body visualized. Breath sounds were equal bilaterally.

Differential Dx:

- Penetrating cardiac, pulmonary, diaphragmatic, or bowel injury

Emergency Care: A chest radiograph was obtained that demonstrated a retained knife blade.

Outcome: The patient went to the operating room where the laceration was extended and explored, the base of the knife blade was located, and the knife blade was removed. A thoracostomy tube was placed with minimal output. The patient recovered without complication.

Key Learning Points:

- This is a relatively common scenario, ie, a knife handle breaking off from the knife blade with the blade retained and not visible on external physical examination.
- There are two other cases in this book illustrating this same scenario: Case 6-33 and Case 6-36. Case 6-33 was a stab wound to the abdomen with the retained and hidden knife blade embedded in the lumbar vertebra, and Case 6-36 was a hidden knife blade after a stab wound to the face.

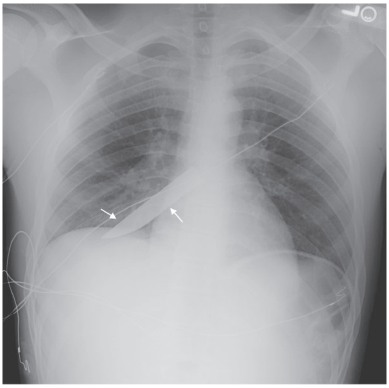

Figure 6-50. Chest x-ray (AP view).
WA = retained knife blade hidden in the chest

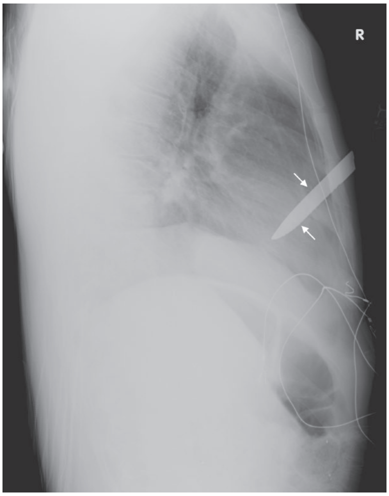

Figure 6-51. Chest x-ray (lateral view).
WA = retained knife blade hidden in the chest

Further Reading:

Dubois-Marshall S, De Kock S. Two days with a broken knife blade in the neck—an interesting case of Horner's syndrome. *Emerg J Med*. 2011;28(7):629-631.

Sobnach S, Nicol A, Nathire H, Kahn D, Navsaria P. Management of the retained knife blade. *World J Surg*. 2010;34(7):1648-1652.

Wang H, Ma L, Ding W. Delayed myelopathy secondary to stab wound with a retained blade tip within the laminae: case report. *Int J Clin Exp Med*. 2015;8(9):16787-16792.

Case 6-35

Retained knife in the back

Patient Presentation: A 25-year-old presented for evaluation of injuries from a stab wound to the back.

Clinical Features: The patient had normal vital signs and displayed moderate painful distress but had no respiratory complaints. The knife blade was deeply embedded in the T5 paraspinous area with the knife handle attached and visible. There were no neurologic deficits.

Differential Dx:

- Cardiovascular or pulmonary injury
- Neurologic injury to spinal cord
- Bony injury

Emergency Care: A chest radiograph demonstrated a deeply embedded knife blade. The white lines on the anteroposterior (AP) chest radiograph are artifact. There was no pneumothorax or hemothorax. A chest CT scan demonstrated the knife blade to be just superior to the intersection of the lamina and transverse process of T5. There was no spinal canal, mediastinal, or pulmonary involvement.

Outcome: The patient was taken to the operating room for removal of the knife. The patient had an uneventful recovery.

Key Learning Points:

- This patient was unfortunate enough to have been stabbed but fortunate enough to have a knife deeply embedded in the upper back without any significant injury.

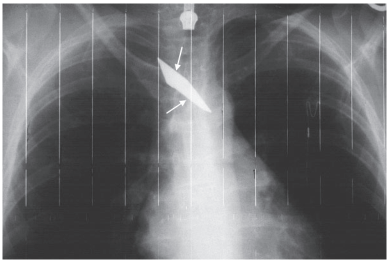

Figure 6-52. Chest x-ray (AP view). WA = retained knife in the back

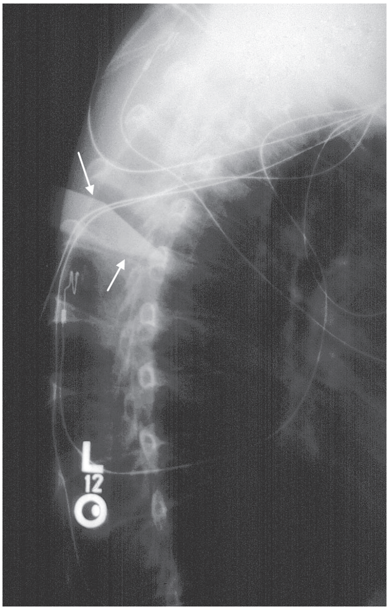

Figure 6-53. Chest x-ray (lateral view). WA = retained knife in the back

Further Reading:

Isenburg S, Jackson N, Karmy-Jones R. Removal of an impaled knife under thoracoscopic guidance. *Can Resp J*. 2008;1:39-40.

Case 6-36

Retained and hidden knife blade in the face

Patient Presentation: A 20-year-old presented for evaluation of injuries after being assaulted. The patient was unable to recall the exact mechanism of trauma, but reports were that he was punched in the face and may have also been stabbed.

Clinical Features: The patient was alert and oriented with stable vital signs. There was blood covering the patient's face. There appeared to be a laceration of the left superior orbital rim. A 2 × 4 mm metallic foreign body was seen within this laceration, and it appeared to be a "staple." No knife blade was visualized on examination.

Differential Dx:
- Blunt and penetrating facial and head traumatic injury

Emergency Care: Facial lateral and anterior radiographs demonstrated a large embedded knife blade. The patient underwent rapid sequence intubation followed by sedation. A head CT scan revealed the knife blade to have fractured the superior orbital rim and superior orbital roof thus involving the frontal sinus, entered the superior orbit, and medially displaced the optic nerve. Amazingly, there was no globe or intracranial penetration.

Outcome: The patient was taken to the operating room, and the knife blade was removed without complication. The patient made an uneventful recovery without any neurologic or visual sequelae.

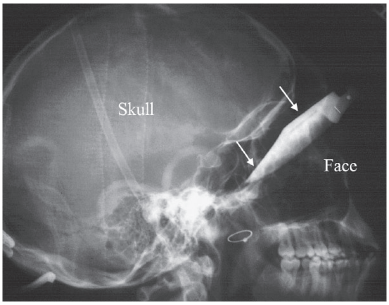

Figure 6-54. Skull x-ray (lateral view). WA = retained knife blade buried in the face

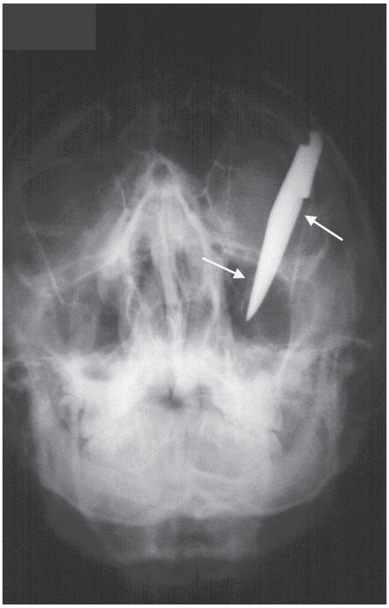

Figure 6-55. Skull x-ray (AP view). WA = retained knife blade buried in the face

Key Learning Points:
- A tongue in cheek medical axiom is that "the role of the face is to protect the brain." This is especially true in blunt trauma where the air-cushioned sinuses and engineering of facial bones absorbs blunt traumatic energy.

- What appeared to be an innocuous small "staple" was a deeply embedded, broken off knife blade. Data obtained from physical examination is limited in penetrating traumatic injury.

Further Reading:

Bourguignon Filho AM, Puppin AA, Pimentel DP, et al. Unusual penetrating orbit injury. *Int J Oral Maxillofac Surg*. 2006;35(1):92-93.

Daya NP, Liversage HL. Penetrating stab wound injuries to the face. *SADJ*. 2004;59(2):55-59.

Meer M, Siddiqi A, Morkel JA, Janse van Rensburg P, Zafar S. Knife inflicted penetrating injuries of the maxillofacial region: a descriptive, record-based study. *Injury*. 2010;41(1):77-81.

Offiah C, Hall E. Imaging assessment of penetrating injury of the neck and face. *Insights Imaging*. 2012;3(5):419-431.

Case 6-37

Knife embedded in the abdomen

Patient Presentation: A young male presented with a self-inflicted stab wound to the abdomen.

Clinical Features: The patient presented alert, in moderate painful distress, and hemodynamically stable with a knife embedded into his right upper abdominal quadrant. The knife was noted to be beating with the patient's pulse. There was minimal external hemorrhage.

Figure 6-56. WA = knife embedded in the right upper quadrant

Differential Dx:

- Penetrating abdominal or pulmonary injury
- Pericardial or intracardiac injury

Emergency Care: After pain management, the patient was taken directly to the operating room.

Outcome: The knife was removed, and an exploratory laparotomy revealed no bowel, nerve, or vascular injury. The patient was subsequently discharged after operative recovery.

Key Learning Points:

- Embedded foreign bodies like knives that have the potential for deep and difficult-to-access vascular involvement should be removed in the operating room.
- Self-inflicted stab wounds are most frequently found in the abdomen, followed by the neck and chest.
- In one study, 19% of the patients that presented with self-inflicted stab wounds stated the wound was accidental and not intentional, but 80% of those were eventually revealed to be intentional.

Further Reading:

Atreya A, Rijal D, Kanchan T, Shekhawat RS. Abdominal self-stabbing: a case report. *Med Leg J*. 2017;85(2):97-99.

Badger JM, Gregg SC, Adams CA. Non-fatal suicide attempt by intentional stab wound: clinical management, psychiatric assessment, and multidisciplinary considerations. *J Emerg Trauma Shock*. 2012;5(3):228-232.

Morita S, Inokuchi S, Aoki H, et al. The comparison of characteristic and clinical features of self-inflicted abdominal stab wound patients in Japan: simple stab wounds versus Hara-kiri wounds. *J Trauma*. 2008;64(3):786-789.

Nielssen OB, Large MM. Potentially lethal suicide attempts using sharp objects during psychotic illness. *Crisis*. 2011;32(1):37-42.

Case 6-38

Stiletto stab wound

Patient Presentation: A 49-year-old was stabbed in the back with a stiletto-like knife.

Clinical Features: The patient was in moderate painful distress without any respiratory distress. His vital signs were stable. There was a knife handle sticking out of his right upper back with the entry just inferior to the inferior tip of the scapula. There was no bleeding, and breath sounds were normal to auscultation.

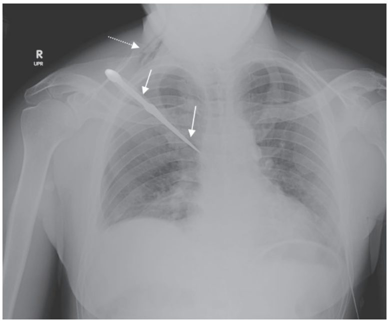

Figure 6-57. Chest x-ray. WA = firmly embedded stiletto-like knife, WDA = subcutaneous emphysema

Differential Dx:
- Cardiovascular injury
- Pulmonary injury
- Intraperitoneal injury

Emergency Care: Bedside ED ultrasound was negative for pericardial effusion or intraperitoneal blood. Chest radiograph revealed the knife tip to project close to the superior vena cava on a single AP view. There was no pneumothorax or hemothorax noted. A small amount of subcutaneous emphysema was noted.

Outcome: The patient was taken to the operating room and had a thoracoscopic exploration of his right hemothorax. No vascular injury or pulmonary injury was noted. There was a rush of air associated with the introduction of the thoracoscope indicating a pneumothorax. The knife was removed, a right thoracostomy tube was placed, and the patient had an uneventful recovery.

Key Learning Points:
- The exact positioning of an embedded object is difficult to discern using a single-view radiographic image.
- This patient had a pneumothorax that was undetected by his initial chest radiograph.
- Bedside ED thoracic ultrasound is more sensitive than supine AP chest radiograph in the detection of pneumothorax.

Further Reading:
Abbasi S, Farsi D, Hafezimoghadam P, Fathi M, Zare MA. Accuracy of emergency physician-performed ultrasound in detecting traumatic pneumothorax after a 2-h training course. *Eur J Emerg Med.* 2013;20(3):173-177.

Balesa J, Rathi V, Kumar S, Tandon A. Chest sonography in the diagnosis of pneumothorax. *Indian J Chest Dis Allied Sci.* 2015;57(1):7-11.

Ku BS, Fields JM, Carr B, Everett WW, Gracias VH, Dean AJ. Clinician-performed beside ultrasound for the diagnosis of traumatic pneumothorax. *West J Emerg Med*. 2013;14(2):103-108.

Soldati G, Testa A, Sher S, Pignataro G, La Sala M, Silveri NG. Occult traumatic pneumothorax: diagnostic accuracy of lung ultrasonography in the emergency department. *Chest*. 2008;33(1):204-211.

Wilkerson RG, Stone MB. Sensitivity of bedside ultrasound and supine anteroposterior chest radiographs for the identification of pneumothorax after blunt trauma. *Acad Emerg Med*. 2010;17(1):11-17.

Case 6-39

Earring and a zipper in the right mainstem bronchus (two patients)

Patient Presentation: These are two young patients who presented after coughing episodes precipitated by placing foreign bodies in their mouths in unrelated incidents.

Clinical Features: Neither patient had any painful or respiratory distress. Careful auscultation over the anterior chest wall at the level of the right mainstem bronchus in both patients revealed a focal, localized, soft wheeze with expiration.

Emergency Care: Chest radiographs revealed an earring to be in the right mainstem bronchus in the first patient and a zipper in the second patient.

Outcome: Both patients underwent sedation with bronchoscopic removal without complication.

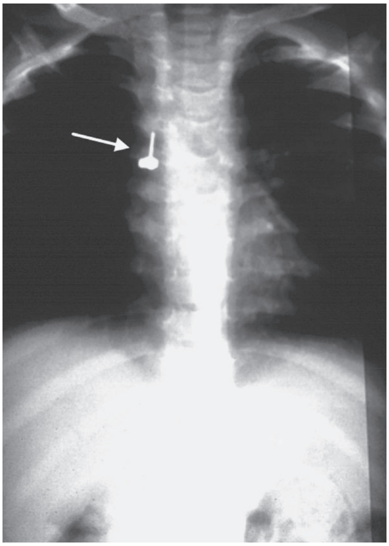

Figure 6-58. First patient. Chest x-ray. WA = earring in the right mainstem bronchus

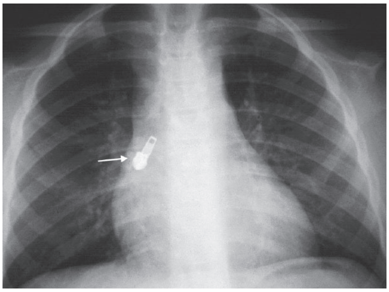

Figure 6-59. Second patient. Chest x-ray. WA = zipper in the right mainstem bronchus

Key Learning Points:

- Foreign bodies can cause obstruction of air flow resulting in a focal wheeze if located in proximal mainstem bronchi.
- The focal wheeze is only appreciated with careful auscultation with a stethoscope.
- "All that wheezes is not asthma."
- Transient episodes of coughing at the time of the incident is not a reliable indicator of either aspiration or ingestion. A chest radiograph, as long as the object is radiodense, is very helpful in determining the location of the foreign body.

Further Reading:

Freiman MA, McMurray JS. Unique presentation of a bronchial foreign body in an asymptomatic child. *Ann Otol Rhinol Laryngol.* 2001;6:495-497.

Koul PA, Wahid A, Bhat TA, Hussain T. Whistle in the bronchus. *Ann Thorac Med.* 2007;2(3):124-125.

Maguire A, Gopalakaje S, Eastham K. All that wheezes is not asthma: a 6-year-old with foreign body aspiration and no suggestive history. *BMJ Case Rep*. 2012;2012. pii: bcr2012006640.

Parida PK, Shanmugasundaram N, Gopalakrishnan S. Clinico-radiological parameters predicting early diagnosis of foreign body aspiration in children. *Kulak Burun Bogaz Ihtis Derg.* 2016;26(5):268-275.

Case 6-40

Pediatric bronchial foreign body

Patient Presentation: A 2-year-old child presented after a brief and resolved choking episode while eating peanuts.

Clinical Features: The child was well appearing and in no painful or respiratory distress.

Differential Dx:
- Aspirated peanut or swallowed peanut

Emergency Care: Chest radiographs taken during inspiration and expiration demonstrate a right lung obstruction due to an aspirated peanut. During inspiration, air can get past the obstruction, which results in a normal-appearing chest radiograph with normal-sized left and right lung volume. However, during expiration, air is not able to get past the obstruction in the right lung, resulting in air trapping and mediastinal shift to the left away from the affected lung. This results in a larger right lung and a smaller left lung.

Outcome: This patient underwent bronchoscopy with removal of the peanut and recovered uneventfully.

Key Learning Points:
- A reliable history of a choking episode in children under the age of 4 is an indication for diagnostic evaluation, even in the setting of a normal physical examination.
- Ingestion or aspiration of a foreign body was responsible for 17,000 emergency department visits in patients under 14 years of age in the year 2000.
- In 2013, there were 4,800 deaths from foreign body aspiration in children under the age of 4 years.
- Peanuts are a commonly aspirated foreign body.

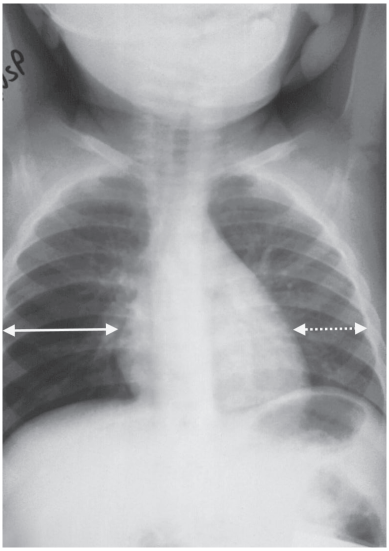

Figure 6-60. Chest x-ray obtained in inspiration. WA = right hemithorax volume, WDA = left hemithorax volume

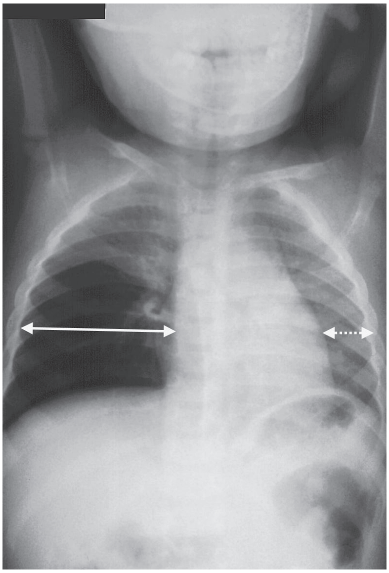

Figure 6-61. Chest x-ray in expiration. WA = increased right hemithorax volume, WDA = decreased left hemithorax volume

- Latex balloons are the most common nonfood cause of fatal choking episodes in children (see Case 1-2).

Further Reading:

Centers for Disease Control and Prevention. Nonfatal choking-related episodes among children—United States, 2001. *MMWR Morb Mortal Wkly Rep.* 2002;51(42):945.

Committee on Injury, Violence, and Poison Prevention. Prevention of choking among children. *Pediatrics*. 2010;125(3):601-607.

National Safety Council, Injury Facts 2017. Available at: http://www.nsc.org/learn/safety-knowledge/Pages/injury-facts.aspx. Accessed May 28, 2018.

Case 6-41

Aspirated teeth

Patient Presentation: This patient presented for evaluation of facial trauma secondary to an assault.

Clinical Features: The patient had facial contusions with significant perioral trauma. Lip lacerations and multiple tooth avulsions were present.

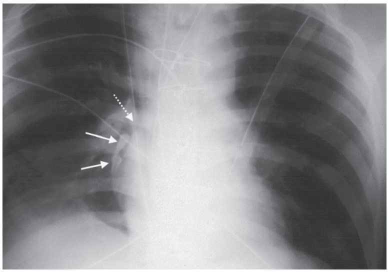

Figure 6-62. Chest x-ray. WA = aspirated teeth, WDA = right bronchus intermedius

Differential Dx:

- Dental fractures
- Tooth avulsions
- Mandibular fracture
- Alveolar fracture
- Aspiration of blood or teeth
- Lip lacerations
- Swallowed teeth and blood

Emergency Care: A chest radiograph revealed two intact teeth in the patient's bronchus intermedius.

Outcome: The facial injuries were repaired, and the aspirated teeth were removed via bronchoscopy.

Key Learning Points:

- Although relatively uncommon, aspiration of avulsed teeth results in obstructive airway or infectious lung complications if undiagnosed.
- A chest radiograph is indicated in patients with acutely avulsed teeth who are unable to inform the provider as to the whereabouts of their missing teeth. This is especially true in patients who have an altered mental status and who are not protecting their airway.
- Aspirated teeth can be difficult to visualize on a chest radiograph. Adjusting the brightness/contrast or other available digital manipulations of the image can be quite useful in discerning the teeth.

Further Reading:

Aliyali M, Abedi S. A 50-year-old man with progressive dyspnea. *Tanaffos.* 2012;11(1):61-62.

Casap N, Alterman M, Lieberman S, Zeltser R. Enigma of missing teeth in maxillofacial trauma. *J Oral Maxillofac Surg.* 2011;69(5):1421-1429.

Delap TG, Dowling PA, McGilligan T, Vijaya-Sekaran S. Bilateral pulmonary aspiration of intact teeth following maxillofacial trauma. *Endod Dent Traumatol*. 1999;15(4):190-192.

Kim DW, Jang JY, Shim H, et al. Removal of aspirated teeth in a multiple trauma patient, using fiberoptic bronchoscopy with simultaneous tracheostomy: review of 2 cases. *Respir Care*. 2014;59(1):e1-e4.

Mohamad I, Mohamad H, Ismail H. Bilateral pulmonary aspiration of teeth and the migration of a foreign body from one main bronchus to another. *Med J Malaysia*. 2010;65(4):309-310.

Case 6-42

Curtain rod airway impalement

Patient Presentation: A young child fell while playing with a curtain rod in her mouth.

Clinical Features: The patient was awake and alert in mild painful distress without any respiratory distress. There was no stridor or bleeding. The child could not talk. The curtain rod had been cut shorter for transport to the hospital and was firmly embedded into the posterior pharynx.

Differential Dx:

- Vascular, neurologic, pharyngeal, esophageal and upper airway injury

Emergency Care: A soft tissue lateral radiograph was obtained and demonstrated the position of the curtain rod. A head and neck CT scan confirmed the position. Radiographically, it did not appear that the curtain rod involved the cranium, spinal canal, or large vascular structures.

The decision was made to remove the curtain rod and perform orotracheal intubation. The curtain rod was first cut below the level of the patient's lips to allow for bag-valve-mask ventilation if required. The patient was sedated and chemically paralyzed. The laryngoscope blade was introduced carefully, and it appeared that visualization of the glottis would be easy. The curtain rod was removed out of the oropharynx, and the patient was endotracheally intubated without difficulty.

Outcome: The patient made an uneventful recovery.

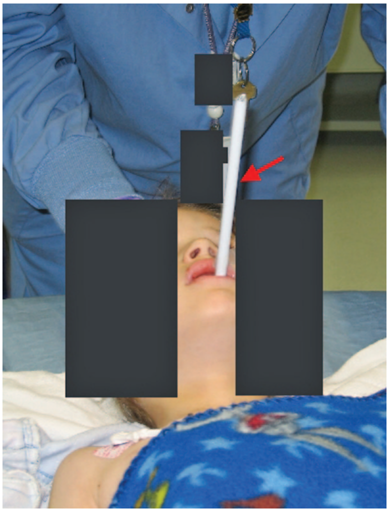

Figure 6-63. RA = curtain rod impaled into posterior pharyngeal wall and exiting the mouth

Figure 6-64. Cervical spine x-ray. WA = impaled curtain rod

Key Learning Points:

- Emergency physicians frequently encounter the unexpected. The ability to innovate in these situations is paramount.

- Reducing the curtain rod length to under the patient's lips to make bag-valve-mask ventilation possible was a simple but very innovative action to ensure patient safety.

Further Reading:

Field HB. Foreign body (curtain rod) penetrating orbit, pharynx and neck, with complete recovery. *AMA Arch Ophthalmol*. 1951;46(2):157-158.

Yaman M, Deitel M, Burul CJ, Shani B, Hadar B. Foreign bodies in the rectum. *Can J Surg*. 1993;36(2):173-177.

Case 6-43

Arm entrapment in a garage door spring

Patient Presentation: A 35-year-old was on a ladder in his garage working on the garage door spring. The spring suddenly recoiled, catching his arm as it retracted. A section of the spring was cut off to free the patient.

Clinical Features: The patient was in moderate painful distress with stable vital signs and a normal color, motor, and sensory examination of his hand. The spring section was firmly attached; it appeared skin had been sucked up into the spring coils.

Differential Dx:

- Musculoskeletal, vascular, or nerve injury

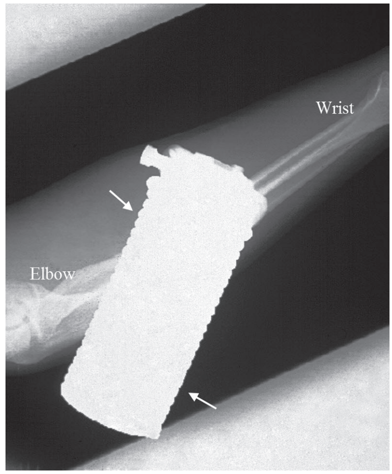

Figure 6-65. Forearm x-ray. WA = section of garage door spring attached to the forearm

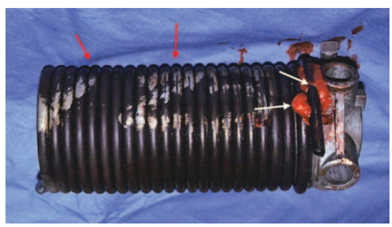

Figure 6-66. RA = section of garage door spring post removal from forearm, WA = entrapped skin and subcutaneous tissue

Emergency Care: Given the incredible force of the recoil from the spring, a two-view forearm radiograph was performed to assess for bony injury and was negative. Local anesthetic was then infiltrated around the entire area that was attached to the spring. The spring was then firmly pulled away from the forearm, and the entrapped tissue cut free as close to the spring as possible with a scalpel. A significant amount of skin and subcutaneous tissue had been forcefully sucked up into the spring coils, and the defect remaining after cutting the spring free was larger than had been anticipated. The wound was undermined and brought together with vertical mattress and simple sutures.

Outcome: The patient returned 10 days later for suture removal, and the wound was healing without complication.

Key Learning Points:

- Adjusting or replacing garage door torsion springs should be done by a professional as serious injury can result.
- In 2007, the National Electronic Injury Surveillance System (NEISS) estimated that there were 313 injuries related to garage door torsion springs.

Further Reading:

Feferman I. Garage door injuries. *Ann Emerg Med*. 1981;10(1):68.

Figure 6-67. RA = wound post closure

CHAPTER 7 Otolaryngology

Case 7-1

Arteriovenous malformation in the mandible

Patient Presentation: A 20-year-old patient presented to her dentist for evaluation of tooth pain and bleeding. A pulsatile mass was palpated along her right gingiva and mandible, and she was transferred to our facility via helicopter. A significant amount of bleeding occurred en route to our hospital.

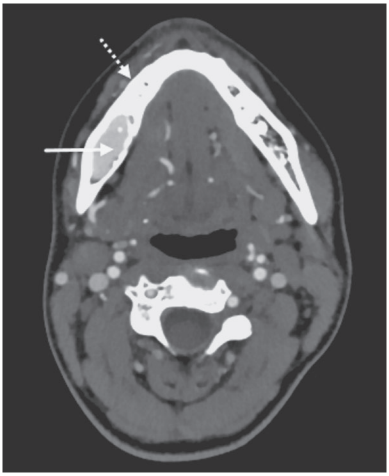

Figure 7-1. Neck CT angiogram. WA = arteriovenous malformation, WDA = body of the mandible

Clinical Features: The patient was hemodynamically stable and in no apparent painful distress. There was some mild active bleeding along her right lower gingiva with a large associated clot.

Differential Dx:

- Arteriovenous malformation (AVM)
- Aneurysm
- Tumor with vascular compromise
- Occult trauma

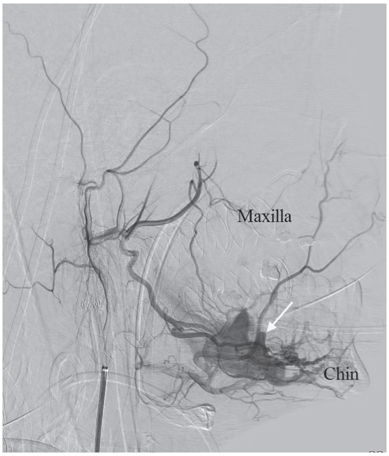

Figure 7-2. Interventional angiogram. WA = arteriovenous malformation

Emergency Care: The patient underwent a computed tomography (CT) angiogram that demonstrated a large arteriovenous malformation involving the mandible. Her initial hemoglobin was 9.3 g/dL. Oral and maxillofacial surgery and interventional radiology were consulted and requested that the patient be nasotracheally intubated prior to transfer to the next level of care. The patient was prepped for a nasotracheal intubation with a lidocaine neb and topical lidocaine and given IV ketamine. She was intubated on the first pass and then sedated with propofol. Shortly after the intubation, the patient began to hemorrhage. This was poorly controlled with direct pressure and packing. The massive transfusion protocol was initiated, and the patient was given tranexamic acid. Vascular surgery was consulted.

Outcome: The patient went to the interventional radiology suite, and initial images demonstrated four arterial vessels feeding into the AVM, which were successfully coiled. The patient did well post coiling, and 1 week later had an extensive mandibular operative intervention to resect the lesion and rebuild the mandible.

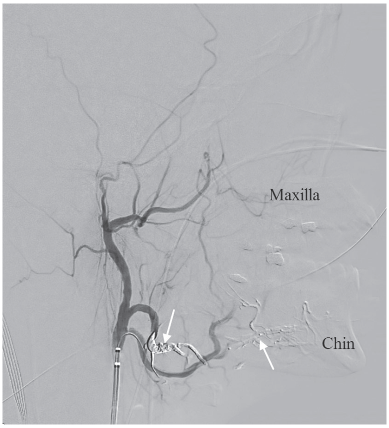

Figure 7-3. Interventional angiogram post coiling. WA = coils placed into vessels feeding the arteriovenous malformation

Key Learning Points:

- Despite the nasal and oropharyngeal preparation with anesthetic and ketamine sedation, the profound hemorrhage after the nasotracheal intubation might have been the result of increased vascular pressure resulting from the minimal and limited coughing that occurred immediately after tube placement before complete sedation and chemical paralysis were obtained.
- Ketamine is a known sympathomimetic drug and may have contributed to the hemorrhage through increased blood pressure and/or cardiac contractility.

Further Reading:

Churojana A, Khumtong R, Songsaeng D, Chongkolwatana C, Suthipongcha S. Life-threatening arteriovenous malformation of the maxillomandibular region and treatment outcomes. *Interv Radiol*. 2012;18(1):49-59.

Dwivedi AD, Pandey A, Kumar I, Agarwal A. Mandibular arteriovenous malformation: a rare life-threatening condition depicted on multidetector CT angiography. *J Oral Maxillofac Pathol*. 2014;18(1):111-113.

Oueis H, Geist JR, Tran MU, et al. High-flow arteriovenous malformations of the mandible and the maxilla: report of 2 cases. *Pediatr Dent*. 2010;32(5):451-456.

Sakkas N, Schramm A, Metzger MC, et al. Arteriovenous malformation of the mandible: a life-threatening situation. *Ann Hematol*. 2007;86(6):409-413.

Case 7-2

Eagle syndrome

Patient Presentation: A middle-aged patient presented for evaluation of chronic lateral neck and throat pain. There was no recent trauma.

Clinical Features: The patient was in mild painful distress, and physical examination revealed no abnormalities.

Differential Dx:
- Musculoskeletal disease
- Osteoarthritis
- Occult trauma
- Tumor
- Indolent infection

Emergency Care: The patient had a normal neurologic examination. A soft tissue neck radiograph demonstrated a calcified and elongated stylohyoid process, which was anatomically the area of the patient's pain. This is concerning for Eagle syndrome.

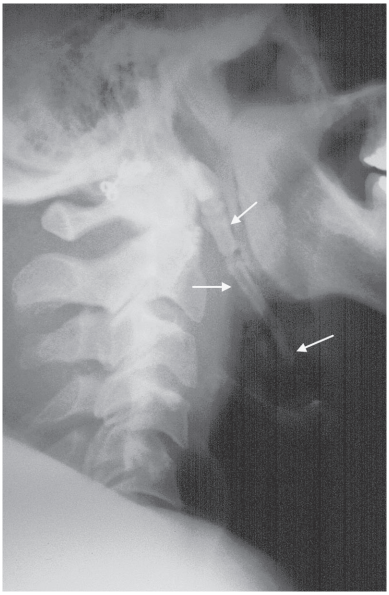

Figure 7-4. Soft tissue neck x-ray. WA = calcified and elongated stylohyoid process

Outcome: The patient was treated symptomatically and referred to clinic.

Key Learning Points:
- Eagle syndrome is a rare disorder characterized by an elongated and/or calcified stylohyoid process that causes symptoms by compression of neurovascular structures. It typically presents with lateral and anterior neck and throat pain, radiation of the pain to the ipsilateral ear, dysphagia, odynophagia, and a parapharyngeal foreign body sensation.
- If conservative medical management fails, surgical resection has been described.

Further Reading:

Kiralj A, Illić M, Pejaković B, Markov B, Mijatov S, Mijatov I. Eagle's syndrome—a report of two cases. *Vojnosanit Pregl*. 2015;72(5):458-462.

Khandelwal S, Hada YS, Harsh A. Eagle's syndrome—a case report and review of the literature. *Saudi Dent J*. 2011;23(4):211-215.

Vieira EM, Guedes OA, Morais SD, Musis CR, Albuquerque PA, Borges ÁH. Prevalence of elongated styloid process in a central brazilian population. *J Clin Diagn Res*. 2015;9(9):ZC90-ZC92.

Case 7-3

Ranula

Patient Presentation: An 8-year-old presented with nonpainful swelling of the floor of her mouth. It had been present "for a long time" per history.

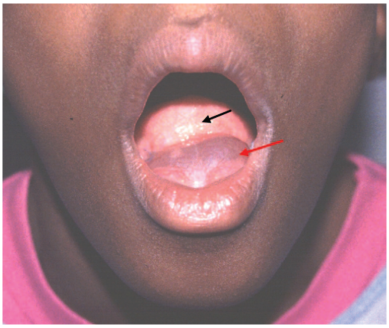

Figure 7-5. BA = elevated tongue, RA = ranula

Clinical Features: A nontender mass was visualized on the floor of her mouth, slightly off to the left, with the tongue elevated. The mass was not pulsatile. No neck adenopathy. The rest of the examination was unremarkable.

Differential Dx:
- Ranula
- Tumor
- Cyst
- Arteriovenous malformation
- Abscess

Emergency Care: An otolaryngology consult was obtained, and the lesion was consistent with a ranula.

Outcome: The patient had an uncomplicated resection of this plunging ranula.

Key Learning Points:
- Ranulas are pseudocysts of the sublingual glands and submandibular ducts.
- They can be congenital or acquired after oral trauma.
- Resection can be difficult depending on the extent of the lesion.
- Plunging ranulas have mucous extravasation with extension below the mylohyoid muscle.

Further Reading:

Jain R, Morton RP, Ahmad Z. Diagnostic difficulties of plunging ranula: case series. *J Laryngol Otol*. 2012;5:506-510.

O'Connor R, McGurk M. The plunging ranula: diagnostic difficulties and a less invasive approach to treatment. *Int J Oral Maxillofac Surg*. 2013;42(11):1469-1474.

Zhi K, Gao L, Ren W. What is new in management of pediatric ranula? *Curr Opin Otolaryngol Head Neck Surg*. 2014;22(6):525-529.

Case 7-4

Nasal septal hematoma

Patient Presentation: A 15-year-old suffered an accidental fall and presented with a lip laceration and nasal pain.

Clinical Features: There was a 1.5-cm lip laceration. The external nose was swollen, ecchymotic, and tender to palpation without nasal bone deviation or deformity. Bilateral nasal septal hematomas were evident.

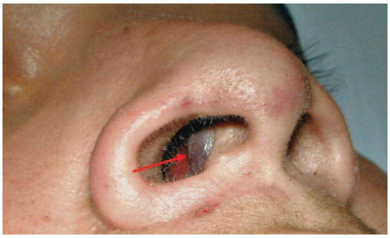

Figure 7-6. RA = nasal septal hematoma

Differential Dx:
- Nasal bone fracture
- Septal hematoma
- Dental injury

Emergency Care: The lip laceration was repaired. The bilateral nasal septal hematomas were drained under local cocaine anesthesia, and the nose was bilaterally packed. He was discharged on amoxicillin.

Outcome: The patient was seen in otolaryngology clinic 3 days later, and the packing was removed without complications.

Key Learning Points:
- It is important to examine every patient with facial trauma specifically for nasal septal hematomas.
- Undiagnosed septal hematomas can result in septal abscess, with subsequent cartilage destruction and nasal deformity.
- When discovered, septal hematomas should be incised and drained.

Further Reading:

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Ginsburg CM. Nasal septal hematoma. *Pediatr Rev*. 1998;19(4):142-143.

Puricelli MD, Zitsch RP. Septal hematoma following nasal trauma. *J Emerg Med*. 2016;50(1):121-122.

Sayin I, Yazici ZM, Bozkurt E, Kayhan FT. Nasal septal hematoma and abscess in children. *J Craniofac Surg*. 2011;22(6):e17-e19.

Case 7-5

Substernal thyroid goiter

Patient Presentation: A 54-year-old presented with a chronic cough without shortness of breath.

Clinical Features: The patient had an unremarkable physical examination except for intermittent coughing.

Differential Dx:
- Bronchitis
- Pneumonia
- Tumor
- Atypical infection including fungal, reactive airway disease, chronic pulmonary obstructive disease

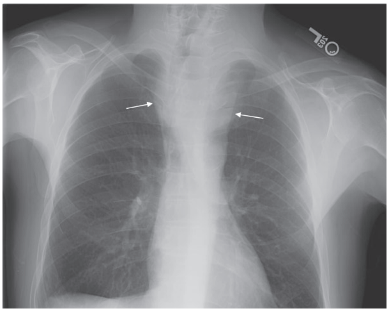

Figure 7-7. Chest x-ray. WA = substernal thyroid goiter

Figure 7-8. Contrast-enhanced chest CT scan. WA = substernal thyroid goiter

Emergency Care: Chest radiograph demonstrated a superior mediastinal mass, deviating the trachea to the right and extending above the clavicle. A subsequent contrast-enhanced chest CT scan demonstrated a large, well-encapsulated, heterogeneously enhancing left thyroid mass. There was no associated adenopathy. The thyroid stimulating hormone level was 0.3 mU/L, indicative of mild hyperthyroidism without associated clinical signs or symptoms.

Outcome: The patient was observed for the next 2 years. However, there was increasing compression of the trachea, and he suddenly developed respiratory distress with hypoxia that led to an emergent tracheostomy followed by thyroidectomy. His chronic cough resolved.

Key Learning Points:
- Asymptomatic substernal goiter can be managed conservatively or by surgical resection. Patients not undergoing resection need to be followed closely for signs and symptoms of airway obstruction.
- The most common presenting complaint of substernal goiter is exertional dyspnea.
- Patients who are not good surgical candidates or who decline surgery can be treated with radioiodine therapy.

Further Reading:

Cannon CR, Lee R, Didlake R. Management of the substernal goiter: a team approach. *J Miss State Med Assoc*. 2010;51(7):179-182.

Nakaya M, Ito A, Mori A, et al. Surgical treatment of substernal goiter: an analysis of 44 cases. *Auris Nasus Larynx*. 2017;44(1):111-115.

Netterville JL, Coleman SC, Smith JC, Smith MM, Day TA, Burkey BB. Management of substernal goiter. *Laryngoscope*. 1998;108(11 pt 1):1611-1617.

Singh B, Lucente FE, Shaha AR. Substernal goiter: a clinical review. *Am J Otolaryngol*. 1994;15(6):409-416.

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CHAPTER 8 Abdomen

Case 8-1

Severe constipation

Patient Presentation: A 23-year-old presented with abdominal pain and constipation. He had a history of stooling every 2 to 4 weeks for most of his life, and he had one episode of constipation requiring rectal disimpaction 1 year prior to this visit.

Clinical Features: The patient's abdomen was significantly distended with a firm mass and mild tenderness to palpation. The mass could be indented or pushed slowly away by the examining physician's hand.

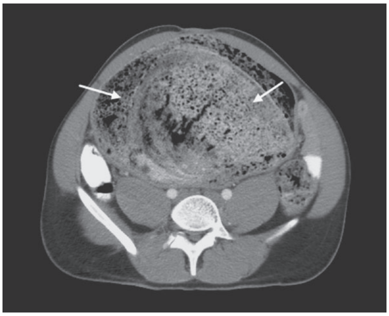

Figure 8-1. Contrast-enhanced abdominal CT scan (axial view). WA = massive colonic dilatation from stool

Differential Dx:

- Severe constipation
- Cancer
- Obstruction

Emergency Care: Contrast-enhanced abdominal computed tomography (CT) scan in axial and coronal plane demonstrated massive colonic dilatation from impacted stool. The patient was admitted for further management.

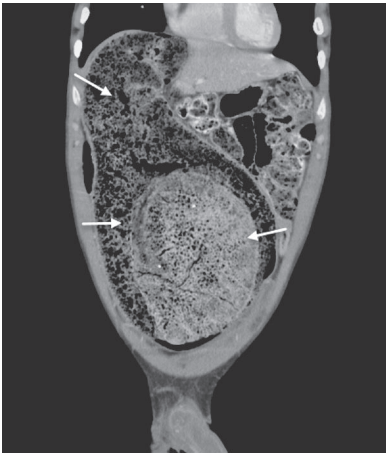

Figure 8-2. Contrast-enhanced abdominal CT scan (coronal view). WA = massive colonic dilatation from stool

Outcome: The patient went to the operating room on two separate occasions for manual per-rectal disimpaction. Biopsies were taken and were negative for Hirschsprung disease. The patient was discharged with a bowel regimen for constipation. He returned 1 year later with a very similar presentation, again requiring intraoperative disimpaction.

Key Learning Points:

- Stercoral perforation occurs when an intraluminal object, most commonly hardened feces, exerts pressure on the bowel wall, causing a locally inflamed and ischemic bowel wall, leading to rupture from local necrosis. It carries a high morbidity and mortality.

Further Reading:

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Chiarioni G. Biofeedback treatment of chronic constipation: myths and misconceptions. *Tech Coloproctol*. 2016;20(9):611-618.

Mosinska P, Salaga M, Fichna J. Novel investigational drugs for constipation-predominant irritable bowel syndrome: a review. *Expert Opin Investig Drugs*. 2016; 25(3):275-286.

Thayalasekeran S, Ali H, Tsai H. Novel therapies for constipation. *World J Gastroenterol*. 2013;19(45):8247-8251.

Wood RJ, Yacob D, Levitt MA. Surgical options for the management of severe functional constipation in children. *Curr Opin Pediatr*. 2016;28(3):370-379.

Case 8-2

Colovesical fistula

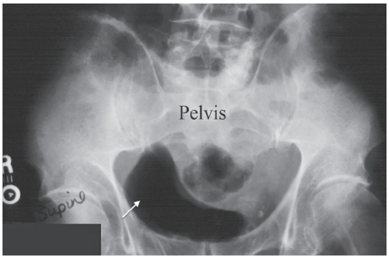

Figure 8-3. Pelvis x-ray. WA = air in the bladder

Patient Presentation: A 73-year-old presented with a 2-week history of abdominal pain as well as passing air in his urine stream. The urine was also described as dark and foul smelling.

Clinical Features: The patient was in mild painful distress and hemodynamically stable. Abdominal examination revealed mild suprapubic tenderness to palpation as well as left lower quadrant tenderness. There were no peritoneal signs.

Differential Dx:

- A fistula from bowel to the bladder secondary to diverticulitis
- Inflammatory bowel disease
- Colon cancer
- Bladder cancer

Emergency Care: The patient had an abdominal radiograph that demonstrated air within the bladder. The patient was admitted for further diagnostic and therapeutic management.

Outcome: The patient had a laparotomy with both general surgery and urology in attendance. A distal sigmoid colon adenocarcinoma was found, along with diverticulitis with a fistula from the distal colon to the dome of the bladder. The patient had multiple operative interventions over the next 3 months and eventually recovered. He was followed for the next 10 years without complications.

Key Learning Points:

- Enteric fistulas occur as a complication of previous surgery, Crohn disease, malignancy, infection, diverticulitis, or complication of radiation.
- Prior surgery and Crohn disease are the two most common etiologies for fistulas.
- Signs and symptoms depend on the origin of the fistula and the point of drainage.
- Treatment is complex and involves both medical and surgical management.

Further Reading:

Aydinli HH, Benlice C, Ozuner G, Gorgun E, Abbas MA. Risk factors associated with postoperative morbidity in over 500 colovesical fistula patients undergoing colorectal surgery: a retrospective cohort study from ACS-NSQIP database. *Int J Colorectal Dis*. 2016;32(4):469-474.

Cirocchi R, Arezzo A, Renzi C, et al. Is laparoscopic surgery the best treatment in fistulas complicating diverticular disease of the sigmoid colon? A systematic review. *Int J Surg*. 2015;24(pt A):95-100.

Yagi Y, Shoji Y, Sasaki S, et al. Sigmoid colon cancer arising in a diverticulum of the colon with involvement of the urinary bladder: a case report and review of the literature. *BMC Gastroenterol*. 2014;14:90.

Case 8-3

Urinary retention from opioid medication

Patient Presentation: Young adult presented with abdominal pain and was requesting opioid medication. The patient stated he had seen several health care professionals in the past 24 hours and had been treated with opioid medications with modest relief.

Clinical Features: The patient was in moderate painful distress with stable vital signs. Abdominal examination revealed a moderately tender abdomen with a large palpable tender mass.

Differential Dx:
- Intraperitoneal pathology

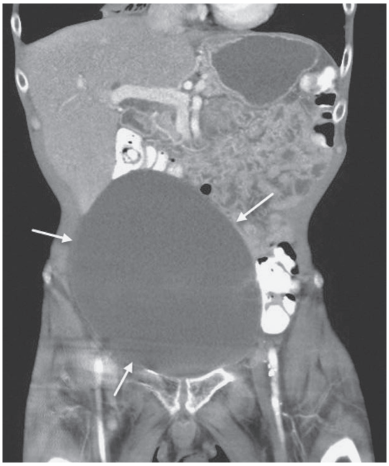

Figure 8-4. Contrast-enhanced abdominal CT scan. WA = distended bladder

Emergency Care: A contrast-enhanced abdominal CT scan in coronal plane demonstrated a markedly distended urinary bladder from urinary retention likely worsened by opioid medication. A urinary catheter was inserted and drained a considerable volume of urine with resolution of the patient's abdominal pain.

Key Learning Points:
- Opioid-induced urinary retention is common and frequently complicates the management of postoperative pain.
- A bedside abdominal ultrasound examination would have obviated the need for an abdominal CT scan in this patient.

Further Reading:

Galbraith JG, Butler JS, McGreal GT. Opioid toxicity as a cause of spontaneous urinary bladder rupture. *Am J Emerg Med*. 2011;29(2):239.e1-3.

Garten L, Buhrer C. Reversal of morphine-induced urinary retention after methylnaltrexone. *Arch Dis Child.* 2012;97(2):F151-F153.

Kane-Gill SL, Rubin EC, Smithburger PL, Buckley MS, Dasta JF. The cost of opioid-related adverse drug events. *J Pain Palliat Care Pharmacother*. 2014;28(3):282-293.

Labianca R, Sarzi-Puttini P, Zuccaro SM, Cherubino P, Vellucci R, Fornasari D. Adverse effects associated with non-opioid and opioid treatment in patients with chronic pain. *Clin Drug Investig*. 2012;32(suppl 1):53-63.

Panicker JN, Game X, Khan S, et al. The possible role of opiates in women with chronic urinary retention: observations from a prospective clinical study. *J Urol*. 2012;188(2):480-484.

Case 8-4

Urinary retention from prostatic hypertrophy

Patient Presentation: A 66-year-old man with multiple medical problems presented with lower abdominal pain and inability to urinate.

Clinical Features: The patient was in mild to moderate painful distress with a distended abdomen that was diffusely tender to palpation.

Differential Dx:

- Bowel obstruction
- Tumor
- Constipation
- Urinary retention

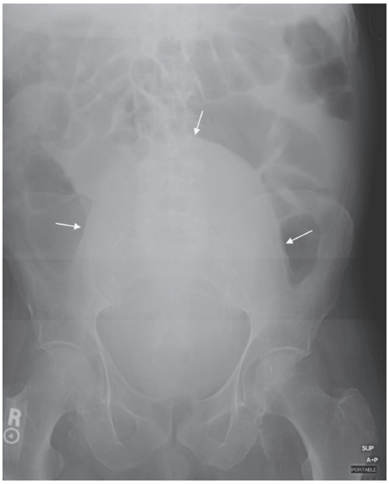

Figure 8-5. Abdominal x-ray. WA = outline of enlarged urinary bladder

Emergency Care: An abdominal radiograph demonstrated a markedly enlarged bladder indicative of urinary retention. Urinary bladder catheterization was unsuccessful likely due to benign prostatic hyperplasia, and a suprapubic catheter was successfully placed with drainage of urine and complete relief of abdominal pain.

Outcome: The patient followed up in the urology clinic with eventual placement of a transurethral bladder catheter.

Key Learning Points:

- The etiologies of acute urinary retention include outflow obstruction, neurologic impairment, medications, trauma, and infection.
- Suprapubic catheter placement is indicated in the setting of contraindications to urinary catheter attempts or unsuccessful placement of a transurethral bladder catheter.
- Bedside abdominal ultrasound is an efficient and reliable examination in the setting of suspected urinary retention.

Further Reading:

Kidd EA, Stewart F, Kassis NC, Hom E, Omar MI. Urethral (indwelling or intermittent) or suprapubic routes for short-term catheterisation in hospitalised adults. *Cochrane Database Syst Rev*. 2015;(12):CD004203.

Mackenzie KR, Aning JJ. Managing lower urinary tract symptoms in men. *Practitioner*. 2016;260(1792):11.

Yoon PD, Chalasani V, Woo HH. Systematic review and meta-analysis on management of acute urinary retention. *Prostate Cancer Prostatic Dis*. 2015;18(4):297-302.

Case 8-5

Kicked by a horse

Patient Presentation: A 17-year-old was kicked in the right flank by a horse. At an outside hospital, she was hypotensive and had a positive focused assessment with sonography for trauma (FAST) indicating intraperitoneal hemorrhage. She was transfused with packed red blood cells, administered tranexamic acid, and transferred to our facility.

Figure 8-6. Right flank contusion caused by a horse kick

Clinical Features: The patient was awake and hemodynamically stable. She was in moderate pain. An ecchymosis in the shape of a horseshoe in the right flank was evident.

Differential Dx:
- Intraperitoneal injury
- Thoracic injury

Emergency Care: The patient received hydromorphone for analgesia. A contrast-enhanced abdominal CT scan demonstrated a grade IV liver laceration with subcapsular hematoma.

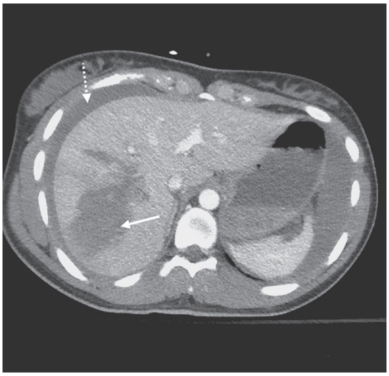

Figure 8-7. Contrast-enhanced abdominal CT scan. WA = hepatic laceration, WDA = subcapsular hepatic hematoma

Outcome: The patient was admitted to the hospital. She received a total of 2 units of packed red blood cells and was discharged 6 days after admission.

Key Learning Points:
- There were 102,904 visits to U.S. emergency departments for nonfatal horse-related injury during the years 2001 to 2003. Of those, 11,502 were traumatic brain injuries.
- Females are more likely to be injured.
- The most common mechanisms of injury were falls from the horse and being kicked by the horse.

Further Reading:

Thomas KE, Annest JL, Gilchrist J, Bixby-Hammett DM. Non-fatal horse related injuries treated in emergency departments in the United States, 2001-2003. *Br J Sports Med*. 2006;40(7):619-626.

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Weber CD, Nguyen AR, Lefering R, Hofman M, Hildebrand F, Pape HC. Blunt injuries related to equestrian sports: results from an international prospective trauma database analysis. *Int Orthop*. 2017;41(10):2105-2112.

Young JD, Gelbs JC, Zhu DS, Gallacher SE, Sutton KM, Blaine TA. Orthopaedic injuries in equestrian sports: a current concepts review. *Orthop J Sports Med*. 2015;3(9):2325967115603924.

Case 8-6

Nephrocalcinosis from hyperparathyroidism and medullary sponge kidney (two patients)

Patient Presentation: These are two unrelated patients who presented with left flank pain.

Clinical Features: Both patients were hemodynamically stable, and both appeared to be in moderate painful distress. Physical examination was otherwise unremarkable.

Differential Dx:

- Renal colic
- Pyelonephritis
- Retroperitoneal pathology
- Vascular pathology including abdominal aortic aneurysm
- Intra-abdominal pathology
- Referred pain from thorax

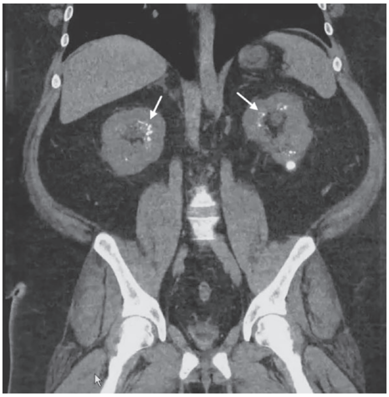

Figure 8-8. First patient. Stone-protocol abdominal CT scan. WA = nephrocalcinosis from hyperparathyroidism

Emergency Care: A stone-protocol abdominal CT scan on the first patient revealed nephrocalcinosis. Subsequent ED diagnostic evaluation revealed the patient to have hyperparathyroidism.

The second patient had an abdominal CT scan that also demonstrated nephrocalcinosis. This patient had medullary sponge kidney as the etiology for the nephrocalcinosis.

Figure 8-9. Second patient. Stone-protocol abdominal CT scan. WA = nephrocalcinosis from medullary sponge kidney

Outcome: Both patients were symptomatically treated for acute renal colic. The patient with hyperparathyroidism was referred to clinic but was lost to follow-up. The patient with medullary sponge kidney had several subsequent episodes of nephrolithiasis requiring ureteral stent placement.

Key Learning Points:

- Nephrocalcinosis can occur in the setting of hypercalciuria with or without hypercalcemia.
- Nephrocalcinosis can present as an incidental finding on medical imaging, or as part of an evaluation for nephrolithiasis.

- Primary hyperparathyroidism, sarcoidosis, and vitamin D therapy cause nephrocalcinosis from hypercalciuria and hypercalcemia.
- Distal renal tubular acidosis and medullary sponge kidney cause nephrocalcinosis in the setting of hypercalciuria without hypercalcemia.

Further Reading:

Dolgin C, Lo Gerfo P, LiVolsi V, Feind C. Twenty-five year experience with primary hyperparathyroidism at Columbia Presbyterian Medical Center. *Head Neck Surg*. 1979;2(2):92-98.

Suh JM, Cronan JJ, Monchik JM. Primary hyperparathyroidism: is there an increased prevalence of renal stone disease? *AJR Am J Roentgenol*. 2008;191(3):908-911.

Thomas WC. Urinary calculi in hypercalcemic states. *Endocrinol Metab Clin North Am*. 1990;19(4):839-849.

Case 8-7

Traumatic anterior abdominal wall hernia

Patient Presentation: A 13-year-old fell 15 feet onto a picket fence.

Clinical Features: The patient was hemodynamically stable and in moderate painful distress. Physical examination revealed superficial abrasions without penetrating injury, and a large, tender, and soft mass. The abdominal examination also revealed significant diffuse generalized tenderness on palpation apart from the large mass.

Figure 8-10. RA = traumatic anterior abdominal wall hernia (anterior view)

Differential Dx:

- Anterior abdominal wall hematoma
- Anterior abdominal wall hernia
- Intraperitoneal pathology including liver and spleen injury
- Pancreatic injury
- Bowel injury

Figure 8-11. RA = traumatic anterior abdominal wall hernia (lateral view)

Emergency Care: The large mass was easily reduced by hand manipulation through a palpable traumatic anterior abdominal wall hernia.

Outcome: The patient was taken to the operating room for exploratory laparotomy that demonstrated two ileal enterotomies and an almost complete transection of the abdominus rectus muscle. His injuries were repaired, and he recovered without complication.

Key Learning Points:

- Traumatic abdominal wall hernias are associated with high incidence of intraperitoneal injury, including hollow viscous injury.

Further Reading:

Coleman JJ, Fitz EK, Zarzaur BL, et al. Traumatic abdominal wall hernias: location matters. *J Trauma Acute Care Surg*. 2016;80(3):390-396.

Pardhan A, Mazahir S, Rao S, Weber D. Blunt traumatic abdominal wall hernias: a surgeon's dilemma. *World J Surg*. 2016;40(1):231-235.

Pathak D, Mukherjee R, Das P, Pathak D, Gangopadhyay A, Das S. Traumatic abdominal wall hernia with concealed colonic perforation. *Ann R Coll Surg Engl*. 2016;98(7):e133-e135.

Case 8-8

Facial gunshot wound with a swallowed bullet

Patient Presentation: A 35-year-old sustained a gunshot to the face.

Clinical Features: The patient was awake, neurologically intact, and hemodynamically stable, with three wounds to the zygomatic arch. There was blood in the posterior oropharynx.

Differential Dx:
- Multiple penetrating traumatic injuries

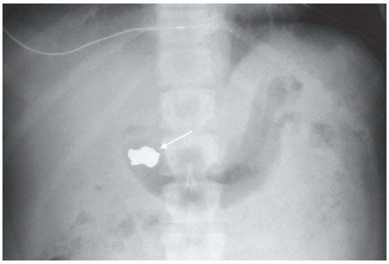

Figure 8-12. Abdominal x-ray (coned down). WA = swallowed bullet

Emergency Care: Given the bleeding in the posterior oropharynx, the patient underwent rapid sequence intubation for airway protection. An abdominal radiograph reveals a bullet fragment in the right upper abdominal quadrant, overlying the distal stomach. A careful physical examination did not reveal another entry point for this bullet fragment.

Outcome: The patient underwent several operative and diagnostic procedures for the bony and soft tissue facial injury. Diagnostic procedures revealed that the bullet had entered the upper nasopharynx and had been swallowed. No further injury to the airway or upper gastrointestinal tract was revealed. The patient recovered from her injuries.

Key Learning Points:
- In a patient with gunshot wounds, careful physical examination is mandatory to determine the number of wounds and the bullet paths. The number of bullets radiographically visualized and their location must be consistent with physical examination findings.
- Plain radiographs are helpful in determining the number and path of bullets.

Further Reading:

Cook A, Osler T, Hosmer D, et al. Gunshot wounds resulting in hospitalization in the United States: 2004-2013. *Injury*. 2017;48(3):621-627.

Kalesan B, Adhikarla C, Pressley JC, et al. The hidden epidemic of firearm injury: increasing firearm injury rates during 2001-2013. *Am J Epidemiol*. 2017;185(7):546-553.

Maurin O, de Régloix S, Dubourdieu S, et al. Maxillofacial gunshot wounds. *Prehosp Disast Med*. 2015;30(3):316-319.

Case 8-9

Retrocecal appendicitis

Patient Presentation: A 17-year-old woman presented with abdominal pain. The pain started 2 days ago in the periumbilical area and migrated into the right lower quadrant.

Clinical Features: The patient was hemodynamically stable and had a temperature of 100.4°F (38°C). The patient had mild to moderate right lower quadrant tenderness to palpation.

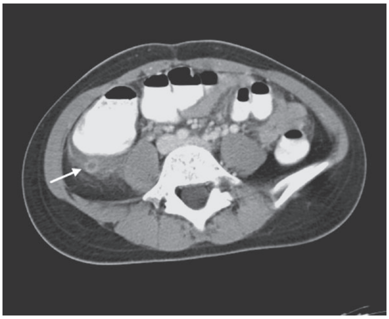

Figure 8-13. Contrast-enhanced abdominal CT scan. WA = retrocecal appendicitis

Differential Dx:

- Appendicitis
- Pelvic pathology such as ovarian torsion, ectopic pregnancy, or pelvic inflammatory disease
- Renal stone or urinary tract infection

Emergency Care: The white blood cell count was 28,000 cells/mm^3. A urinary pregnancy test was negative. A contrast-enhanced abdominal CT scan revealed a classic appearance of retrocecal appendicitis.

Outcome: The patient underwent appendectomy without complications.

Key Learning Points:

- The position of the appendix can affect the signs and symptoms of presentation, most notably the location of both pain and tenderness to palpation.
- Patients with retrocecal appendicitis may not have much pain or tenderness to palpation in the right lower abdominal quadrant, but rather have increased pain and tenderness to palpation on rectal or adnexal vaginal examination.
- The psoas sign is a classic finding in retrocecal appendicitis.
- Retrocecal appendicitis is associated with atypical presentations and an increased chance of perforation secondary to delayed diagnosis.

Further Reading:

Ghorbani A, Forouzesh M, Kazemifar AM. Variation in anatomical position of vermiform appendix among Iranian population: an old issue which has not lost its importance. *Anat Res Int*. 2014, 313575, 2014.

Herscu G, Kong A, Russell D, et al. Retrocecal appendix location and perforation at presentation. *Am Surg*. 2006;72(10):890-893.

Kim S, Lim HK, Lee JY, et al. Ascending retrocecal appendicitis: clinical and computed tomographic findings. *J Comput Assist Tomog*. 2006;30(5):772-776.

Case 8-10

Infrahepatic appendicitis

Patient Presentation: A 14-year-old adolescent presented with two days of abdominal pain and nausea with vomiting.

Clinical Features: The patient was afebrile and in mild painful distress. He had mild tenderness to palpation in the epigastric and right upper quadrant.

Differential Dx:
- Gastritis
- Viral gastroenteritis
- Hepatic disease
- Gallbladder pathology
- Food poisoning

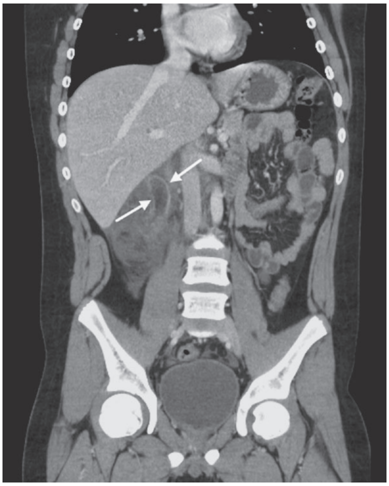

Figure 8-14. Contrast-enhanced abdominal CT scan. WA = infrahepatic appendicitis

Emergency Care: The patient was treated symptomatically with ondansetron and discharged home. He returned the next day with continued pain. Examination revealed tenderness to palpation in the right upper quadrant. A contrast-enhanced abdominal CT scan in the coronal plane demonstrated appendicitis with the tip of the appendix in the right upper quadrant close to the liver edge.

Outcome: The patient was taken to the operating room where a ruptured appendix was removed. The patient had a brief postoperative ileus but recovered without complication.

Key Learning Points:
- The position of the appendix can affect the signs and symptoms of presentation, most notably the location of both pain and tenderness to palpation.
- Appendicitis was not high in the differential diagnosis list on the first ED visit secondary to the location of pain in the right upper quadrant and epigastrium.
- Infrahepatic appendicitis can be difficult to diagnose.

Further Reading:

Jaliawala HA, Mannan F, Gill RC, Alvi AR. Perforated sub-hepatic appendix; rare presentation of a common disease. *J Pak Med Assoc*. 2016;66(6):765-767.

Kumar D, Ramanathan S, Al Faki A, Nepal P. Faecolith migrating from the appendix to produce liver abscess after subhepatic laparoscopic appendectomy. *Trop Doct*. 2015;45(4):241-244.

Odabasi M, Arslan C, Abuoglu H, et al. An unusual presentation of perforated appendicitis in epigastric region. *Int J Surg Case Rep*. 2014;5(2):76-78.

Case 8-11

Porcelain gallbladder

Patient Presentation: A 45-year-old woman with a 3-day history of bilateral lower quadrant abdominal pain associated with constipation.

Clinical Features: The patient was afebrile and in mild painful distress. Abdominal examination revealed minimal tenderness to palpation of the lower abdomen with no guarding or peritoneal signs. Pelvic examination was unremarkable.

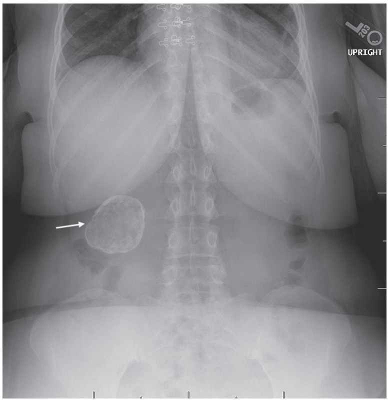

Figure 8-15. Abdominal x-ray. WA = porcelain gallbladder

Differential Dx:
- Constipation
- Gastroenteritis
- Appendicitis
- Urinary tract infection
- Pelvic pathology such as pelvic inflammatory disease
- Ovarian pathology

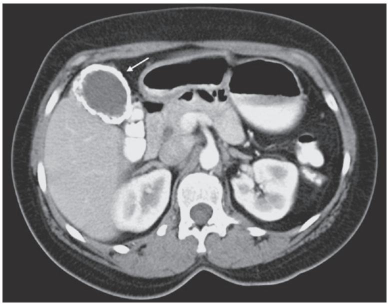

Figure 8-16. Contrast-enhanced abdominal CT scan. WA = porcelain gallbladder

Emergency Care: An abdominal radiograph demonstrated a porcelain gallbladder. This was thought to be an incidental finding. The patient was treated symptomatically and referred to the surgery clinic for follow-up.

Outcome: The patient had a colonoscopy subsequent to her ED visit that demonstrated a sigmoid colon mass. An abdominal CT scan as part of her cancer workup demonstrated her porcelain gallbladder. She underwent a hemicolectomy and cholecystectomy without complication.

Key Learning Points:
- A porcelain gallbladder is rare, occurring at a rate of 0.2% of patients undergoing cholecystectomy.
- Porcelain gallbladder results from chronic cholecystitis and is frequently associated with cholelithiasis. There is intramural calcification of the gallbladder wall.
- Traditionally, a porcelain gallbladder was thought to increase the risk of gallbladder carcinoma significantly. However, more recent studies have shown the risk to be much lower.
- Recent studies have advocated for either observation of those patients with porcelain gallbladder or cholecystectomy for those patients with few comorbid conditions and low surgical risk.

Further Reading:

Cariati A, Piromalli E, Cetta F. Gallbladder cancers: associated conditions, histological types, prognosis, and prevention. *Eur J Gastroenterol Hepatol*. 2014;26(5):562-569.

Chen GL, Akmal Y, DiFronzo AL, Vuong B, O'Connor V. Porcelain gallbladder: no longer an indication for prophylactic cholecystectomy. *Am Surg*. 2015;81(10):936-940.

Pilgrim CC, Groeschl RT, Christians KK, Gamblin TC. Modern perspectives on factors predisposing to the development of gallbladder cancer. *HPB (Oxford)*. 2013;15(11):839-844.

Schnelldorfer T. Porcelain gallbladder: a benign process or concern for malignancy? *J Gastrointest Surg*. 2103;17(6):1161-1168.

Case 8-12

Renal cyst with rupture and hemorrhage

Patient Presentation: A 75-year-old presented with multiple medical problems, including chronic renal failure with bilateral renal cysts and atrial fibrillation on warfarin therapy. He presented with sepsis.

Clinical Features: The patient was critically ill, hypotensive, and tachycardic.

Differential Dx:
- Sepsis, source unclear

Emergency Care: The patient was aggressively treated for sepsis with intravenous fluids and antibiotics, and he was admitted to the hospital.

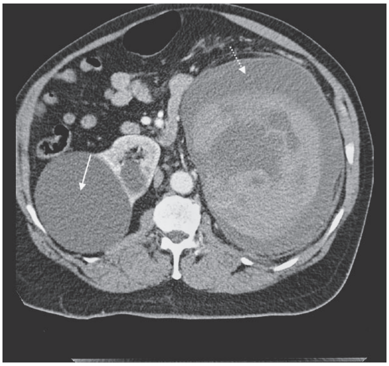

Figure 8-17. Contrast-enhanced abdominal CT scan. WA = right renal cyst, WDA = left renal cyst with rupture and hemorrhage

Outcome: While in the hospital, he developed severe abdominal pain, and a contrast-enhanced abdominal CT scan demonstrated a simple-appearing right renal cyst and a large left renal cyst with acute rupture and hemorrhage. The warfarin was stopped, and the patient was supported with blood product transfusions. The patient eventually stabilized without operative or interventional radiologic procedures for the hemorrhage. He did develop acute-on-chronic renal failure thought to be a result of renal vasculature compression from the hemorrhage that necessitated acute hemodialysis.

Key Learning Points:
- Anticoagulation can be associated with spontaneous and significant hemorrhage essentially anywhere there are blood vessels.
- The CT scan is the mainstay of diagnostic evaluation for hemorrhage source related to anticoagulation.

Further Reading:
Chan TK. Life-threatening retroperitoneal bleeding due to warfarin-drug interactions. *Pharmacoepidemiol Drug Saf*. 2009;18(5):420-422.

Danaci M, Kesici GE, Kesici H, Polat C, Belet U. Coumadin-induced renal and retroperitoneal hemorrhage. *Ren Fail*. 2006;28(2):129-132.

Tonolini M, Ippolito S, Patella F, Petullà M, Bianco R. Hemorrhagic complications of anticoagulant therapy: role of multidetector computed tomography and spectrum of imaging findings from head to toe. *Curr Probl Diagn Radiol*. 2012;41(6):233-247.

Case 8-13

Hepatic portal air

Patient Presentation: A 66-year-old presented in respiratory distress.

Clinical Features: The patient was lethargic and in moderate respiratory distress. He was hypotensive and tachycardic with signs of hypoperfusion. The abdomen was distended, tender to palpation, and dull to percussion.

Differential Dx:

- Cardiovascular, pulmonary, infectious, metabolic, and endocrine etiologies
- Intraperitoneal pathology

Figure 8-18. Abdominal CT scan. WA = air within the portal system, WAH = free intraperitoneal fluid, WDA = liver

Emergency Care: The patient underwent rapid sequence intubation without complication. Placement of a nasogastric tube returned 2,500 mL of black fluid. Intravenous fluids, antibiotics, and dopamine were administered. An abdominal CT scan revealed extensive portal air within his liver and free intraperitoneal fluid.

Outcome: The patient was diagnosed with mesenteric infarction, declined surgical intervention and subsequently died the day of admission.

Key Learning Points:

- Air within the liver can be in either the portal or biliary systems. Air within the portal system is visualized in the liver periphery, while biliary air tends to be centrally located.
- Although air within the portal venous system can occur with a wide variety of conditions of varying severity, in the setting of mesenteric ischemia it is an ominous finding.
- Air within the biliary system is often from prior biliary procedures, but it may be indicative of serious pathology, most often ascending cholangitis.

Further Reading:

Beall DP, Khanna A, Shaffrey JK. Imaging case of the month. Extensive pneumatosis intestinalis and portal venous air developing after bowel infarction. *Md Med J.* 1997;46(3):139-140.

Hoddick W, Jeffrey RB, Federle MP. CT differentiation of portal venous air from biliary tract air. *J Comput Assist Tomog.* 1982;6(3):633-634.

Preventza OA, Kendrick ML, Sawyer MD. Portal venous air and pneumatosis intestinalis. *Dig Dis.* 1999;17(1):63-64.

Case 8-14

Isolated spontaneous superior mesenteric artery dissection

Patient Presentation: A 58-year-old man with a history of hypertension presented with intense, dull, constant midabdominal pain that began 10 minutes after lifting a 50-lb (22.7 kg) object in his garage.

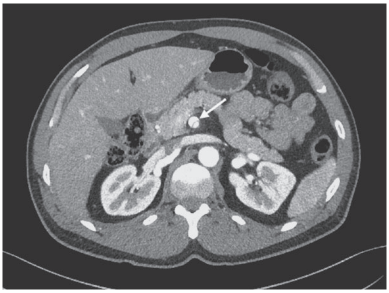

Figure 8-19. Contrast-enhanced abdominal CT scan (axial view). WA = dissection of superior mesenteric artery

Clinical Features: The patient was in moderate pain and was hemodynamically stable. Abdominal examination revealed a nondistended abdomen with mild tenderness to palpation in the midabdominal region. The patient's report of pain was disproportionately high compared to his unimpressive abdominal examination.

Differential Dx:

- Abdominal aortic aneurysm
- Gastritis
- Bowel obstruction
- Pancreatic or gallbladder disease
- Mesenteric ischemia
- Appendicitis

Figure 8-20. Contrast-enhanced abdominal CT scan (coronal view). WA = dissection of superior mesenteric artery

Emergency Care: Laboratory analysis was unremarkable except for a modest leukocytosis. Axial and coronal views of a contrast-enhanced abdominal CT scan demonstrated a dissection of the superior mesenteric artery. The dissection started at the origin of the superior mesenteric artery (SMA) and extended 6 cm inferiorly. It did not involve the aorta.

The patient had a systolic blood pressure of 170 mm Hg with a heart rate of 80 beats/min. A heparin infusion was started. Esmolol and clevidipine infusions were utilized to lower heart rate and blood pressure to a systolic blood pressure of 120 mm Hg and a pulse of 60 beats/min. The patient was admitted to the hospital.

Outcome: A diagnostic workup did not reveal any underlying connective tissue, vascular, or inflammatory process that might have been the etiology for the spontaneous SMA dissection. The patient was transitioned to oral antihypertensive medications and started on warfarin and low-dose aspirin. No complications occurred.

Key Learning Points:

- Isolated spontaneous dissection of the SMA is rare.
- Conservative management with anticoagulation is the preferred approach with excellent long-term outcome.
- Bowel ischemia or arterial rupture are indications for endovascular or surgical repair.

Further Reading:

Decarlo C, Ganguli S, Borges JC, et al. Presentation, treatment, and outcomes in patients with spontaneous isolated celiac and superior mesenteric artery dissection. *Vasc Med*. 2017;22(6):505-511.

Gao D, Qi Q, Gong P. Endovascular stenting of spontaneous isolated dissection of the superior mesenteric artery: a case report and literature review. *Medicine (Baltimore)*. 2017;96(46):e8598.

Heo S, Kim YW, Woo SY, Park YJ, Park KB, Kim DK. Treatment strategy based on the natural course for patients with spontaneous isolated superior mesenteric artery dissection. *J Vasc Surg*. 2017;65(4):1142-1151.

Loeffler JW, Obara H, Fujimura N, et al. Medical therapy and intervention do not improve uncomplicated isolated mesenteric artery dissection outcomes over observation alone. *J Vasc Surg*. 2017;66(1):202-208.

Mizuno A, Iguchi H, Sawada Y, et al. Real clinical management of patients with isolated superior mesenteric artery dissection in Japan. *J Cardiol*. 2018;71(2):155-158.

Case 8-15

Traumatic bilateral adrenal gland hemorrhages

Patient Presentation: A 43-year-old involved in a motorcycle crash presented critically injured.

Clinical Features: The patient had a markedly decreased level of consciousness and was in moderate respiratory distress.

Differential Dx:

- Multiple traumatic injuries

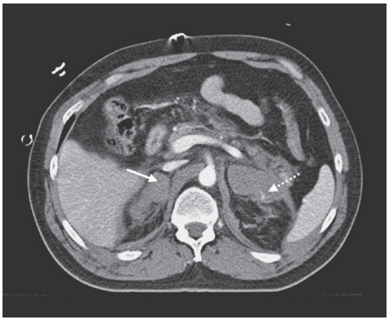

Figure 8-21. Contrast-enhanced abdominal CT scan. WA = right adrenal gland hematoma, WDA = left adrenal gland with contrast extravasation from active hemorrhage

Emergency Care: The patient underwent rapid sequence intubation and placement of a right thoracostomy tube for pneumothorax. Physical examination and medical imaging revealed pelvis and scapular fractures, a vertebral compression fracture, bilateral rib fractures, splenic and liver lacerations, a subdural hemorrhage, and a ruptured hemidiaphragm. The initial contrast-enhanced abdominal CT scan demonstrated an unusual injury: a right adrenal gland hemorrhage and a left adrenal gland hemorrhage with extravasation of contrast indicative of active hemorrhage.

Outcome: The patient had a long and complicated hospital stay with several operative interventions followed by discharge to a short-term rehabilitation facility. The patient did not develop clinically overt adrenal insufficiency.

Key Learning Points:

- Bilateral blunt traumatic adrenal gland injuries are uncommon and reflect high-energy traumatic mechanisms.
- Adrenal insufficiency can develop as a result of this injury.
- In the setting of significant adrenal gland hemorrhage, interventional radiologic embolization can be performed.

Further Reading:

Chernyak V, Patlas MN, Menias CO, et al. Traumatic and non-traumatic adrenal emergencies. *Emerg Radiol*. 2015;22(6):697-704.

Guichelaar MJ, Leenen LH, Braams R. Transient adrenocortical insufficiency following traumatic bilateral adrenal hemorrhage. *J Trauma*. 2004;56(5):1135-1137.

Ikeda O, Urata J, Araki Y, et al. Acute adrenal hemorrhage after blunt trauma. *Abdom Imaging*. 2007;32(2):248-252.

Knorr M, Evans D. Bedside ultrasound of acute adrenal hemorrhage. *Am J Emerg Med*. 2012;30(9):2088.e1-e2.

Sinelnikov AO, Abujudeh HH, Chan D, Novelline RA. CT manifestations of adrenal trauma: experience with 73 cases. *Emerg Radiol*. 2007;13(6):313-318.

Case 8-16

Nephroblastoma

Patient Presentation: This patient was a 23-month-old who immigrated to the United States 2 days prior to presentation. The chief complaint was abdominal distension that started 6 months ago.

Clinical Features: The patient had stable vital signs. The abdomen was markedly distended and tense, with a firm mass that was tender to palpation.

Differential Dx:
- Tumor is the most likely diagnosis given the history and physical examination.

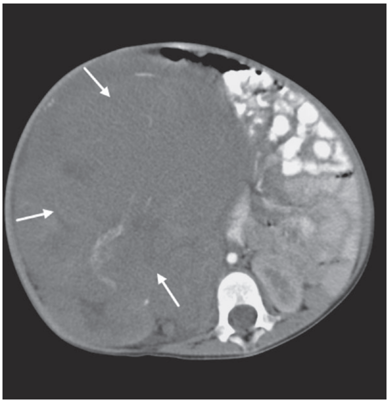

Figure 8-22. Contrast-enhanced abdominal CT scan. WA = large heterogenous solid mass

Emergency Care: Contrast-enhanced abdominal CT scan demonstrated a large heterogenous solid mass arising from the right kidney. There was hepatic and pulmonary metastatic disease with invasion of the inferior vena cava. The radiographic and clinical impression was a nephroblastoma.

Outcome: The patient was transferred to another specialty health care facility capable of the complex management this illness would require and was lost to follow-up.

Key Learning Points:
- Nephroblastoma (Wilms tumor) has an overall 5-year survival rate approaching 90% in cases treated in the United States.
- Survival depends on several factors, including tumor histology, stage, and size as well as the age of the patient at diagnosis.

Further Reading:

McMahon S, Carachi R. Wilms' tumor with intravascular extension: a review article. *J Indian Assoc Pediatr Surg*. 2014;19(4):195-200.

Paintsil V, David H, Kambugu J, et al. The Collaborative Wilms Tumour Africa Project; baseline evaluation of Wilms tumour treatment and outcome in eight institutes in sub-Saharan Africa. *Eur J Cancer*. 2015;51(1):84-91.

Rabeh W, Akel S, Eid T, et al. Wilms tumor: Successes and challenges in management outside of cooperative clinical trials. *Hematol Oncol Stem Cell Ther*. 2016;9(1):20-25.

Visser YT, Uys R, van Zyl A, Stefan DC. Nephroblastoma—a 25-year review of a South African unit. *J Med Life*. 2014;7(3):445-449.

Case 8-17

Pyloric stenosis

Patient Presentation: A 4-week-old neonate presented with 9 days of forceful vomiting associated with feedings. The infant had been seen twice in clinic prior to ED presentation.

Clinical Features: The patient was afebrile with normal vital signs and was in no apparent painful or respiratory distress. The abdomen was distended and mildly tender to palpation.

Differential Dx:

- Bowel obstruction
- Gastric outlet obstruction
- Malrotation
- Tumor
- Ileus
- Constipation
- Hirschsprung disease
- Esophageal disease

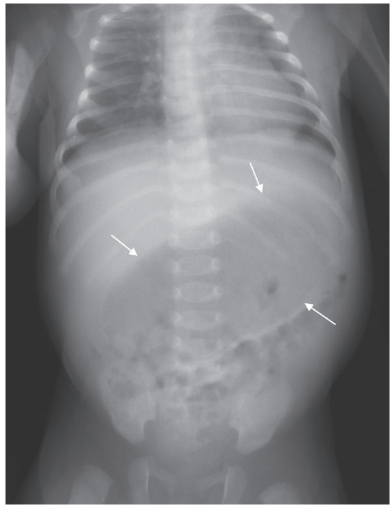

Figure 8-23. Abdominal x-ray. WA = distended stomach

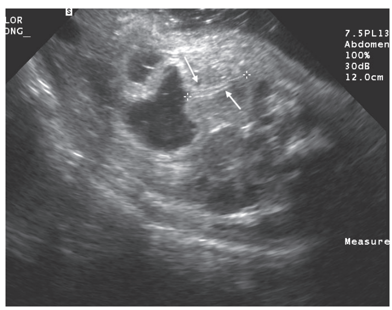

Figure 8-24. Abdominal ultrasound (longitudinal view). WA = hypertrophic pyloris. Pyloris length measured at 18 mm (asterisks)

Emergency Care: Abdominal radiograph revealed a markedly distended stomach. An abdominal ultrasound revealed hypertrophic pyloric stenosis. The length of the pylorus was 18 mm and the wall thickness was 5.2 mm. The infant was admitted for further management.

Outcome: The patient underwent successful pyloromyotomy without complication.

Key Learning Points:

- The etiology of hypertrophic pyloric stenosis is unknown, but environmental influences such as maternal smoking and bottle feeding, genetics, and exposure to macrolide antibiotics in the first 2 weeks of life are thought to be the risk factors.
- Forceful vomiting post feeding is the classic presentation.
- Palpation of the pyloric hypertrophy (the "olive" sign) is possible in many cases.
- The generally accepted minimum measurements for a diagnosis of pyloric stenosis are 15 mm in pyloric length and a wall thickness of 4 mm. However, the age and weight of the infant modifies these thresholds. Younger and lighter infants may have pyloric stenosis with measurements less than the generally accepted minimum values.

Further Reading:

Murchison L, De Coppi P, Eaton S. Postnatal erythromycin exposure and risk of infantile hypertrophic pyloric stenosis: a systematic review and meta-analysis. *Pediatr Surg Int*. 2016;32(12):1147-1152.

Peters B, Oomen MW, Bakx R, Benninga MA. Advances in infantile hypertrophic pyloric stenosis. *Expert Rev Gastroenterol Hepatol*. 2014;8(5):533-541.

Rohrschneider WK, Mittnacht H, Darge K, Tröger J. Pyloric muscle in asymptomatic infants: sonographic evaluation and discrimination from idiopathic hypertrophic pyloric stenosis. *Pediatr Radiol*. 1998;28(6):429-434.

Said M, Shaul DB, Fujimoto M, Radner G, Sydorak RM, Applebaum H. Ultrasound measurements in hypertrophic pyloric stenosis: don't let the numbers fool you. *Perm J*. 2012;16(3):25-27.

Sathya C, Wayne C, Gotsch A, Vincent J, Sullivan KJ, Nasr A. Laparoscopic versus open pyloromyotomy in infants: a systematic review and meta-analysis. *Pediatr Surg Int*. 2017;33(3):325-333.

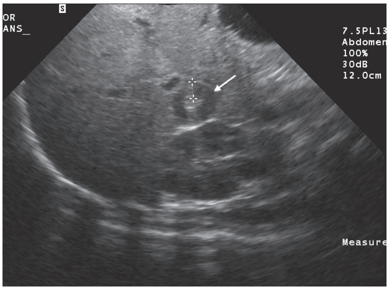

Figure 8-25. Abdominal ultrasound (transverse view). WA = hypertrophic pyloris. Pyloris wall thickness measured at 5.2 mm (asterisks)

Case 8-18

Idiopathic delayed gastric emptying

Patient Presentation: A 4-year-old presented with abdominal pain and distension that started 2 days prior to ED arrival. The child had a history of intermittent constipation, and the last bowel movement was 2 weeks ago.

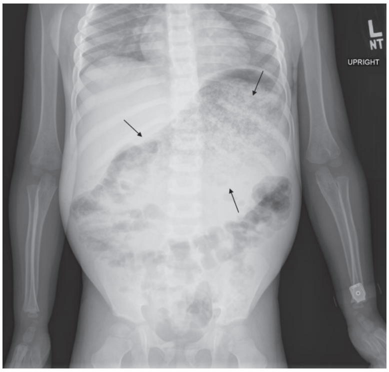

Figure 8-26. Abdominal x-ray. BA = distended stomach

Clinical Features: The patient had normal vital signs. The abdomen was significantly distended, tympanitic to percussion, and tender to palpation.

Differential Dx:
- Constipation
- Bowel obstruction
- Gastric outlet obstruction
- Malrotation
- Tumor

Emergency Care: An abdominal radiograph demonstrated a markedly distended stomach. A contrast-enhanced abdominal CT scan demonstrated the same finding, along with an air/fluid level within the stomach. The patient was admitted to the hospital.

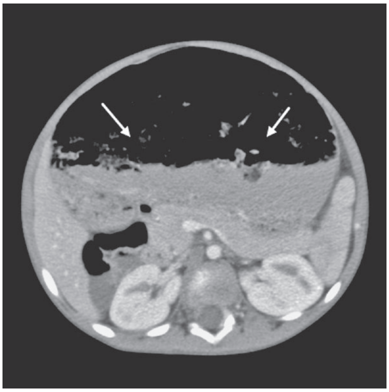

Figure 8-27. Contrast-enhanced abdominal CT scan. WA = distended stomach with air-fluid level

Outcome: The patient was scheduled for an upper endoscopy. However, physical examination and subsequent repeat plain abdominal x-ray before the endoscopy revealed the stomach had emptied into the small intestine. Delayed gastric emptying was diagnosed. Tests for celiac disease, cystic fibrosis, and chromosomal abnormalities, including fragile X disease, were pending, but results were lost to follow-up.

Key Learning Points:
- Gastroparesis typically presents with abdominal pain and distension with vomiting.
- Gastroparesis is defined as delayed gastric emptying in the absence of mechanical obstruction.
- Pediatric gastroparesis can be caused by medications or postsurgical changes, but most cases are idiopathic.

Further Reading:

Islam S. Gastroparesis in children. *Curr Opin Pediatr*. 2015;27(3):377-382.

Saliakellis E, Fotoulaki M. Gastroparesis in children. *Ann Gastroenterol*. 2013;26(3):204-211.

Waseem S, Islam S, Kahn G, Moshiree B, Talley NJ. Spectrum of gastroparesis in children. *J Pediatr Gastroenterol Nutr*. 2012;55(2):166-172.

Case 8-19

Stercoral perforation

Patient Presentation: A 74-year-old presented for evaluation of altered mental status.

Clinical Features: The patient was critically ill appearing, unresponsive to painful stimuli, and in clinical shock. The patient was tachypneic and not protecting his airway. The abdomen was soft but distended.

Differential Dx:

- Sepsis
- Central nervous system pathology
- Toxicologic
- Metabolic or endocrine pathology
- Intraperitoneal catastrophe
- Cardiovascular or pulmonary event

Emergency Care: The patient was endotracheally intubated. Bedside ultrasound examination was difficult at all anatomic points of examination. Intravenous fluids, antibiotics, and a norepinephrine infusion were started. Abdominal radiograph demonstrated a large central area without bowel gas, concerning for a mass. A noncontrast abdominal CT scan demonstrated significant dilatation of the sigmoid colon, with wall thickening and fecal impaction. A large amount of intraperitoneal free air was also noted.

Outcome: After discussing the critical nature of the illness and the necessary surgical management, the family elected to place the patient on comfort care, and he died.

Key Learning Points:

- Stercoral perforation occurs when an intraluminal bowel object, most commonly hardened feces, exerts pressure on the bowel wall, causing a locally inflamed and ischemic bowel wall, leading to rupture from local necrosis. It carries high morbidity and mortality.

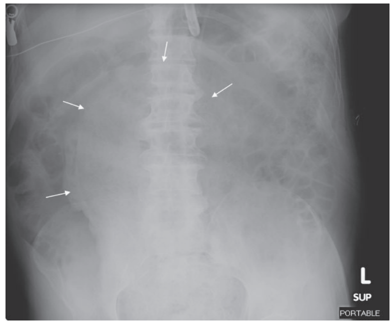

Figure 8-28. Abdominal x-ray. WA = outline of a mass

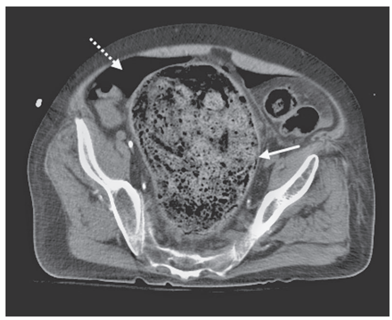

Figure 8-29. Noncontrast abdominal CT scan (axial view). WA = distended colon with significant feces, WDA = free intraperitoneal air

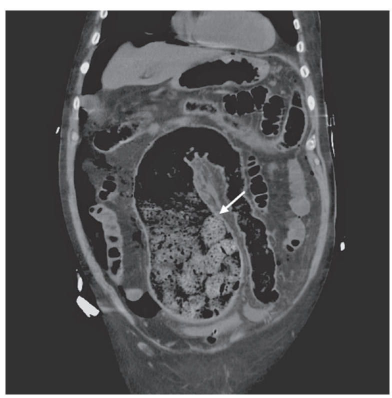

Figure 8-30. Noncontrast abdominal CT scan (coronal view). WA = distended colon with feces

Further Reading:

Chakravartty S, Chang A, Nunoo-Mensah J. A systematic review of stercoral perforation. *Colorect Dis.* 2103;15(8)930-935.

Kumar P, Pearce O, Higginson A. Imaging manifestations of faecal impaction and stercoral perforation. *Clin Radiol*. 2011;66(1):83-88.

Ryu C, Kim P, Cho MJ, Shin M, Jung EJ. Clinical analysis of stercoral perforation without mortality. *Dig Surg*. 2017;34(3):253-259.

Case 8-20

Sigmoid volvulus (two patients)

Patient Presentation: These are two different patients who presented with a history of increasing abdominal pain and vomiting.

Clinical Features: The first patient, a 50-year-old, presented with a 5-day history of increasing abdominal pain. The second patient, an 85-year-old, presented with a 2-day history of increasing abdominal pain. Both patients had distended and tympanitic abdominal exams with generalized and marked tenderness to palpation.

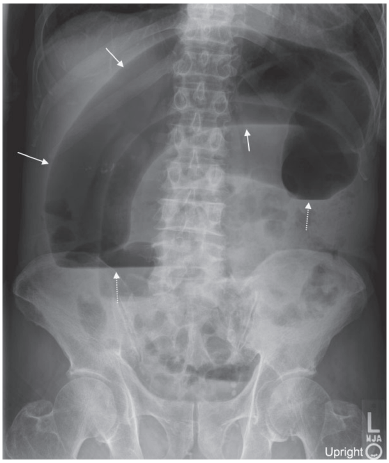

Figure 8-31. First patient. Abdominal x-ray. WA = dilated colon, WDA = air/fluid level

Differential Dx:
- Bowel obstruction
- Volvulus
- Cancer
- Ruptured viscous

Emergency Care: Both patients were diagnosed radiographically with sigmoid volvulus.

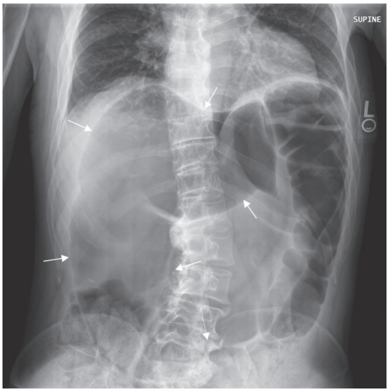

Figure 8-32. Second patient. Abdominal x-ray. WA = dilated colon, WDA = point of mesenteric twisting

Outcome: The 50-year-old patient underwent an unsuccessful sigmoidoscopy and required laparotomy for reduction. The 85-year-old was successfully reduced with colonoscopy. Both patients recovered well.

Key Learning Points:
- The average age of a patient at the time of sigmoid volvulus diagnosis is 70 years old.
- Sigmoid volvulus is the result of the sigmoid colon twisting on itself causing mechanical obstruction.
- If the patient does not have any signs or symptoms of bowel perforation or infarction, an attempt at reduction with sigmoidoscopy is generally preferred. If sigmoidoscopy fails, open reduction via laparotomy is performed. Percutaneous endoscopic colostomy may be attempted in patients who are poor candidates for surgery. Nonoperative management can result in recurrent episodes of sigmoid volvulus.

Further Reading:

Frank L, Moran A, Beaton C. Use of percutaneous endoscopic colostomy (PEC) to treat sigmoid volvulus: a systematic review. *Endosc Int Open*. 2016;4(7):E737-E741.

Lou Z, Yu ED, Zhang W, Meng RG, Hao LQ, Fu CG. Appropriate treatment of acute sigmoid volvulus in the emergency setting. *World J Gastroenterol*. 2013;19(30):4979-4983.

Swenson BR, Kwaan MR, Burkart NE, et al. Colonic volvulus: presentation and management in metropolitan Minnesota, United States. *Dis Colon Rect*. 2012;55(4):444-449.

Yassaie O, Thompson-Fawcett M, Rossaak J. Management of sigmoid volvulus: is early surgery justifiable? *ANZ J Surg*. 2013;83(1-2):74-78. ISSN: 1445-2197.

Case 8-21

Spontaneous inferior epigastric artery hemorrhage

Patient Presentation: A young male presented with abdominal pain without nausea, vomiting, fever, or other associated intraperitoneal symptoms. There had been no trauma.

Clinical Features: The patient was well appearing and in mild painful distress. Vital signs were normal. Abdominal examination revealed marked focal tenderness to palpation of the right lower quadrant, along with a palpable and visual fullness to the tender area.

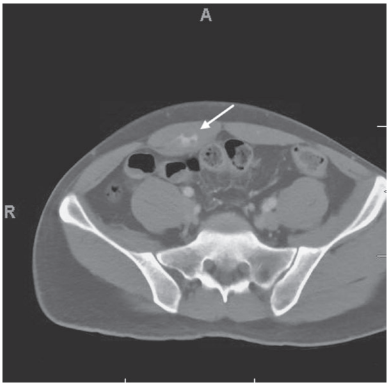

Figure 8-33. Contrast-enhanced abdominal CT scan (axial view). WA = active hemorrhage from inferior epigastric artery

Differential Dx:

- Appendicitis
- Enteritis
- Cancer
- Irritable bowel
- Urinary pathology
- Abdominal wall pathology
- Cellulitis
- Abscess
- Hernia

Emergency Care: Laboratory values were unremarkable. Given the fullness to the tender area, a contrast-enhanced abdominal CT scan was performed. This revealed active contrast extravasation thought to be spontaneous hemorrhage from the inferior epigastric artery.

Figure 8-34. Contrast-enhanced abdominal CT scan (coronal view). WA = active hemorrhage from inferior epigastric artery

Outcome: The patient had successful embolization of his inferior epigastric artery.

Key Learning Points:

- The inferior epigastric artery is responsible for a significant amount of the vascular supply to the anterior abdominal wall.
- The inferior epigastric artery is frequently involved in iatrogenic injury.
- Spontaneous inferior epigastric artery hemorrhage has been associated with anticoagulant use. Spontaneous hemorrhage of the inferior epigastric artery without trauma or anticoagulation, as in this young, healthy patient, is uncommon.

Further Reading:

Matsui K, Machida S, Shirai S. Retroperitoneal hemorrhage caused by inferior epigastric artery injury. *Clin Exp Nephrol*. 2016;20(1):143-144.

Silverman MM, Reno GL. Spontaneous rupture of the inferior epigastric artery. *J Mich State Med Soc*. 1953;52(5):532-534.

Sobkin PR, Bloom AI, Wilson MW, et al. Massive abdominal wall hemorrhage from injury to the inferior epigastric artery: a retrospective review. *J Vasc Interv Radiol.* 2008;19(3):327-332.

Wick MC, Klocker J, Grundtman C, Jaschke W, Chemelli AP. Transcatheter embolization for the management of acute active inferior epigastric artery hemorrhages. *J Endovasc Ther.* 2013;20(4):561-567.

Case 8-22

Horseshoe kidney

Patient Presentation: A 61-year-old was involved in a high-speed motor vehicle crash. His chief complaint was left wrist pain.

Clinical Features: Vital signs were normal. The patient was awake and in moderate distress from an open left wrist fracture/dislocation.

Differential Dx:
- Multiple blunt traumatic injuries

Figure 8-35. Contrast-enhanced abdominal CT scan. WA = incidental finding of horseshoe kidney

Emergency Care: Given the significant mechanism of injury and his painful distracting wrist injury, a contrast-enhanced chest/abdomen/pelvis CT scan was performed. This revealed the incidental finding of a horseshoe kidney.

Outcome: The patient had closed reduction of his fracture/dislocation in the ED followed by open reduction and internal fixation.

Key Learning Points:
- Most cases of horseshoe kidney present as an incidental finding, as in the above case.
- Patients with horseshoe kidneys have a higher incidence of renal calculi and renal infection, both a result of partial obstruction and urinary stasis.
- Accompanying additional urologic or genital abnormalities frequently exist.

Further Reading:

Natsis K, Piagkou M, Skotsimara A, Protogerou V, Tsitouridis I, Skandalakis P. Horseshoe kidney: a review of anatomy and pathology. *Surg Radiol Anat*. 2014;36(6):517-526.

Rodriguez MM. Congenital anomalies of the kidney and the urinary tract (CAKUT). *Fetal Pediatr Pathol*. 2014;33(5-6):293-320.

Taghavi K, Kirkpatrick J, Mirjalili SA. The horseshoe kidney: surgical anatomy and embryology. *J Pediatr Urol*. 2016;12(5):275-280.

Case 8-23

Severe hemorrhage from splenic artery pseudoaneurysm to stomach fistula

Patient Presentation: A 44-year-old presented with an upper gastrointestinal hemorrhage. He had vomited bright red blood several times over the last 3 days. He had a history of alcohol abuse.

Clinical Features: The patient was ill appearing and very pale. He had a blood pressure 95/55 mm Hg with a heart rate of 128 beats/min. Abdominal examination was unremarkable.

Differential Dx:

- Upper gastrointestinal hemorrhage from esophageal varices
- Gastric or duodenal ulcer
- Gastritis
- Mallory-Weis tear
- Esophageal rupture

Emergency Care: The initial hemoglobin level was 3.4 g/dL. The massive transfusion protocol was initiated. Octreotide and pantoprazole boluses were given, and subsequent infusions were started. Ondansetron was given for nausea, and the patient was admitted to the intensive care unit.

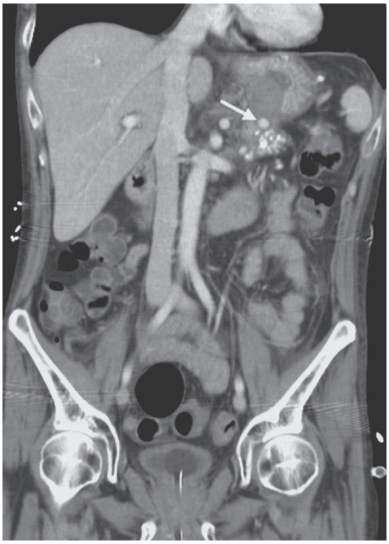

Figure 8-36. Contrast-enhanced abdominal CT scan (coronal view). WA = splenic artery pseudoaneurysm

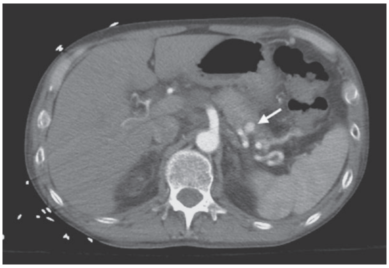

Figure 8-37. Contrast-enhanced abdominal CT scan (axial view). WA = splenic artery pseudoaneurysm

Outcome: The patient underwent upper endoscopy that showed gastric varices without esophageal varices. This raised the concern for a noncirrhotic cause of portal hypertension, and a contrast-enhanced abdominal CT scan was performed. This demonstrated a splenic artery pseudoaneurysm thought secondary to chronic pancreatitis. The severe upper gastrointestinal hemorrhage was a result of a fistula between the splenic artery pseudoaneurysm and the gastric fundus. The patient underwent interventional radiographic embolization with coils of his pseudoaneurysm. Approximately 1 month later the patient presented again with upper gastrointestinal bleeding, the result of collateral blood flow to his previously coiled splenic artery pseudoaneurysm. He underwent a second coiling and recovered.

Key Learning Points:

- Splenic artery aneurysms are often found as incidental findings on abdominal CT scan.
- Symptomatic splenic artery aneurysms present with abdominal pain and nausea. Ruptured splenic artery aneurysms present with acute blood loss anemia and associated signs.
- Splenic artery aneurysms are associated with conditions that increase blood flow such as pregnancy, arteriovenous malformations, and portal hypertension.
- Splenic artery pseudoaneurysm to gastric fundus fistulas have been described but are rare events.

Further Reading:

Budimir I, Jurčić P, Nikolić M, Ljubičić N. Upper gastrointestinal bleeding caused by fistula of the stomach and splenic artery pseudoaneurysm. *Br J Hosp Med (Lond).* 2016;77(12):721.

Herrera-Fernandez FA, Palomeque-Jiménez A, Serrano-Puche F, Calzado-Baeza SF, Reyes-Moreno M. Rupture of splenic artery pseudoaneurysm: an unusual cause of upper gastrointestinal bleeding [in Spanish]. *Cirugia Y Cirujanos*. 2014;82(5):551-555.

Shah NA, Akingboye A, Haldipur N, Mackinlay JY, Jacob G. Embolization coils migrating and being passed per rectum after embolization of a splenic artery pseudoaneurysm, "the migrating coil": a case report. *Cardiovasc Intervent Radiol.* 2007;30(6):1259-1262.

Takahashi T, Shimada K, Kobayashi N, Kakita A. Migration of steel-wire coils into the stomach after transcatheter arterial embolization for a bleeding splenic artery pseudoaneurysm: report of a case. *Surg Today*. 2001;31(5):458-462.

Case 8-24

Splenocolic fistula

Patient Presentation: A 37-year-old man presented complaining of bright red blood per rectum. He had a history of lymphoma as well as alcohol abuse.

Clinical Features: The patient was pale, hemodynamically stable, with moderate tenderness to palpation of the left upper quadrant. No external source of bleeding was visualized on rectal examination.

Differential Dx:

- Lower gastrointestinal bleeding from cancer
- Angiodysplasia
- Inflammatory bowel disease
- Infection
- Meckel diverticulum
- Diverticulitis
- Internal hemorrhoids
- Rectal fistula

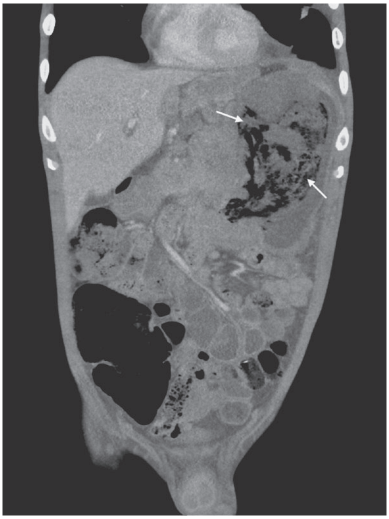

Figure 8-38. Contrast-enhanced abdominal CT scan (coronal view). WA = large collection of stool in left upper quadrant in vicinity of the spleen

Emergency Care: The initial hemoglobin was 6.5 g/dL. Contrast-enhanced abdominal CT scan in coronal and axial plane shows a connection between the splenic flexure of the colon and the spleen, with a large collection of stool in the expected location of the spleen. The stool collection significantly displaces adjacent structures in the abdomen. This was a splenocolic fistula caused by his lymphoma.

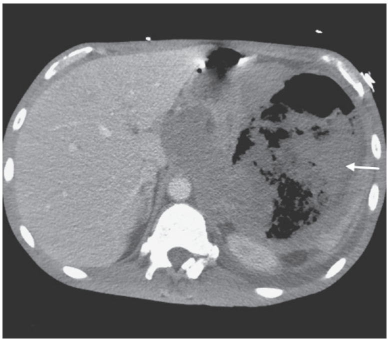

Figure 8-39. Contrast-enhanced abdominal CT scan (axial view). WA = large collection of stool in left upper quadrant in vicinity of the spleen

Outcome: The patient was treated with antibiotics and supportive care. On hospital day 4 he underwent a splenic artery embolization in preparation for an en bloc splenectomy. He remained stable and was discharged from the hospital. Thirteen days later he presented again with gastrointestinal bleeding and a hemoglobin of 4.1 g/dL. Repeat imaging demonstrated a new gastrosplenic fistula. A percutaneous drain was placed into the splenic cavity to drain feculent material as he was thought to be a poor candidate for surgery. The drain into the splenic cavity remained in place for several months until it was accidentally removed.

Key Learning Points:

- Splenocolic fistula formation is rare.
- Splenocolic fistula has been reported in isolated case reports related to primary splenic cyst, polycythemia vera, postsurgical infectious complications, and Crohn disease.

Further Reading:

Benizri EI, Rahili A, Bernard JL, Benchimol D. Primary cyst of the spleen presenting as a splenocolic fistula. *Clin Res Hepatol Gastroenterol*. 2011;35(8-9):511-512.

Goldberg JB, Moses RA, Holubar SD. Colosplenic fistula: a highly unusual colonic fistula. *J Gastrointest Surg*. 2012;16(12):2338-2340.

Means JR, Villella ER, Stahlfeld KR. Splenocolic fistula in a patient with polycythemia vera. *Am J Surg*. 2003;185(2):173-174.

Winter MW, Lee S. Colosplenopleural fistula: an unusual colonic fistula in a 44-year-old male with Crohn's disease. *Radiol Case Rep*. 2015;9(4):1028.

Case 8-25

Traumatic posterior abdominal herniation of the cecum and appendix

Patient Presentation: A 48-year-old man presented for evaluation of injuries after a high-speed motorcycle crash.

Clinical Features: The patient was hemodynamically stable, but initially confused and combative. He had numerous abrasions, and a large right flank contusion.

Differential Dx:
- Multiple blunt traumatic injuries

Emergency Care: He required light sedation to facilitate radiographic evaluation. A contrast-enhanced chest/abdominal/pelvis CT scan demonstrated a right posterior abdominal wall defect (lumbar hernia) with herniation of the cecum and tip of the appendix.

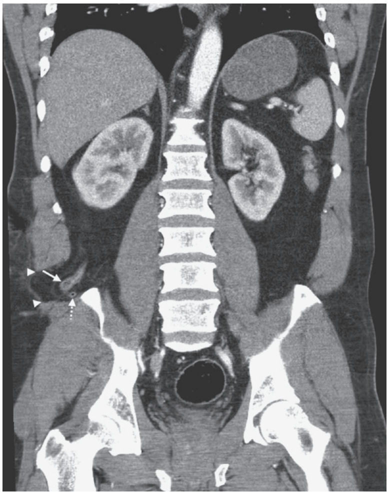

Figure 8-40. Contrast-enhanced abdominal CT scan. WA = cecum, WAH = defect in posterior abdominal wall, WDA = appendix

Outcome: The patient was observed in the hospital, and remained stable. Six weeks following this injury the patient underwent elective mesh repair of his traumatic lumbar hernia.

Key Learning Points:
- Lumbar hernias are rare.
- Case reports have described several etiologies resulting in lumbar hernia, including congenital, traumatic, and athletic mechanisms.

Further Reading:

Ali SM, Subramaniam S. Appendicular abscess as an unprecedented cause of an inferior lumbar hernia. *Ann R Coll Surg Engl*. 2017;99(2):e85-e87.

Ka I, Gueye ML, Thiam O, Akpo LG, Toure AO. Strangulated lumber hernias in adults: a case report and review of the literature. *Ann R Coll Surg Engl*. 2016;98(8):e160-e161.

Mellnick VM, Raptis C, Lonsford C, Lin M, Schuerer D. Traumatic lumbar hernias: do patient or hernia characteristics predict bowel or mesenteric injury? *Emerg Radiol*. 2014;21(3):239-243.

Saboo SS, Khurana B, Desai N, et al. Traumatic lumbar hernia: can't afford to miss. *Emerg Radiol*. 2014;21(3):325-327.

Sundaramurthy S, Suresh HB, Anirudh AV, Prakash Rozario A. Primary lumbar hernia: a rarely encountered hernia. *Int J Surg Case Rep*. 2016;20:53-56.

Case 8-26

Colo-ovarian fistula

Patient Presentation: A 46-year-old woman presented with increasing lower pelvic pain. She had recently been diagnosed with acute diverticulitis and treated as an outpatient with ciprofloxacin and metronidazole.

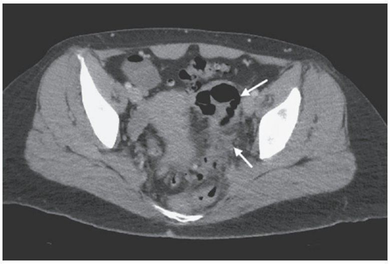

Figure 8-41. Contrast-enhanced abdominal CT scan. WA = rupture of diverticulum into the left adnexa

Clinical Features: The patient was afebrile and nontoxic in appearance. There was moderate tenderness to palpation in the left lower quadrant. Pelvic examination revealed no discharge and no cervical motion tenderness.

Differential Dx:
- Failure of outpatient antibiotic management of diverticulitis
- Abscess formation
- Fistula

Emergency Care: Contrast-enhanced abdominal CT scan demonstrated a colo-ovarian fistula where the diverticula had ruptured into the left adnexa. The patient was admitted for further diagnostic and therapeutic intervention.

Outcome: The patient was started on ertapenem and discharged on amoxicillin/clavulanate 3 days later. No surgical interventions were performed.

Key Learning Points:
- In patients with diverticulitis, the presence of gas, with or without fluid, in the adnexum is a sensitive and specific finding for a fistula between the colon and adnexum.
- Fistulas from diverticulitis to pelvic organs rarely close spontaneously and in the absence of critical illness are managed with elective surgery.

Further Reading:

Panghaal VS, Chernyak V, Patlas M, Rozenblit AM. CT features of adnexal involvement in patients with diverticulitis. *AJR Am J Roentgenol.* 2009;192(4):963-966.

Ruiz-Tovar J, Gamallo C. Pneumosalpynx caused by colosalpingeal fistula secondary to acute colonic diverticulitis. *Int J Colorectal Dis.* 2011;26(10):1357-1358.

Smith JP, Weissman RC, Lockhart ME. Colosalpingeal fistula diagnosed by computed tomography. *Clin Gastroenterol Hepatol.* 2009;7(1):e5.

Stettler G, Asfour RH, Mora-Pinzon MC. Colosalpingeal fistula after acute diverticulitis. *Am Surg.* 2014;80(7):e192-e193.

Case 8-27

Large inguinal hernia

Patient Presentation: Elderly male presented with painful swelling of his inguinal region associated with nausea and vomiting.

Clinical Features: There was a large, extremely tender mass involving the inguinal region with bowel sounds present within the mass.

Differential Dx:

- Incarcerated inguinal hernia with possible strangulation

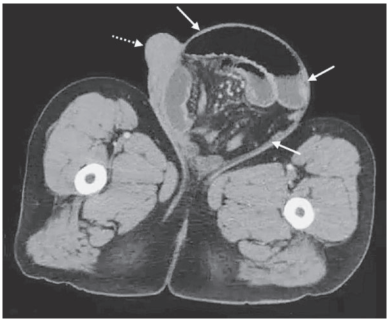

Figure 8-42. Contrast-enhanced abdominal CT scan. WA = inguinal hernia, WDA = penis

Emergency Care: The patient was treated with pain medication, and contrast-enhanced abdominal CT scan demonstrated a large inguinal hernia adjacent to his penis.

Outcome: This patient was taken to the operating room for hernia reduction and examination of his bowel for possible strangulation. The patient was lost to follow-up.

Key Learning Points:

- An incarcerated hernia mandates operative reduction and repair.
- Complications of a strangulated hernia include bowel perforation and bowel obstruction.
- The neutrophil to lymphocyte ratio has been used to predict the presence of strangulation in incarcerated hernias.

Further Reading:

Bittner JG 4th. Incarcerated/strangulated hernia: open or laparoscopic? *Adv Surg*. 2016;50(1):67-78.

Zhou H, Ruan X, Shao X, Huang X, Fang G, Zheng X. Clinical value of the neutrophil/lymphocyte ratio in diagnosing adult strangulated inguinal hernia. *Int J Surg*. 2016;36(pt A):76-80.

Case 8-28

Radiographic "seat belt" sign

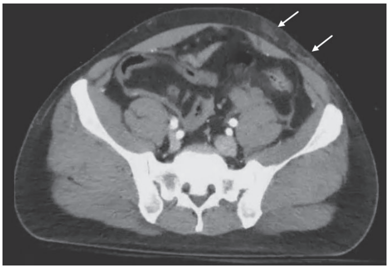

Figure 8-43. Contrast-enhanced abdominal CT scan. WA = subcutaneous bleeding and inflammatory changes from the seat belt

Patient Presentation: Young patient involved in a high-speed motor vehicle crash with sudden deceleration. The patient was complaining of abdominal pain.

Clinical Features: The patient was hemodynamically stable with mild abdominal pain on palpation.

Differential Dx: Multiple blunt traumatic injuries

Emergency Care: Given the concerning mechanism of injury, a contrast-enhanced abdominal CT scan was obtained and was unremarkable except for the presence of a "radiographic seat belt sign": subcutaneous bleeding and inflammatory changes in the anterior abdominal wall because of abdominal seat belt injury.

Outcome: The patient was observed in the hospital and did not develop any symptoms or signs of significant injury.

Key Learning Points:

- The seat belt sign, ie, ecchymosis of the anterior chest wall or abdominal wall, caused by either the chest or lap seat belt, is indicative of a high-speed deceleration mechanism.
- Traumatic injury to the thoracic aorta and abdominal hollow viscous injury are the classic injuries associated with this mechanism.
- In this patient, a "radiographic seat belt sign" without any external skin findings was present.

Further Reading:

Al-Ozaibi L, Adnan J, Hassan B, Al-Mazroui A, Al-Badri F. Seat belt syndrome: delayed or missed intestinal injuries, a case report and review of literature. *Int J Surg Case Rep*. 2016;20:74-76.

Chidester S, Rana A, Lowell W, Hayes J, Groner J. Is the "seat belt sign" associated with serious abdominal injuries in pediatric trauma? *J Trauma*. 2009 Jul;67(1 suppl):S34-S36.

Paris C, Brindamour M, Ouimet A, St-Vil D. Predictive indicators for bowel injury in pediatric patients who present with a positive seat belt sign after motor vehicle collision. *J Pediatr Surg*. 2010;45(5):921-924.

Wotherspoon S, Chu, K, Brown AF. Abdominal injury and the seat-belt sign. *Emerg Med (Fremantle)*. 2001;13(1):61-65.

Case 8-29

Hydrogen peroxide ingestion

Patient Presentation: A 97-year-old man accidentally ingested an unknown quantity of food grade (35%) hydrogen peroxide. He was initially evaluated at an outside institution, where a noncontrast abdominal CT scan demonstrated portal venous air within the liver. He was transferred to our facility for the consideration of hyperbaric oxygen treatment.

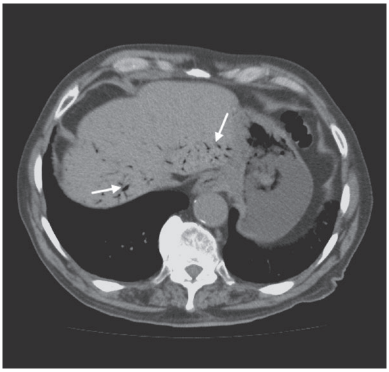

Figure 8-44. Noncontrast enhanced abdominal CT scan. WA = hepatic portal air

Clinical Features: The patient was well appearing and in no apparent distress.

Differential Dx:

- Air (oxygen) embolism

Emergency Care: Despite a minor troponin elevation, there were no symptoms, signs, or test results indicative of any acute significant cardiovascular, pulmonary, or intraperitoneal pathology.

Outcome: The patient was taken to the hyperbaric oxygen chamber where a U.S. Navy Table 6 +/– extension was performed. The patient was unable to equalize the pressure in his ears and had bilateral myringotomies performed. The hyperbaric therapy lasted 5 hours, and he tolerated the dive well.

Key Learning Points:

- Ingestion of hydrogen peroxide results in the release of large quantities of oxygen. One (1) mL of 35% hydrogen peroxide will release 100 mL of oxygen. A tablespoon (15 mL) of 35% hydrogen peroxide will liberate 1,500 mL of oxygen.
- Ingestion of 3% hydrogen peroxide (the concentration found in most over-the-counter products) is generally a nontoxic event but can result in gastric mucosal injury.
- More severe injury occurs at >10% concentrations.
- Hyperbaric oxygen therapy is effective in resolving hepatic portal air (oxygen).
- Deaths have been reported with 35% hydrogen peroxide.
- Portal air can be distinguished from biliary air on a CT scan. Air in the portal system is located in the periphery of the liver, while biliary air is more centrally located.

Further Reading:

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Papafragkou S, Gasparyan A, Batista R, Scott P. Treatment of portal venous gas embolism with hyperbaric oxygen after accidental ingestion of hydrogen peroxide: a case report and review of the literature. *J Emerg Med*. 2012;43(1):e21-e23.

Case 8-30

Umbilical hernia with a cutaneous fistula draining ascites

Patient Presentation: A 59-year-old with end-stage liver disease presented with his umbilical hernia draining ascites.

Clinical Features: The patient had signs of hepatic cirrhosis. The patient had a distended abdomen and a large umbilical hernia with a fistula in the middle of an ulcer that was actively draining ascites.

Differential Dx:
- Fistula from peritoneal cavity

Emergency Care: A sample of the draining ascites fluid through his umbilical hernia was collected for laboratory analysis. The patient was admitted to the hospital.

Outcome: An exploratory laparotomy and repair of the umbilical hernia with closure of the fistula was performed. However, the patient had numerous postoperative complications, including bacterial peritonitis, and subsequently died.

Figure 8-45. BA = abdomen, RA = stream of ascites draining from a cutaneous fistula, WA = umbilical hernia

Key Learning Points:
- Umbilical hernias in the setting of significant ascites in patients with liver failure is common.
- Complications such as ulceration, fistula formation, or frank rupture of the umbilical hernia cause significant morbidity and mortality.
- Successful early elective repair of noncomplicated umbilical hernia in the setting of ascites is plausible.

Further Reading:

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CHAPTER 9 Electrocardiogram

Case 9-1

Spontaneous coronary artery dissection in a young, postpartum female

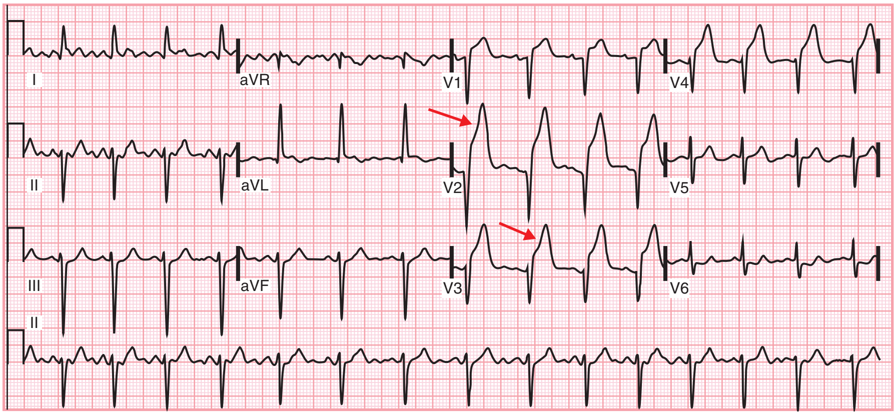

Figure 9-1. 12-lead electrocardiogram. RA = ST segment elevations in the anterior precordial leads

Patient Presentation: A 27-year-old woman presented with severe, substernal chest pain 2 weeks after a normal spontaneous vaginal delivery.

Clinical Features: This patient had stable vital signs and was in moderate painful distress with no abnormal physical findings.

Differential Dx:

- Aortic dissection
- Pericardial tamponade
- Pericarditis
- Acute myocardial infarction
- Myocarditis
- Postpartum cardiomyopathy
- Pulmonary embolism

Emergency Care: An EKG was remarkable for ST-segment elevations in the anterior precordial leads. Bedside emergency department (ED) cardiac ultrasound demonstrated an apical and septal wall motion abnormality. The patient was treated with nitroglycerin, aspirin, heparin, and ticagrelor and went to the cardiac catheterization lab.

Outcome: Cardiac catheterization revealed a 100% occlusion of the proximal left anterior descending coronary artery from a spontaneous coronary artery dissection, with initial thrombolysis in myocardial infarction (TIMI) flow = 0. Two drug-eluding stents were placed, and her EKG returned to normal. Shortly after returning to the coronary care unit, the patient suffered a ventricular fibrillation cardiac arrest and was successfully resuscitated with one defibrillation. Repeat cardiac catheterization revealed patent stents, and the arrest was thought secondary to a reperfusion arrhythmia. The patient went on to have an uncomplicated hospital course and was discharged neurologically intact.

Key Learning Points:

- The classic patient profile for spontaneous coronary artery dissection is young, female, and postpartum.
- The left anterior descending artery is most commonly involved.
- Spontaneous coronary artery dissection has been increasingly discovered in women, accounting for 24% of myocardial infarctions in women under the age of 50 years.
- Treatment can be complex and depends on the presence or absence of acute myocardial infarction.

Further Reading:

Alfonso F, Bastante T, García-Guimaraes M, et al. Spontaneous coronary artery dissection: new insights into diagnosis and treatment. *Coron Art Dis*. 2016;27(8):696-706.

Cade JR, Szarf G, de Siqueira ME, et al. Pregnancy-associated spontaneous coronary artery dissection: insights from a case series of 13 patients. *Eur Heart J Cardiovasc Imaging*. 2017;18(1):54-61.

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Case 9-2

Incorrect computer read of a 12-lead electrocardiogram

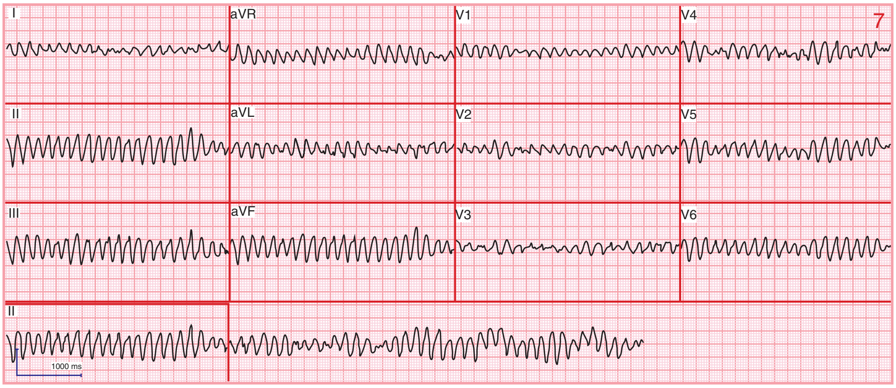

Figure 9-2. 12-lead electrocardiogram. Ventricular fibrillation read incorrectly by the EKG computer software as "sinus rhythm, nonspecific ST and T wave changes, improved vs prior EKG"

Patient Presentation: A 54-year-old man presented to the ED after suffering an out-of-hospital ventricular fibrillation cardiac arrest. He was defibrillated once by paramedics with return of spontaneous circulation.

Clinical Features: The patient was awake, following commands, and answering questions appropriately. He was tachycardic with a heart rate of 130 beats/min with a normal blood pressure.

Differential Dx:
- Sudden cardiac arrest
- Arrhythmia
- Myocardial infarction
- Pulmonary embolism

Emergency Care: An initial ED EKG showed ST elevation in aVR and ST depression in the inferior and anterior leads. Amiodarone 150 mg was given IV along with 0.4 mg of sublingual nitroglycerin. While a repeat EKG was being performed 20 minutes after arrival, the patient was noted to become unresponsive and was again in ventricular fibrillation. This ventricular fibrillation was caught at the exact time the 12-lead EKG was being performed. The computer did not keep up with the actual rhythm, instead reading the 12-lead EKG incorrectly as "sinus rhythm, nonspecific ST and T wave changes, improved vs prior EKG."

Outcome: The patient was successfully defibrillated. The patient had a cardiac catheterization that demonstrated severe coronary artery disease, and three stents were placed in the left anterior descending coronary artery. The patient made an uneventful recovery.

Key Learning Points:

- Computers have allowed significant improvements in medical documentation, fast access to just-in-time resources for diagnosis and management, and the ability to perform invasive procedures.
- However, computers are only as good as their software, and human oversight is still very important.
- Studies examining the utility of computer-assisted EKG interpretation have shown that a basic level of understanding of EKG interpretation is required for the computer interpretations to provide diagnostic assistance.
- Human EKG interpreters who are not skilled in EKG reading are more likely to accept an inaccurate computer-generated EKG interpretation.
- This EKG also has some characteristics of torsades de pointes, and treatment with magnesium would have been reasonable.

Further Reading:

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Rosendahl L, Pahlm O. ECG interpretation by computer. How reliable is rhythm diagnosis? [in Swedish] *Lakartidningen*. 1994;91(21):2140-2142.

Tsai TL, Fridsma DB, Gatti G. Computer decision support as a source of interpretation error: the case of electrocardiograms. *J Am Med Inform Assoc*. 2003;10(5):478-483.

Case 9-3

Right coronary artery spasm related to tobacco, cocaine, and erlotinib

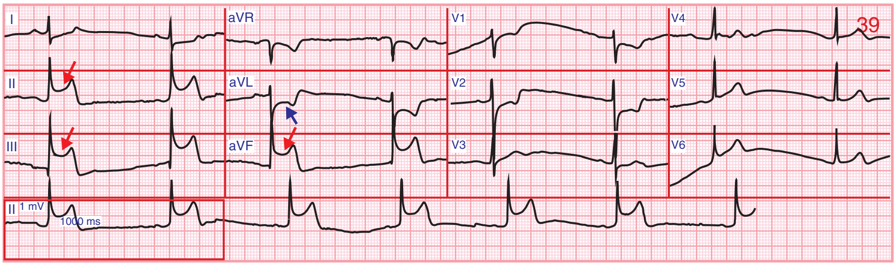

Figure 9-3. 12-lead electrocardiogram. RA = inferior ST-segment elevation, blue arrow = reciprocal ST-segment depression in aVL

Patient Presentation: A 49-year-old woman presented with an altered mental status after a witnessed seizure. Patient had a history of non–small-cell lung carcinoma and cocaine abuse. The patient had recently been started on erlotinib (a tyrosine inhibitor for lung cancer patients with specific mutations in the epidermal growth factor receptor).

Clinical Features: The patient was postictal on presentation, but did endorse chest pain. Her heart rate was noted to be 40 beats/min.

Differential Dx:
- Cardiac, metabolic, toxicologic, endocrine, central nervous system, infectious etiologies for the altered mental status

Emergency Care: A 12-lead EKG was obtained and demonstrated marked ST elevation in leads II, III, aVF, and ST depression in lead aVL consistent with an acute inferior myocardial infarction. Atropine was administered, which increased her heart rate to 90 beats/min. The patient was treated with aspirin, nitroglycerin infusion, and heparin infusion and was sent to the cardiac catheterization lab.

Outcome: No culprit lesion was identified with coronary angiography. The right coronary artery had mild to moderate disease. Repeat EKG in the cardiac catheterization lab showed return to baseline normal. Troponins showed a very modest rise to 0.12 ng/mL (normal <0.030). The initial EKG changes were thought to have been caused by coronary vasospasm, induced by a combination of several factors including a fixed lesion in the right coronary artery, tobacco and cocaine use, and erlotinib.

Key Learning Points:
- Erlotinib, a chemotherapeutic drug, has an associated incidence of coronary vasospasm of 1% to 2%.

- Coronary artery vasospasm caused by cocaine is associated with myocardial infarctions as well as fatal arrhythmias.
- Management of cocaine cardiotoxicity without apparent ST-elevation myocardial infarction includes managing the sympathomimetic effects, namely tachycardia and hypertension, and increased myocardial oxygen demand. A stepwise progression would be use of benzodiazepines, which may alleviate the tachycardia and hypertension. If that is not successful, the use of a dual ß-blocker and α-adrenergic blocker, such as labetalol, has been advocated but is controversial as labetalol has predominantly ß-blocking effects. For severe cardiac toxicity, starting phentolamine first followed quickly with esmolol is another reasonable strategy.

Further Reading:

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Rezkalla SH, Kloner RA. Cocaine-induced acute myocardial infarction. *Clin Med Res*. 2007;5(3):172-176.

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Case 9-4

Brugada phenocopy associated with hypernatremia

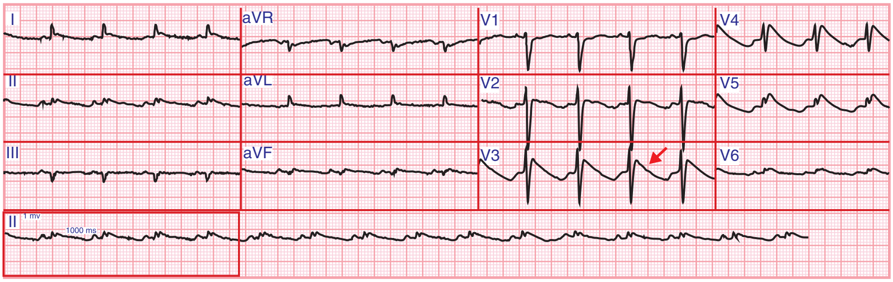

Figure 9-4. 12-lead electrocardiogram. RA = Brugada-type pattern in leads V3-V5

Patient Presentation: A 76-year-old man with multiple medical conditions presented from a nursing home with an altered mental status in the setting of decreased oral intake.

Clinical Features: The patient had a significant alteration in mental status with an inability to follow simple commands or verbalize, and appeared severely dehydrated with dry mucous membranes. His vital signs were normal, and he was afebrile.

Differential Dx:

- Altered mental status from metabolic, endocrine, infectious, toxicologic, or central nervous system pathology

Emergency Care: An EKG was performed and revealed a Brugada type pattern in leads V3-V5. He was significantly hypernatremic with a serum sodium of 169 mEq/L. Volume resuscitation was initiated with a normal saline infusion, and he was admitted to the hospital.

Outcome: The patient had a complex hospitalization, but his hypernatremia and altered mental status resolved. Interestingly, his EKG Brugada pattern resolved completely with correction of his hypernatremia. This can be classified as Brugada phenocopy.

Key Learning Points:

- A Brugada pattern describes the associated EKG abnormalities, while Brugada syndrome is the presence of both EKG abnormalities and clinical manifestations such as syncopal episodes. It is associated with sudden cardiac death.
- Brugada phenocopy is the electrocardiographic appearance of Brugada pattern that resolves with correction of underlying reversible (typically metabolic) conditions.

- Brugada phenocopy has been associated with hyperkalemia, Takotsubo cardiomyopathy, hyponatremia, hypophosphatemia, exercise, fever, balloon angioplasty, and hypothermia conditions.
- Brugada syndrome is an autosomal dominant genetic disorder characterized by a pseudo-right bundle block pattern with elevation of ST segments in a very characteristic cove back morphology in leads V1-V3. The cove back morphology can be described as a "shark-fin" appearance at the terminal end of the QRS.
- In 30% to 50% of the patients who die with documented Brugada syndrome, cardiac arrest was the first disease manisfestation.

Further Reading:

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Case 9-5

Osborne waves with hypothermia (two patients)

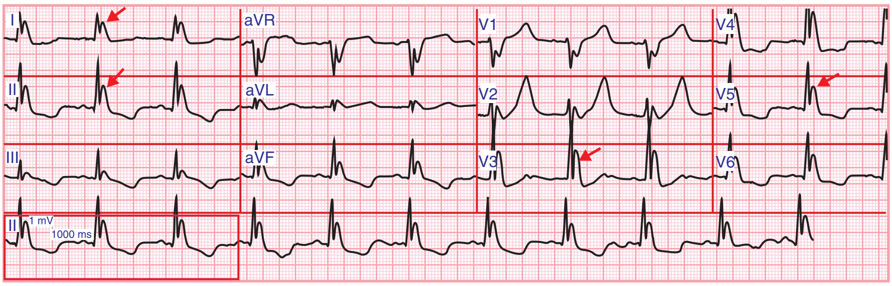

Figure 9-5. First patient. 12-lead electrocardiogram. RA = Osborne waves

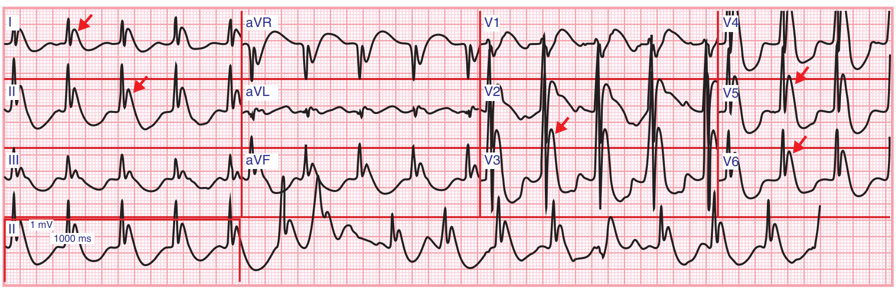

Figure 9-6. Second patient. 12-lead electrocardiogram. RA = Osborne waves

Patient Presentation: The first patient, a 41-year-old woman was found unresponsive with signs of head trauma. No other history was available. The second patient, a 41-year-old man was found outside and unresponsive on a cold winter night.

Clinical Features: Initial temperatures on the female and male patients were 28 °C (82.4 °F) and 26 °C (78.8 °F), respectively.

Differential Dx:

- Multiple trauma
- Hypothermia

Emergency Care: Both patients underwent rapid sequence intubation. Initial electrocardiograms showed Osborne waves. Shortly after ED arrival, both patients had a ventricular fibrillation cardiac arrest. The female patient had cardiopulmonary resuscitation using the Lund University Cardiopulmonary Assist System (LUCAS) for 70 minutes while being slowly rewarmed by conventional internal rewarming methods.

At 31°C (87.8°F), the patient had spontaneous return of a perfusing rhythm. The male patient received cardiopulmonary resuscitation and was taken immediately to the operating room for extracorporeal rewarming.

Outcome: Both patients had complex hospitalizations and made full neurologic recoveries.

Key Learning Points:

- The literature is replete with case reports of miraculous recovery from anoxic insult related to severe hypothermia. This includes a patient with an initial temperature of 13.8°C (56.8°F), a cold water submersion time of 83 minutes, and an initial serum potassium of 11.3 mmol/L.
- The height of the Osborne wave may or may not be predictive of the degree of hypothermia.
- The presence of Osborne waves and bradycardia on an electrocardiogram is strongly suggestive, but not pathognomonic, of severe hypothermia.

Further Reading:

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Case 9-6

Congenital prolonged QT syndrome

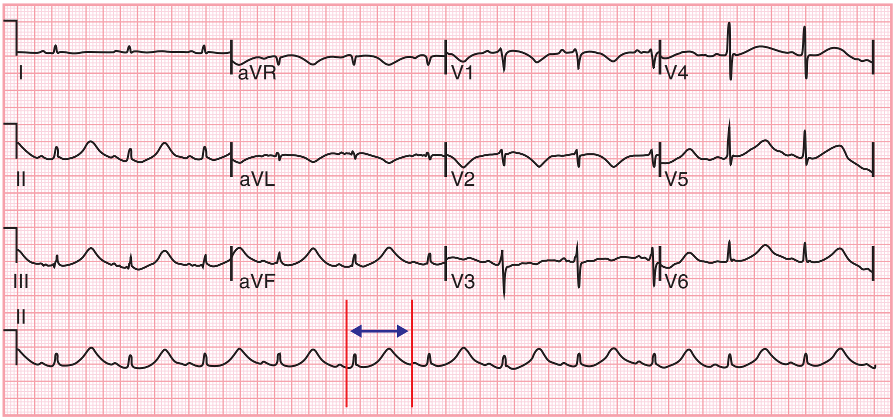

Figure 9-7. 12-lead electrocardiogram. Blue double arrow = prolonged QT interval

Patient Presentation: A 33-year-old woman presented to the ED stabilization room after suffering a sudden cardiac arrest. The initial rhythm in the field was ventricular fibrillation, and she received several doses of epinephrine and amiodarone with unsuccessful attempts at defibrillation. The patient had a long history of multiple syncopal and presyncopal episodes associated with her menses.

Clinical Features: The patient arrived in full cardiopulmonary arrest.

Differential Dx:
- Cardiac arrhythmia
- Brugada syndrome
- Prolonged QT syndrome
- Electrolyte or metabolic abnormality
- Pulmonary embolism

Emergency Care: Magnesium sulfate 2 g and lidocaine 100 mg were given IV followed by unsuccessful defibrillation. Alteplase 100 mg was given because of the possibility of massive pulmonary embolism. A bolus of esmolol for ventricular fibrillation electrical storm was administered, followed by successful defibrillation. A subsequent EKG performed several hours after the initial resuscitation demonstrated a markedly prolonged QT interval.

Outcome: Unfortunately, this young patient had a severe anoxic brain injury and did not survive.

Key Learning Points:

- Congenital long QT syndrome is a genetically mediated disease.
- The abnormal QT interval that causes the syndrome is variable depending on gender, heart rate, and genetic subtype. A corrected QT interval >480 is abnormal.
- Congenital long QT syndrome can have triggers, including facial immersion in cold water, or arousal events such as sudden loud noise, exercise, or strong emotion.
- ß-Blockers and automated internal cardiac defibrillators are the mainstays of treatment.
- There is an increased risk of symptoms from congenital long QT syndrome in the postpartum and menopausal time periods.
- There are numerous medications that can cause a prolonged QT interval, with associated morbidity and mortality, in the absence of the congenital syndrome.

Further Reading:

Barsheshet A, Dotsenko O, Goldenberg I. Genotype-specific risk stratification and management of patients with long QT syndrome. *Ann Noninvasive Electrocardiol.* 2013;18(6):499-509.

Beauregard LM. Incidence and management of arrhythmias in women. *J Gend Specif Med.* 2002;5(4):38-48.

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Van Laecke S, Vanholder R. Letter by Van Laecke and Vanholder regarding article, “Risk of recurrent cardiac events after onset of menopause in women with congenital long-QT syndrome types 1 and 2.” *Circulation*. 2012;125(1):e236.

Case 9-7

Atrial fibrillation and Wolff-Parkinson-White syndrome

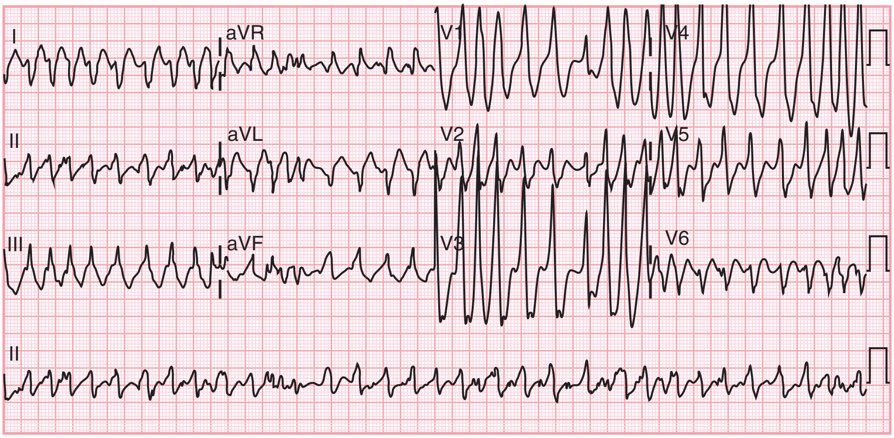

Figure 9-8. 12-lead electrocardiogram showing atrial fibrillation with wide QRS complexes and a rapid ventricular response

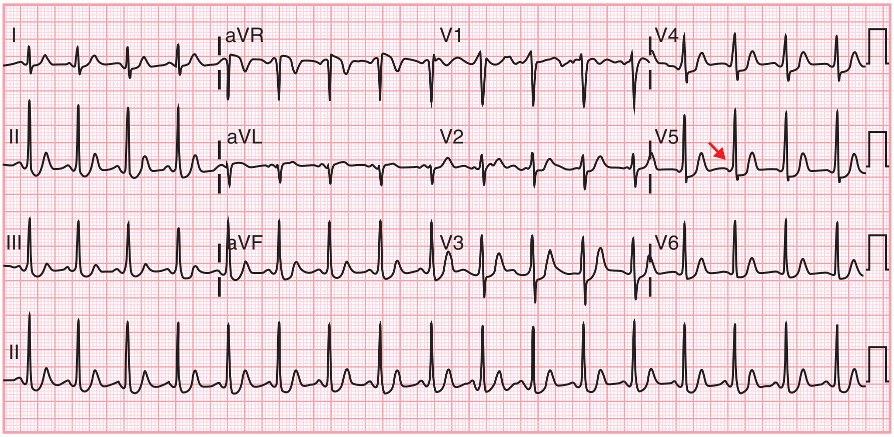

Figure 9-9. 12-lead electrocardiogram post synchronized cardioversion. RA = delta wave and short PR interval

Patient Presentation: A 21-year-old presented with a sudden onset of palpitations, diaphoresis, and presyncopal symptoms. The patient had no significant prior medical history.

Clinical Presentation: The patient was diaphoretic and had a systolic blood pressure of 90 mm Hg systolic and a heart rate over 200 beats/min.

Differential Dx:

- Arrhythmia secondary to primary cardiac abnormality, metabolic, toxicologic, or endocrine pathology
- Acute blood loss

Emergency Care: A 12-lead electrocardiogram demonstrated atrial fibrillation with wide QRS complexes. Given the clinical appearance of the patient, immediate synchronized cardioversion with 50 J under propofol sedation was performed resulting in a normal sinus rhythm. The post cardioversion electrocardiogram demonstrated a short PR interval and a delta wave indicative of a preexcitation pathway (Wolff-Parkinson-White [WPW] syndrome).

Outcome: An electrophysiology study was performed, and the patient had radiofrequency ablation of an accessory pathway.

Key Learning Points:

- WPW is uncommon.
- Atrial fibrillation occurs in 20% to 30% of patients with WPW and is not correlated with additional structural cardiac disease.
- Patients with WPW presenting in rapid atrial fibrillation without signs of shock can be treated with IV procainamide. Atrial nodal blocking medications are generally avoided because of the risk of precipitating ventricular fibrillation.
- Hemodynamically unstable WPW with atrial fibrillation necessitates synchronized cardioversion.

Further Reading:

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CHAPTER 10 Intriguing

Case 10-1

Marijuana analgesia for a finger injury

Patient Presentation: A young man presented for evaluation of a finger injury.

Clinical Features: The proximal interphalangeal joint was swollen and tender to palpation without any deformity. Finger abrasions with minor bleeding were noted. The finger was covered in a fine greenish organic substance which turned out to be marijuana. The patient had applied marijuana to his finger attempting to decrease the pain from his injury.

Figure 10-1. Finger coated with marijuana as a home remedy for a finger injury

Differential Dx:
- Fracture
- Sprain
- Contusion

Emergency Care: The marijuana was removed (but saved by the patient), and a radiograph was unremarkable. The patient was treated for a sprain of his proximal interphalangeal joint.

Key Learning Points:
- Transdermal marijuana has little systemic effect and no local anesthetic properties.

Further Reading:

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Tennstedt D, Saint-Remy A. Cannabis and skin diseases. *Eur J Dermatol*. 2011;21(1):5-11.

Woods JA, Wright NJ, Gee J, Scobey MW. Cannabinoid hyperemesis syndrome: an emerging drug-induced disease. *Am J Ther*. 2016;23(2):e601-e605.

Case 10-2

Near escape from restraints

Patient Presentation: A young man who was physically restrained presented to the emergency department (ED).

Clinical Features: The patient was agitated, combative, and an imminent danger to self and others.

Differential Dx:

- Psychiatric disease
- Toxicologic syndrome
- Central nervous system pathology

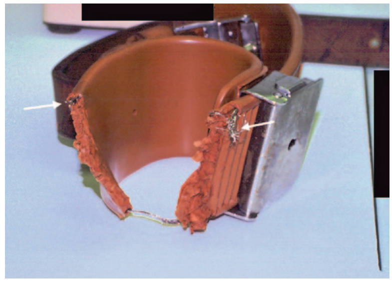

Figure 10-2. Physical restraints that had been chewed loose. WA = reinforcing wires

Emergency Care: The patient was restrained by hospital security using commercially produced, two-point, reinforced restraint devices (upper arm and contralateral leg), and his agitation required sedation. He settled down and became cooperative. However, he surreptitiously began to chew his way out of his restraints, including the reinforcing wires.

Outcome: The patient's escape attempt was recognized and thwarted.

Key Learning Points:

- Careful examination of a patient's clothing and body is necessary with patients who are a danger to themselves or to others. Items that can be a danger to the patient or healthcare providers may be hidden.
- It is important to visually observe restrained patients at frequent time intervals. Restraints are never a guarantee of incapacitation or safety for the patient or provider.
- Complications of physical restraints applied in the ED occurred in 20 out of 298 patients (7%) in one study. Half of those complications (10) were patients who escaped from their restraint.

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Zun LS. A prospective study of the complication rate of use of patient restraint in the emergency department. *J Emerg Med*. 2003;24(2):119-124.

Case 10-3

Personal supply of naloxone

Patient Presentation: Young adult presented with an altered mental status with no history available.

Clinical Features: The patient was minimally responsive with a markedly decreased respiratory effort and hypoxemic. His pupils were miotic. Needle track marks were noted on his upper extremities.

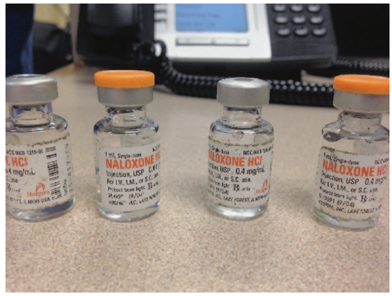

Figure 10-3. Four bottles of naloxone were found in a patient's clothing after presenting with an opioid overdose

Differential Dx:

- Metabolic, endocrine, toxicologic, central nervous system, trauma, infectious etiologies

Emergency Care: The patient's clothes were quickly removed, and four bottles of naloxone were retrieved from his pant pockets. The patient was given naloxone (not from his stash), and he made an immediate recovery. These bottles of naloxone were illegally obtained and were not part of any governmental or medical program distributing rescue naloxone.

Outcome: The patient was observed for several hours, did not require any additional doses of naloxone, and was discharge from the ED.

Key Learning Points:

- There is currently an epidemic of opioid-related overdose deaths in the United States.
- Naloxone can be administered many ways, including intravenously, sublingually, intranasally, intramuscularly, subcutaneously, intraosseously, and instilled into the lungs via an endotracheal tube.
- The U.S. Department of Health and Human Services (HHS) provides federal funding for naloxone rescue kits for distribution to high-risk individuals and first responders.

Further Reading:

Davis C, Carr D. State legal innovations to encourage naloxone dispensing. *J Am Pharm Assoc*. 2017;57(2S):S180-S184.

Faul M, Lurie P, Kinsman JM, et al. Multiple naloxone administrations among emergency medical service providers is increasing. *Prehosp Emerg Care*. 2017;1-8.

Jones CM, Muhuri PK, Lurie PG. Trends in the nonmedical use of oxycontin, United States, 2006 to 2013. *Clin J Pain*. 2017;33(5):452-461.

Martins SS, Sarvet A, Santaella-Tenorio J, et al. Changes in US lifetime heroin use and heroin use disorder: prevalence from the 2001-2002 to 2012-2013 National Epidemiologic Survey on Alcohol and Related Conditions. *JAMA Psychiatry*. 2017;74(5):445-455.

Osborn SR, Yu J, Williams B, Vasilyadis M, Blackmore CC. Changes in provider prescribing patterns after implementation of an emergency department prescription opioid policy. *J Emerg Med*. 2017;52(4):538-546.

Panther SG, Bray BS, White JR. The implementation of a naloxone rescue program in university students. *J Am Pharm Assoc*. 2017;57(2S):S107-S112.e2.

Vashishtha D, Mittal ML, Werb D. The North American opioid epidemic: current challenges and a call for treatment as prevention. *Harm Reduct J*. 2017;14(1):7.

Case 10-4

Pictorial medical and surgical history

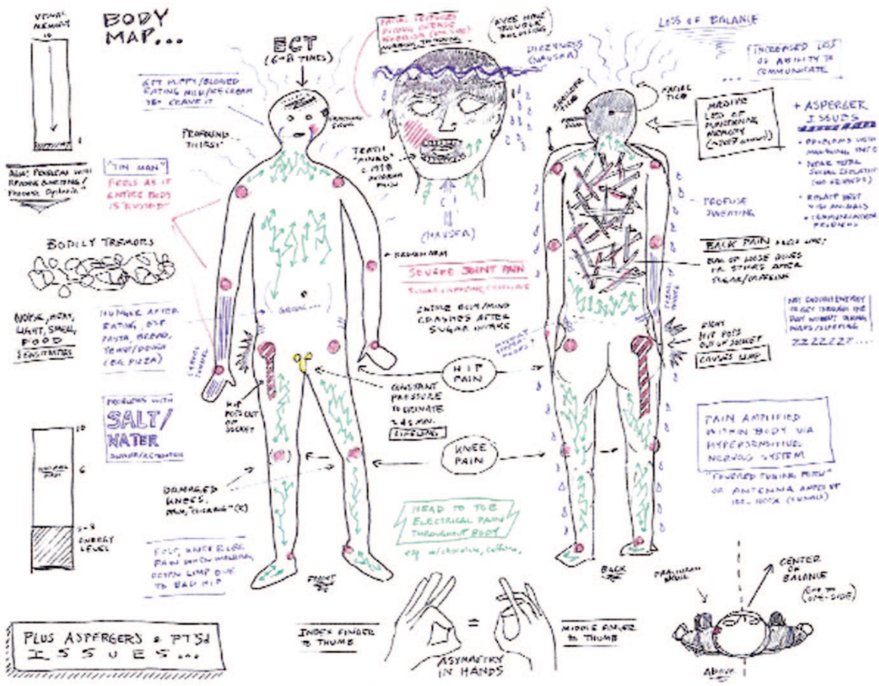

Figure 10-4. Pictorial illustration provided by a patient in response to a question about her past medical and surgical history

Patient Presentation: This middle-aged female patient presented with a benign complaint.

Clinical Features: During the historical interview, when asked about past medical history, the patient produced a self-illustrated pictorial history of her past and current medical conditions.

Key Learning Points:

- *"A picture is worth a thousand words."*

Further Reading:

Speakers give sound advice. *Syracuse Post Standard*. March 28, 1911:18.
One look is worth a thousand words. *Piqua Leader-Dispatch*. August 15, 1913:2.
Pictorial magazine of the war (advertisement). *San Antonio Light*. January 10, 1918:6.

Case 10-5

Gunshot wound to the nose

Patient Presentation: A young man presented for evaluation of a gunshot wound to the face. The patient had heard gunshots. He peeked around the corner of a building to visualize the scene, and was shot.

Figure 10-5. RA = through and through gunshot wound to the nose, WA = nasal packing

Clinical Features: The patient was in mild to moderate painful distress with a through and through gunshot wound to his nose.

Differential Dx:

- Obvious injury

Outcome: The epistaxis was controlled with bilateral anterior nasal packs, and the patient was lost to follow-up.

Key Learning Points:

- It is hard to decide if this injury was lucky or unlucky…
- *"No animal in the wild suddenly overcome with fear would spend any of its mental energy thinking, "It's probably nothing."*—Gavin de Becker, *The Gift of Fear*

Further Reading:

de Becker G. *The Gift of Fear: Survival Signals That Protect Us From Violence*. London: Bloomsbury Publishing; 2000.

Ozturk S, Zor F, Sengezer M. Nasal dorsum skin expansion for reconstruction of saddle nose due to gunshot injury: a case report. *Can J Plastic Surg.* 2005;13(3):148-150.

Pircher R, Preiß D, Pollak S, Thierauf-Emberger A, Perdekamp MG, Geisenberger D. The influence of the bullet shape on the width of abrasion collars and the size of gunshot entrance holes. *In J Leg Med.* 2017;131(2):441-445.

Rafailov VV, Andreeva IG, Plotnik IO. Penetrating gunshot wound with an injury to external nose bones and intranasal structures [in Russian]. *Vestn Otorinolaringol.* 2008;6:37-38.

Case 10-6

Coffee grinds used for hemostasis

Patient Presentation: A 28-year-old was washing dishes and sustained a laceration to the left index finger from broken glass.

Clinical Features: Most of the patient's finger had a thick coating of black coffee grinds which the patient had applied to stop the bleeding. It appeared to have worked as the wound was hemostatic on presentation.

Figure 10-6. Coffee grinds applied to a laceration to stop the bleeding

Differential Dx:
- Underlying tendon, vascular, joint, or nerve injury

Emergency Care: The coffee grinds were removed, and the simple laceration repaired without difficulty. The patient was lost to follow-up.

Key Learning Points:
- The authors could not find any references in the medical literature as to the utility of using coffee grinds for hemorrhage control, but the internet was full of references.

Further Reading:
Be Well Buzz. The many different uses for coffee grounds. Available at: https://www.bewellbuzz.com/wellness-buzz/coffee-grounds/. Accessed May 31, 2018.

Graedon J. Coffee grounds to stop bleeding. *The People's Pharmacy*. Available at: https://www.peoplespharmacy.com/2014/12/01/coffee-grounds-to-stop-bleeding/. Accessed May 31, 2018.

Case 10-7

A condom tourniquet

Patient Presentation: This young male patient presented after suffering a forearm stab wound during an assault at a bar. Another bar patron used a condom he was carrying as a proximal tourniquet.

Figure 10-7. This condom was used as a tourniquet to stop the bleeding from a stab wound to the forearm

Clinical Features: The patient had a single stab wound to the distal forearm with mild active hemorrhage. The condom was tied circumferentially at a site proximal to the stab wound.

Differential Dx:

- Vascular, nerve, or tendon injury

Emergency Care: The wound was explored. Minor arterial bleeding not requiring operative intervention was noted. No other significant injuries were discovered. The laceration was repaired, and the patient was discharged home.

Outcome: The patient was lost to subsequent follow-up.

Key Learning Points:

- Everyday objects can be utilized as a tourniquet. Belts, shoe strings, knotted clothes, and zip ties are perhaps the most commonly utilized. Condoms likely do not have the tensile strength to occlude major arteries.
- Tourniquets applied in the prehospital setting for major arterial or venous hemorrhage save lives.

Further Reading:

Callaway DW, Puciaty A, Robertson J, Hannon T, Fabiano SE. Case report: life saving application of commercial tourniquet in pediatric extremity hemorrhage. *Prehosp Emerg Care.* 2017;21(6):786-788.

El Sayed MJ, Tamim H, Mailhac A, Mann NC. Trends and predictors of limb tourniquet use by civilian emergency medical services in the United States. *Prehosp Emerg Care.* 2017;21(1):54-62.

King DR, Larentzakis A, Ramly EP. Tourniquet use at the Boston Marathon bombing: lost in translation. *J Trauma Acute Care Surg.* 2015;78(3):594-599.

Kragh JF, Dubick MA. Bleeding control with limb tourniquet use in the wilderness setting: review of science. *Wilderness Environ Med.* 2017;28(2S):S25-S32.

Kue RC, Temin ES, Weiner SG, et al. Tourniquet use in a civilian emergency medical services setting: a descriptive analysis of the Boston EMS experience. *Prehosp Emerg Care.* 2015;19(3):399-404.

Ode G, Studnek J, Seymour R, Bosse MJ, Hsu JR. Emergency tourniquets for civilians: can military lessons in extremity hemorrhage be translated? *J Trauma Acute Care Surg*. 2015;79(4):586-591.

Passos E, Dingley B, Smith A, et al. Tourniquet use for peripheral vascular injuries in the civilian setting. *Injury*. 2014;45(3):573-577.

Scerbo MH, Mumm JP, Gates K, et al. Safety and appropriateness of tourniquets in 105 civilians. *Prehosp Emerg Care*. 2016;20(6):712-722.

Case 10-8

Macaroni in the stomach

Patient Presentation: Patient presented with generalized abdominal pain.

Clinical Features: The abdominal examination was concerning for significant intraperitoneal pathology.

Differential Dx:

- Multiple intraperitoneal pathologic conditions

Emergency Care: Noncontrast abdominal CT scan showed no acute pathology. However, there was an unusual pattern noted in the stomach. This was caused by the ingestion of a significant amount of macaroni, likely the etiology for the patient's pain.

Outcome: The patient was treated symptomatically.

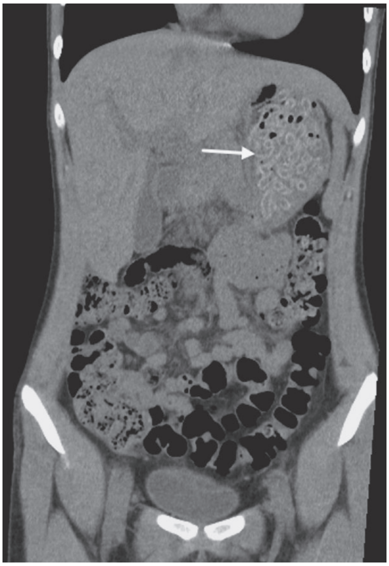

Figure 10-8. Noncontrast abdominal CT scan. WA = macaroni in the stomach

Key Learning Points:

- History taking, even in the high-tech world of diagnostic medicine, is still the king.
- My radiology consultant informed me that large amounts of macaroni in the stomach is a common finding.
- The CT scan appearance of the macaroni in this patient's stomach is uncooked and swallowed whole.

Case 10-9

Calcium carbonate tablets in the bowel

Patient Presentation: A 28-year-old presented with abdominal pain.

Clinical Features: The patient was afebrile and in mild painful distress. There was focal tenderness to palpation in the right lower quadrant.

Differential Dx:

- Appendicitis
- Urinary tract infection
- Renal colic
- Colitis
- Obstruction
- Referred pain

Figure 10-9. Contrast-enhanced abdominal CT scan. WA = calcium carbonate tablets

Emergency Care: History and physical examination was concerning for appendicitis, and a contrast-enhanced abdominal CT scan was performed. High-density material was noted in the right lower quadrant. On further questioning, it was revealed that the patient, attempting to relieve his abdominal pain, had swallowed many intact tablets of calcium carbonate, which were clearly visualized on the CT scan.

Outcome: The patient was lost to follow-up.

Key Learning Points:

- Iron-containing preparations, calcium carbonate, iodinated compounds, acetazolamide, busulfan, and potassium preparations are generally radiopaque.
- The presence of enteric coating on pills does not necessarily make them radiopaque.

Further Reading:

Judge BS, Hoyle JD. Incidental discovery of radiopaque pills on abdominal CT in a patient with abdominal pain. *Clin Toxicol (Phila)*. 2008;46(6):574-575.

Savitt DL, Hawkins HH, Roberts JR. The radiopacity of ingested medications. *Ann Emerg Med*. 1987;16(3):331-339.

Case 10-10

Lemonade substituted for urine

Patient Presentation: An 18-year-old woman presented with lower abdominal pain.

Clinical Features: The patient was afebrile and well appearing. Abdominal examination was unimpressive, with a mild amount of suprapubic tenderness to palpation. The patient's friend accompanying her in the examination room was noted to be drinking a can of lemonade.

Figure 10-10. A urinalysis cup filled with lemonade

Differential Dx:
- Urinary tract infection
- Pregnancy
- Large or small bowel pathology
- Pelvic pathology within the uterus or adnexa

Emergency Care: The patient did not consent to pelvic examination. A urinalysis and urinary pregnancy test were ordered, but the patient stated she did not have the urge to urinate. Several glasses of water and juice were provided to the patient without success in providing a urine sample. The patient, growing impatient, told me she was going to leave without providing the urine sample. I explained to her that it was important we test for urinary infection and for pregnancy, and I would check in on her in 20 minutes to see if she was able to provide a urine sample. Within a couple of minutes the nurse handed me a urine specimen cup filled with odd-looking urine. The nurse stated the patient had gone into the bathroom, provided the sample to the nurse, and left the department. It had the same color and smell as lemonade.

Outcome: The lemonade was sterile, and the pregnancy test was negative.

Key Learning Points:
- Never underestimate the mind of a teenager.
- Lemonade therapy can be utilized for the treatment of hypocitraturic nephrolithiasis.

Further Reading:

Kang DE, Sur RL, Haleblian GE, Fitzsimons NJ, Borawski KM, Preminger GM. Long-term lemonade based dietary manipulation in patients with hypocitraturic nephrolithiasis. *J Urology*. 2007;177(4):1358.

Odvina CV. Comparative value of orange juice versus lemonade in reducing stone-forming risk. *Clin J Am Soc Nephrol*. 2006;1(6):1269-1274.

Penniston KL, Steele TH, Nakada SY. Lemonade therapy increases urinary citrate and urine volumes in patients with recurrent calcium oxalate stone formation. *Urology*. 2007;70(5):856-860.

Zuckerman JM, Assimos DG. Hypocitraturia: pathophysiology and medical management. *Rev Urol*. 2009;11(3):134-144.

Case 10-11

A misplaced band aid

Patient Presentation: A young, non–English-speaking patient presented with a simple hand laceration. His last tetanus booster was 12 years ago.

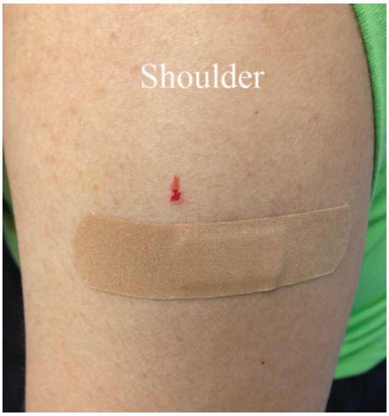

Figure 10-11. A bandaid not applied over the tetanus injection site

Clinical Features: Simple hand laceration with no other complications.

Differential Dx:

- Tendon, nerve, vascular, joint injury

Emergency Care: The laceration was repaired without difficulty. I placed an order for a tetanus booster. Shortly thereafter, I went into the patient room with the interpreter to give discharge instructions, and he was pleasantly and sheepishly smiling at me. He glanced down to his left upper arm, and then I understood his facial expression. The nurse had given him his tetanus booster, but had misplaced the bandaid …. We had a good doctor–patient chuckle.

Outcome: The patient was lost to follow-up after ED discharge.

Key Learning Points:

- Pay attention to details and to anatomy.

Case 10-12

Bilateral long finger subungual hematomas

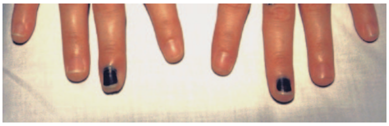

Figure 10-12. Bilateral long finger subungual hematomas

Patient Presentation: A young woman presented with bilateral long finger pain after a window that was being pulled down crushed both fingers. The patient had appropriate self-deprecating humor, noting the oddity of having identical injuries on both long fingers from the same traumatic event.

Clinical Features: Bilateral subungual hematomas were present without finger deformity or other open wounds.

Differential Dx:
- Finger fracture
- Nail-bed injury
- Subungual hematoma

Emergency Care: Radiographs were negative for fracture. The patient underwent bilateral subungual hematoma drainage via nail trephination.

Outcome: The patient was discharged and lost to follow-up.

Key Learning Points:
- Nail trephination for subungual hematoma drainage is generally done when the injury is less than 48 hours old.
- Digital anesthesia is not needed if done carefully and without placing external pressure on the distal fingertip.
- Simple trephination of a subungual hematoma, even in the presence of a fingertip fracture, provides excellent pain reduction and obviates the need for removal of the nail plate and repair of a nailbed laceration.
- Complications of the procedure include onycholysis, nail deformity, nail loss, and infection.

Further Reading:
Gellman H. Fingertip-nail bed injuries in children: current concepts and controversies of treatment. *J Craniofac Surg*. 2009;20(4):1033-1035.

Patel L. Management of simple nail bed lacerations and subungual hematomas in the emergency department. *Pediatr Emerg Care*. 2014;30(10):742-745.

Seaberg DC, Angelos WJ, Paris PM. Treatment of subungual hematomas with nail trephination: a prospective study. *Am J Emerg Med*. 1991;9(3):209-210.

Watkins KG. Treatment of subungual hematoma. *Am Family Phys*. 2002;65(10):1997.

Case 10-13

The Santa Claus burglar

Patient Presentation: A 34-year-old man presented on Christmas morning at 8:00 A.M. The paramedic radio report indicated the patient attempted to gain access to a property for the purposes of burglary by sliding down a chimney. He became stuck in the chimney and was entrapped for several hours. His precarious position was fortuitously discovered by the property owner who heard screaming coming from inside the wall. The chimney was accessed by the fire department via punching a large hole in the wall. The patient was found naked in the chimney. The patient complained of shortness of breath.

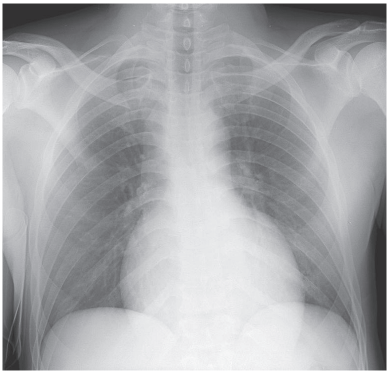

Figure 10-13. Chest x-ray. Increased interstitial markings consistent with inhalation injury

Clinical Features: The patient was covered in soot and was in mild respiratory distress with hypoxia.

Differential Dx:

- Inhalation injury

Emergency Care: The patient's respiratory distress responded to mask oxygen. A chest radiograph demonstrated increased interstitial lung marking consistent with inhalation injury.

Outcome: The patient was admitted to the hospital. He developed mild rhabdomyolysis that was treated with intravenous fluids. His pulmonary injury resolved.

Key Learning Points:

- The author took the radio call from this incoming ambulance. Until the ambulance transporting the patient arrived, it was presumed the paramedics were playing a joke on the ED.
- Professional "chimney sweeps" are at an increased risk for symptoms including chronic productive cough, increased rates of lung and esophageal cancer, and ischemic cardiac disease.

Further Reading:

Hansen ES. Chest symptoms in chimney sweeps and postmen—a comparative survey. *Int J Epidemiol.* 1990;19(2):339-342.

Hansen ES. Mortality from cancer and ischemic heart disease in Danish chimney sweeps: a five-year follow-up. *Am J Epidemiol.* 1983;117(2):160-164.

Hogstedt C, Andersson K, Frenning B, Gustavsson A. A cohort study on mortality among long-time employed Swedish chimney sweeps. *Scand J Work Environ Health.* 1982;8(suppl 1):72-78.

Case 10-14

Ultrasound reverberation artifact

Patient Presentation: This is a young woman who presented with lower abdominal pain and was concerned she might be pregnant.

Clinical Features: This patient was well appearing, in no painful distress, and hemodynamically stable. Abdominal examination revealed minor tenderness to palpation suprapubically and bilateral lower quadrants without any peritoneal signs. Pelvic examination was unremarkable.

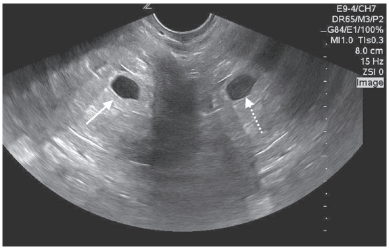

Figure 10-14. Pelvic ultrasound. WA = actual gestational sac, WDA = reverberation artifact

Differential Dx:

- Pregnancy
- Threatened spontaneous abortion
- Ectopic pregnancy
- Urinary infection
- Pelvic inflammatory disease

Emergency Care: A urinary pregnancy test was positive. A bedside ED ultrasound was performed and initially was very confusing. There appeared to be two gestational sacs. This raised concern for heterotopic pregnancy. After further review, it was determined that there was a software malfunction, and the anechoic sac on the left was the real gestational sac, and the other was a reverberation artifact.

Outcome: No specific pathology was discovered, and the patient was discharged and lost to follow-up.

Key Learning Points:

- If your first initial impression of any medical imaging test is confusion because something just does not look right, it is time to take a step back and figure out why. Careful analysis and deliberation in your reading of the image will likely reveal the issue.

Further Reading:

Ahn H, Hernández-Andrade E, Romero R, et al. Mirror artifacts in obstetric ultrasound: case presentation of a ghost twin during the second-trimester ultrasound scan. *Fetal Diagn Ther*. 2013;34(4):248-252.

Malhotra R, Bramante RM, Radomski M, Nelson M. Mirror image artifact mimicking heterotopic pregnancy on transvaginal ultrasound: case series. *West J Emerg Med*. 2014;15(6):712-714.

Rubin JM, Gao J, Hetel K, Min R. Duplication images in vascular sonography. *J Ultrasound Med*. 2010;29(10):1385-1390.

Case 10-15

Interesting patient request in the ED triage nurse note

Emergency Department

Triage Nurse Assessment

Chief Complaint:
"I want a depo shot and a panic attack"

Figure 10-15. Verbatim response of a patient as to why she came to the ED

Patient Presentation: A young woman presented with two requests.

Clinical Features: The patient was in no painful distress and was well appearing.

Emergency Care: Figure 10-15 is a reproduction of the ED nurse's note in our electronic medical record. The patient's requests have quotation marks, presumably a direct patient quote.

Outcome: We referred the patient to the OB/GYN clinic for her "depo shot," but we did not provide her with a "panic attack."

Key Learning Points:

- The author's career spanned the invention, introduction, and complete adoption of the electronic medical record. It has been, to say the least, an interesting evolution in the provision of medical care.

Further Reading:

Burley D. Better communication in the emergency department. *Emerg Nurse.* 2011;19(2):32-36.

Herrick DB, Nakhasi A, Nelson B, et al. Usability characteristics of self-administered computer-assisted interviewing in the emergency department: factors affecting ease of use, efficiency, and entry error. *Appl Clin Inform*. 2013;4(2):276-292.

Case 10-16

Patient marking his territory with urine

Emergency Department

Initial Staff Nurse Note

Patient presents for evaluation of mental status change...Patient is currently manic. Speech is organized...Patient immediately urinated himself on the 3 walls of the exam room. When asked why, he responded that "*I'm just marking my territory.*"

Figure 10-16. Verbatim response of a patient who was asked why he urinated on three walls of his examination room

Patient Presentation: A 42-year-old man presented with an altered mental status.

Clinical Features: Almost immediately after being placed in his ED examination room, the patient walked around the room and urinated on three of the walls. When asked by the nurse why he did that, his answer, documented in the nurse's note above was "just marking my territory."

Differential Dx:

- Psychiatric disease
- Central nervous system disease
- Metabolic, endocrine, urinary, or infectious pathology

Emergency Care: Diagnostic workup did not reveal any acute medical conditions.

Outcome: The patient was transferred to acute psychiatric services for further evaluation.

Key Learning Points:

- Paruresis is a psychiatric condition that describes a social phobia of urinating in public bathrooms.
- This patient did not have paruresis.

Further Reading:

Park H, Kim D, Jang EY, Bae H. Desensitization of triggers and urge reduction for paruresis: a case report. *Psychiatry Investig.* 2106;13(1):161-163.

Case 10-17

"I'm not sexually active, I'm married."

PARAMEDIC RUN SHEET

History of Present Illness/Injury

Abdominal pain began 1 week ago, intermittent. Today is worse.
Complains of pain when urinating. Vomited one today
Denies Pregnancy stating "I'm Not Sexually Active, I'm Married."

Past Medical History

None

Physical Examination

BP 134/palp, HR 80, RR 24
Good color, skin dry and warm
Alert and oriented
No respiratory distress
Mild lower abdominal tenderness

Figure 10-17. Verbatim response of a patient to a paramedic question of "Are you sexually active?"

Case Information: A young woman called 911 for abdominal pain. Some might find the documentation on the ambulance run sheet humorous. In response to the paramedic question of the possibility of pregnancy, the patient responded "I'm not sexually active. I'm married."

Case 10-18

A very long list of allergies

Allergy List

A
Acetaminophen
Albuterol
Aldactone
Amitriptyline
Aminophylline
Antihistamines
Amlodipine
Aspartame
Avlox

B
Benadryl
Bioxin

C
Caffeine
Capoten
Captopril
Caraco
Carafate
Ceftin
Celebrex
Cephalexin
Chemet
Cimetadine
Clinoril
Codeine
Compazine
Contrast Dye
Cortisone
Cytomel

D
Diazepam
Diphenhydramine
Donnatal

E
Ecotrin
EES
ERCY
Erythromycin
Erythrum

F
Feldene

G
Glytamate
Guaifenesin
Gatafloxacin

H
Halcion

I, J, K
Ibuprofen
Klonopin

L
Lasix
Lopressor
Lotrel

M
Mellaril
Monosodium
MSG
Morphine
Motrin
Moxefloxacin

N
Naprosen
Naprosyn
Naproxen
Nitroglycerine
Nitrous Oxide
Nitrostat
Norvasc
Novacaine

P
Pamelor
Penicillin
Phenobarbitol
Phenylalanine
Prednisone
Propulsid
Prilosec
Prozac

Q
Quadsenial

R
Robitussin Green
Robitussin PE
RXN Dye

S
Serentil
Sodium Nitrate
Synthroid

T
Tagamet
Tedrol
Theophylline
Tofranil
Triazolam
Tylenol #3
Tyramine

V,W,X,Y,Z
Valium
Vanconase
Vasotec
Yellow Dye
Zantac

Other
Milk
Tobacco

Med Combo's
Halcion
Klonopin
Prozac
Serentil
Tofranil

Figure 10-18. List of medications produced by a patient when asked for her allergy history

Patient Presentation: A 50-year-old presented for evaluation of multiple complaints.

Clinical Features: The patient was well appearing.

Differential Dx:
- Long and vast

Emergency Care: The examining physician asked the patient about allergies. The patient removed from her purse a seven-page, alphabetized list of allergies. Figure 10-18 reveals the first page listing nearly 100 medications. In the remaining six pages, each medication had a detailed paragraph on the clinical features associated with each specific allergic reaction.

Outcome: The patient was lost to follow-up.

Key Learning Points:
- Somatization disorder plays a significant role in some patients with extensive and exhaustive drug allergy or drug intolerance lists.

Further Reading:

Bailer J, Witthöft M, Paul C, Bayerl C, Rist F. Evidence for overlap between idiopathic environmental intolerance and somatoform disorders. *Psychosom Med*. 2005;67(6):921-929.

Crayton JW. Adverse reactions to foods: relevance to psychiatric disorders. *J Allergy Clin Immunol*. 1986;78(1 pt 2):243-250.

Feldman KW, Stout JW, Inglis AF. Asthma, allergy, and sinopulmonary disease in pediatric condition falsification. *Child Maltreat*. 2002;7(2):125-131.

Hassel JC, Danner D, Hassel AJ. Psychosomatic or allergic symptoms? High levels for somatization in patients with drug intolerance. *J Dermatol*. 2011;38(10):959-965.

Hausteiner-Wiehle C, Sokollu F. Magical thinking in somatoform disorders: an exploratory study among patients with suspected allergies. *Psychopathology*. 2011;44(5):283-288.

Robbins NM, Larimer P, Bourgeois JA, Lowenstein DH. Number of patient-reported allergies helps distinguish epilepsy from psychogenic nonepileptic seizures. *Epilepsy Behav*. 2016;55:174-177.

Case 10-19

A positive Throckmorton sign

Patient Presentation: A 17-year-old who felt a sudden and very painful "pop" in his lateral hip area while running.

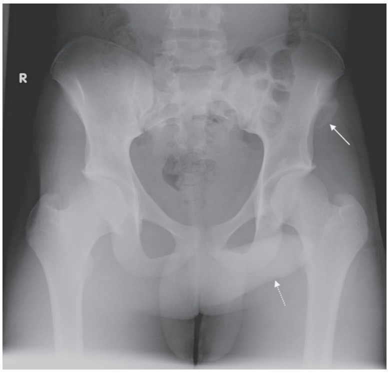

Figure 10-19. Pelvis x-ray. WA = avulsion fracture of the left anterior superior iliac spine, WDA = penis

Clinical Features: The patient was in mild to moderate painful distress. There was swelling and tenderness to palpation over his left anterior superior iliac spine. He could ambulate with significant pain.

Differential Dx:

- Tendon, muscle, ligament injury
- Avulsion fracture

Emergency Care: A pelvic radiograph demonstrated two findings. There is an avulsion fracture of his anterior superior iliac spine. There is also a positive "Throckmorton" sign, ie, the penis pointing to the side of the injury.

Outcome: The patient was treated with crutches and weight-bearing as tolerated.

Key Learning Points:

- Avulsion of the anterior superior iliac spine is caused by sudden contraction of the sartorius and tensor fascia latae muscles that insert at this location. Running with forceful hip extension is the typical mechanism of injury.
- The infamous "Throckmorton" sign is also known as the "John Thomas" sign. It is a slang medical term in which the penis projects radiographically toward the side of the pathology. It is attributed to Dr. Tom Bentley Throckmorton, an American neurologist. The term "John Thomas" is a British euphemism for a penis, likely the explanation and origin of the British version of this radiographic finding.

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CHAPTER 11 Ophthalmology

Case 11-1

Autoenucleation

Patient Presentation: A young patient presented with alcoholic hallucinosis. The patient had reportedly autoenucleated his eye.

Clinical Features: The patient had an obvious enucleation of his eye.

Differential Dx:
- Altered mental status secondary to toxicologic exposure
- Central nervous system disorder
- Metabolic or endocrine disorder
- Psychiatric disease

Figure 11-1. Autoenucleated eye

Emergency Care: The patient had no other injuries and was admitted to the hospital for further management of his self-enucleation and alcoholic hallucinosis.

Outcome: This patient was lost to follow-up.

Key Learning Points:
- Alcohol hallucinosis develops 12 to 24 hours after the last alcohol ingestion, generally lasts 1 to 2 days, and the hallucinations are most often visual, although auditory and tactile hallucinations can also occur.
- Alcohol hallucinosis is not related to delirium tremens.
- Patients maintain a clear sensorium, and thus they are aware they are experiencing hallucinations.
- Autoenucleation is most common in the context of significant psychiatric disease.

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Zhang M, Tanaka S, Mercier M, et al. Gender and racial disparities in cases of autoenucleation. *Semin Ophthalmol*. 2016;31(4):415-425.

Case 11-2

High-pressure injection of air into the orbit

Patient Presentation: A 3-year-old child accidentally injected her orbit with a high-pressure air hose.

Clinical Features: The patient had a markedly swollen left periorbital area. Subcutaneous emphysema could be palpated.

Differential Dx:
- Ocular injury
- Intracranial injury

Emergency Care: The patient underwent a noncontrast head computed tomography (CT) scan that revealed air within the orbit as well as pneumocephaly.

Outcome: The patient was admitted to the hospital for observation and treated with antibiotics. There were no operative interventions, and the patient was discharged home.

Key Learning Points:
- Tension orbital emphysema leading to orbital compartment syndrome with loss of vision from increased ocular pressure requires decompression. This can be initially accomplished with either emergent lateral canthotomy or needle aspiration of the air with a syringe.
- While orbital emphysema is common from facial trauma with fractures involving the sinuses, tension orbital emphysema requiring decompression is rare.
- See Case 11-3, Figure 11-4.

Figure 11-2. Left periorbital swelling with palpable subcutaneous emphysema

Figure 11-3. Noncontrast head CT scan (bone windows). WA = orbital air, WDA = pneumocephaly

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Case 11-3

Needle aspiration of orbital air

Patient Presentation: A young man presented for evaluation of facial injuries after being punched in the face. He was complaining of right periorbital pain.

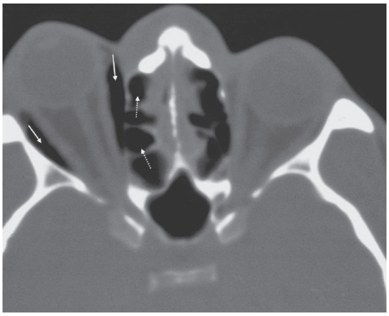

Figure 11-4. Non-contrast head CT scan (bone windows). WA = orbital air, WDA = ethmoid sinus

Clinical Features: Facial examination revealed a right periorbital hematoma with swelling and ecchymosis without any open wounds. Proptosis was present, along with conjunctival chemosis. The pupil was mid position and sluggish to light. Visual acuity was markedly diminished compared to the uninjured eye. Intraocular pressure was 30 mm Hg in the right eye. There was palpable subcutaneous emphysema contributing to the periorbital swelling.

Differential Dx:
- Retrobulbar hematoma
- Orbital fractures
- Extraocular muscle entrapment
- Retinal detachment
- Optic nerve injury
- Vitreal hemorrhage
- Acute glaucoma
- Lens detachment
- Ruptured globe

Emergency Care: A facial CT scan revealed a significant amount of orbital air with proptosis. The air most likely came from a fracture through his ethmoid sinus. There was no retrobulbar hematoma, and the proptosis and decreased vision was thought to be due to increased intraocular pressure from the entrapped orbital air. The ophthalmology service was consulted, and they emergently aspirated the orbital air with a needle and syringe.

Outcome: The patients intraocular pressure normalized, and his vision returned to baseline. No further acute management was required.

Key Learning Points:
- Post traumatic orbital emphysema is generally related to medial and/or orbital floor fractures into the maxillary or ethmoid sinuses.
- Tension orbital emphysema leading to orbital compartment syndrome with loss of vision from increased ocular pressure requires decompression accomplished initially with emergent lateral canthotomy and canthal tendon lysis, and/or needle aspiration.

- It should be noted that the presence of proptosis, decreased vision and elevated intraocular pressures in the setting of trauma should be diagnosed clinically as a likely retrobulbar hematoma, and emergent therapy should not await the confirmation of the diagnosis by CT scan. Tension orbital emphysema is rare, but retrobulbar hematoma is not. Needle aspiration for retrobulbar hematoma will likely not be successful, and a lateral canthal tendon release should be the emergent treatment of choice in this condition.

Further Reading:

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Case 11-4

Orbital apex syndrome

Patient Presentation: A 51-year-old presented with nontraumatic acute ocular swelling and pain in his right eye that started 24 hours prior to emergency department (ED) arrival.

Clinical Features: The patient was in moderate painful distress. Proptosis and chemosis were present, and visual acuity was markedly reduced. Pupils were 3 mm bilaterally and reactive. Intraocular pressure of the right eye was 59 mm Hg.

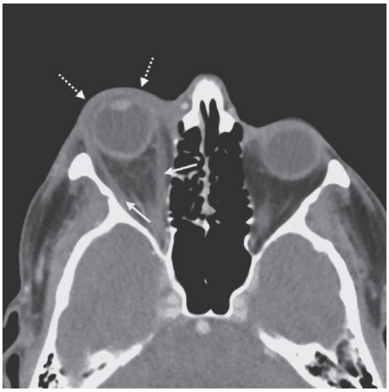

Figure 11-5. Contrast-enhanced head CT scan. WA = inflammatory changes, WDA = proptosis

Differential Dx:

- Orbital cellulitis and/or orbital abscess
- Cavernous sinus thrombosis
- Arteriovenous (AV) fistula

Emergency Care: Contrast-enhanced orbital CT scan demonstrated proptosis and marked inflammatory changes initially thought consistent with orbital cellulitis without abscess. Acetazolamide was given PO, and brimonidine and dorzolamide/timolol were administered topically to reduce intraocular pressure. Methylprednisolone 1 g was given IV. Ceftriaxone and vancomycin were administered for treatment of infection. His intraocular pressure did not decline, and ED bedside lateral canthotomy and cantholysis were performed.

Outcome: The patient was taken emergently to the operating room for surgical decompression when medical therapy and lateral canthotomy and cantholysis were unsuccessful. Significant inflammatory changes were encountered, but cultures and biopsies were negative for infection. The patient was continued on antibiotics and high-dose steroids. The patient developed a cavernous sinus thrombosis, which was thought to be a consequence, rather than a cause, of the problem, and consequently the patient was anticoagulated. An AV fistula was the presumed etiology for the final diagnosis of orbital apex syndrome in this patient. Unfortunately, despite his intraocular pressure normalizing, he had no light perception in the involved eye.

Key Learning Points:

- Visual loss from optic neuropathy and ophthalmoplegia involving multiple cranial nerves are the hallmarks of an orbital apex syndrome.
- Causes of orbital apex syndrome include infection, hemorrhage, cavernous sinus thrombosis, tumor, trauma, and AV fistula.

Further Reading:

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Case 11-5

Retrobulbar hematoma

Patient Presentation: A 51-year-old presented with altered mental status after closed head trauma sustained from a fall. The patient was taking warfarin for a mechanical aortic valve.

Clinical Features: Vital signs were normal, but the patient had an altered mental status without focal findings. There was a left periorbital contusion associated with proptosis. The patient was clinically intoxicated with alcohol and visual acuity could not be obtained.

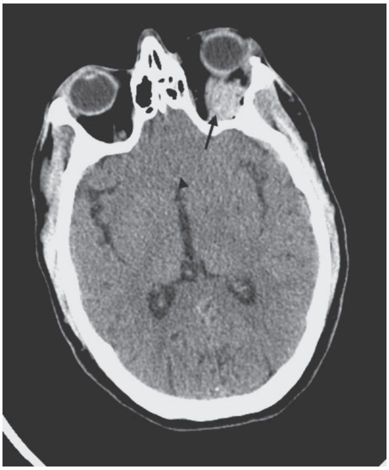

Figure 11-6. Noncontrast head CT scan. BA = retrobulbar hematoma with proptosis

Differential Dx:
- Intracranial traumatic injury
- Retrobulbar hematoma
- Globe injury
- Facial fractures
- Cervical spine injury

Emergency Care: A noncontrast head CT scan demonstrated a retrobulbar hematoma with resultant proptosis. There also was a small left subdural hematoma and bleeding overlying the tentorium. Intraocular pressure of the left eye was 37 mm Hg. A lateral canthotomy without cantholysis was performed with intraocular pressure decreasing to 25 mm Hg. The patient had reversal of his anticoagulation with vitamin K, fresh frozen plasma, and prothrombin complex concentrate. The patient was admitted to the hospital.

Outcome: The patient made a full recovery from his ocular injury.

Key Learning Points:
- Orbital compartment syndrome caused by retrobulbar hematoma is an ocular emergency.
- The diagnosis of orbital compartment syndrome is a clinical one with proptosis, decreased visual acuity, and elevated intraocular pressure present. Emergent treatment should not await confirmatory medical imaging studies.
- Lateral canthotomy and inferior cantholysis are emergency procedures that should be performed in the ED.
- Lateral canthotomy without cantholysis can occasionally reduce orbital pressure sufficiently, but inferior cantholysis is generally required for the appropriate reduction of orbital pressure.

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Case 11-6

Retained pencil graphite in orbit

Patient Presentation: A pediatric patient presented for repair of a laceration to her left upper eyelid suffered in an accidental fall. The patient had been seen running with a pencil prior to her injury.

Clinical Features: The patient was alert and in mild pain. Examination revealed a laceration to her left upper eyelid. Her ocular examination was otherwise unremarkable.

Differential Dx:
- Eyelid laceration from blunt trauma
- Ocular penetrating injury
- Intracranial penetrating injury

Emergency Care: The parents produced the pencil in question. The tip was broken off flush with the wood. A noncontrast head CT scan revealed the tip of the pencil and orbital air.

Outcome: The patient underwent operative exploration with removal of the foreign body. There was no ocular injury, and the patient was discharged without complication.

Key Learning Points:
- Innocuous-appearing eyelid lacerations can have significant underlying penetrating ocular and intracranial injury.
- If the exact mechanism of an eyelid laceration is unknown, medical imaging should be considered for evaluation of a penetrating injury.
- Pencils are made of wood and graphite. Failure to diagnose retained ocular pencil fragments can lead to vision-threatening complications.

Figure 11-7. Laceration to the left upper eyelid

Figure 11-8. Pencil with graphite tip broken

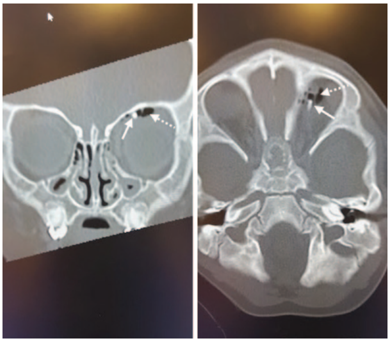

Figure 11-9. Noncontrast head CT scan. WA = retained graphite tip of pencil, WDA = orbital air

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Case 11-7

Infant hit with baseball at Major League Baseball game

Patient Presentation: An 8-month-old infant was hit in the face by a batted baseball at a Major League Baseball (MLB) game. The infant cried immediately, and there was no loss of consciousness.

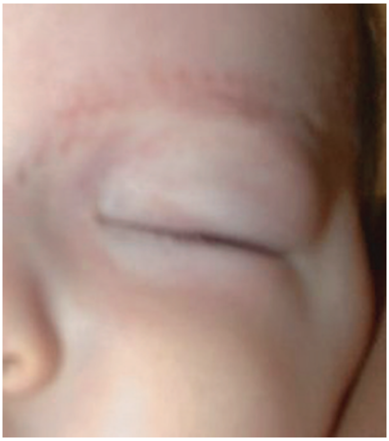

Figure 11-10. Imprinted baseball laces just above the left eyebrow

Clinical Features: The infant had a normal mental status. The imprint of the baseball's laces could be clearly visualized just above the left eyebrow.

Differential Dx:
- Intracranial injury
- Skull or facial fractures
- Ocular injury

Emergency Care: The infant was sedated with midazolam, and a noncontrast head CT scan demonstrated a large left parietotemporal bone skull fracture and a nondisplaced left lateral orbital wall fracture. No intracranial injury was visualized.

Outcome: The patient was admitted to the hospital for serial neurologic examinations and was discharged 1 day later.

Key Learning Points:
- Over 1,700 fans per year are injured by a foul ball or flying bat at MLB games. Most injuries are minor.
- An average of 35 to 40 foul balls enter the spectator stands per MLB game.
- Significant injury to spectators from errant baseballs does occur, but death is distinctly rare.
- The MLB recommended distance of protective netting for fans at baseball games is 70 ft. Foul balls can travel at speeds exceeding 100 mph. This would leave spectators a fraction of a second to react to an incoming baseball at a distance just beyond the protective netting.

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Case 11-8

Pseudotumor cerebri

Patient Presentation: A 24-year-old woman with previously diagnosed pseudotumor cerebri presented with a headache. The headache started 1 week prior, was constant in nature, and was associated with blurry vision, nausea, and vomiting. Her last episode of headache was 3 years prior, at which time she had a lumbar puncture with therapeutic cerebral spinal fluid removal.

Clinical Features: Vital signs and neurologic examination were normal. The patient was in moderate painful distress with a throbbing, bilateral headache.

Differential Dx: Headache has many possible etiologies, including vascular, subarachnoid hemorrhage, tumor, infectious, and tension. In this patient, pseudotumor cerebri was first on the differential diagnosis.

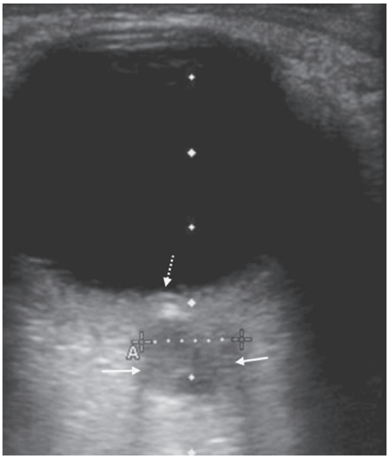

Figure 11-11. Ocular ultrasound. WA = optic nerve sheath diameter measured at 6.7 mm, WDA = elevated optic nerve head

Emergency Care: A head CT scan was performed and unremarkable. A bedside ED ocular ultrasound was performed and demonstrated an abnormally widened optic nerve sheath diameter measuring 6.7 mm (normal <6.0 mm). An elevated optic nerve head could also be visualized. A lumbar puncture was performed, with opening pressure measured at 50 cm H_2O. Approximately 25 cc of cerebral spinal fluid (CSF) was removed, and CSF pressure was reduced to 25 cm H_2O with marked improvement in her headache. The patient was admitted to the hospital.

Outcome: The patient was started on acetazolamide. The ophthalmology service was consulted and discovered many fixation deficits and an enlarged blind spot that improved but did not resolve with therapy.

Key Learning Points:

- The most common symptoms of pseudotumor cerebri are headache, visual obscurations, tinnitus, and photopsia.
- The most common signs are papilledema, visual field defects, and sixth cranial nerve palsy.
- Bedside ED ocular ultrasound can be used for assessment of static and dynamic changes associated with elevated intracranial pressure. Optic nerve sheath diameter equal or greater than 6 mm is highly suggestive of increased intracranial pressure.
- Elevated opening CSF pressure is consistent with intracranial hypertension.

- Medical treatment includes acetazolamide and possibly furosemide.
- Serial lumbar puncture with CSF removal is only temporizing and is not a good long-term solution.
- Optic nerve sheath fenestration, CSF shunting procedures, and venous sinus stenting are the main surgical options available.

Further Reading:

Bauerle J, Nedelmann M. Sonographic assessment of the optic nerve sheath in idiopathic intracranial hypertension. *J Neurol*. 2011;258(11):2014-2019.

Daulaire S, Fine L, Salmon M, et al. Ultrasound assessment of optic disc edema in patients with headache. *Am J Emerg Med*. 2012;30(8):1654.e1-e4.

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Case 11-9

Potato gun ocular injury

Patient Presentation: This is a patient who presented for evaluation of head, facial, and ocular injury after being shot with a "potato gun."

Clinical Features: The patient was awake, neurologically intact, and in moderate painful distress. There was an upper eyelid laceration and significant periorbital and orbital swelling, with no visualization or examination of the eye possible.

Differential Dx:
- Intracranial injury
- Ocular injury
- Facial fractures

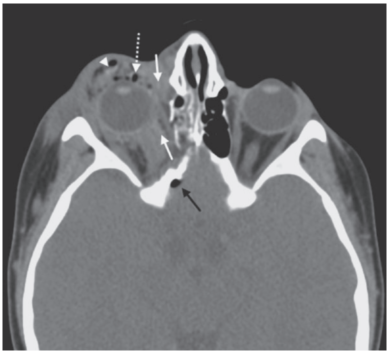

Figure 11-12. Noncontrast head CT scan. BA = pneumocephaly, WA = hemorrhage, WAH = foreign body (potato), WDA = orbital air

Emergency Care: The patient was treated for significant pain. A noncontrast head CT scan showed multiple orbital wall fractures, herniation of inferior rectus muscle through the inferior orbital wall, significant hemorrhage, swelling along the optic nerve, foreign body, and orbital emphysema. There was intracranial injury with frontal lobe contusions, subarachnoid hemorrhage, and pneumocephaly. The patient was taken to the operating room.

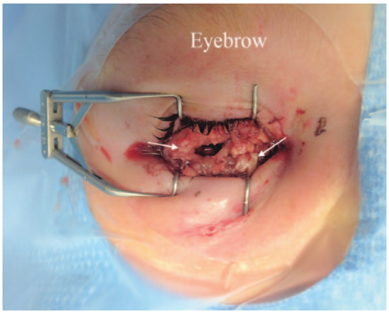

Figure 11-13. Operative photo of potato gun injury

Outcome: Intraoperatively, a significant amount of potato was noted in the orbit. The potato pieces were removed, and an iridodialysis, vitreous hemorrhage, and subretinal hemorrhage were identified. Amazingly, the globe was intact. Unfortunately, the patient suffered a severe ocular injury and had light perception only at the time of last follow-up.

Key Learning Points:
- Searching the internet will reveal step-by-step instructions on how to build potato guns of varying sizes and strengths.

Further Reading:

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Case 11-10

Bilateral posterior lens dislocations

Patient Presentation: A 71-year-old presented to an outside hospital for evaluation of injuries after a motor vehicle crash. She was sedated, intubated, and transported to our facility. A head CT scan performed prior to transport revealed multiple facial fractures involving the orbits, but no intracranial pathology.

Clinical Features: There was significant swelling and contusions of the entire face, including bilateral periorbital contusions. Examination of the eyes revealed bilateral dilated pupils with sluggish reaction to light and a left hyphema.

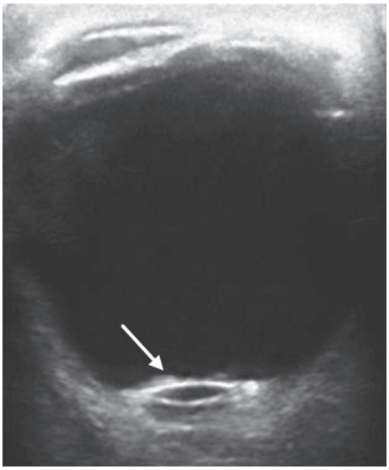

Figure 11-14. Ocular ultrasound (right eye). WA = lens in posterior vitreous

Differential Dx:

- The bilateral mydriasis and sluggish pupillary responses to light suggested traumatic optic neuropathy, retinal injury, vitreal hemorrhage, or traumatic mydriasis.

Emergency Care: Bedside ED ocular ultrasound demonstrated bilateral lens dislocations and a left vitreous hemorrhage. Review of the outside head CT scan confirmed bilateral lens dislocation. Direct ophthalmoscopy revealed a right preretinal hemorrhage. Intraocular pressures were 19 mm Hg bilaterally. The patient was admitted for further management of her facial and ocular injuries.

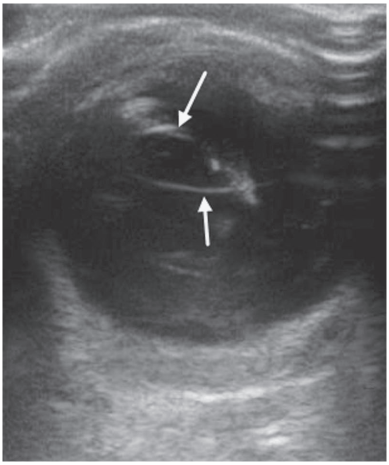

Figure 11-15. Ocular ultrasound (left eye). WA = lens dislocation

Outcome: The patient underwent open reduction and internal fixation of her extensive facial fractures. The left hyphema cleared without complication. Ophthalmology followed the patient throughout the course of her hospitalization, and no operative ocular procedures were performed. Last recorded visual acuity was count fingers and 20/400 using a +10 lens of the right eye, and hand motion only with no improvement using a +10 lens of the left eye. The patient was lost to follow-up post hospital discharge as her ocular injuries were subsequently managed at another facility.

Key Learning Points:

- Bedside ED ocular ultrasound can provide useful diagnostic ocular information.
- Retinal detachment, vitreous hemorrhage, foreign bodies, and lens dislocations are generally readily visualized injuries using ocular ultrasound.
- Use of bedside ocular ultrasound in the setting of possible globe rupture or perforation is controversial secondary to the concern of applying pressure to the injured globe with the probe and worsening the injury. Recent data demonstrate an average increase of 1.8 mm Hg in intraocular pressure while ocular ultrasound is being performed on healthy subjects, lessening this concern. If ocular ultrasound is performed in the setting of ocular trauma, care must be taken to exert as little pressure on the globe as possible by using a large amount of ultrasound gel and avoiding physical contact between the ultrasound probe and the eyelids.

Figure 11-16. Noncontrast head CT scan. WA = lens in posterior vitreous of right eye

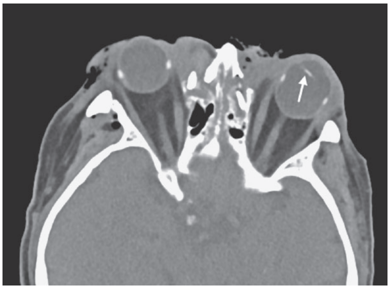

Figure 11-17. Noncontrast head CT scan. WA = left lens dislocation

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Case 11-11

Ocular ultrasound and central retinal artery occlusion

Patient Presentation: Elderly patient presented with acute, nontraumatic, and painless visual loss in one eye. The patient had no other complaints.

Clinical Features: The patient had a markedly decreased visual acuity with detection of light and hand movement only from the involved eye.

Differential Dx:
- Central retinal artery occlusion
- Central retinal venous occlusion
- Retinal detachment
- Optic nerve pathology

Emergency Care: Physical examination revealed an afferent pupillary defect in the involved eye. Bedside ED ultrasound of the normal eye demonstrated retinal artery blood flow within the optic sheath and arterial pulsations. Ultrasound examination of the involved eye revealed lack of arterial blood flow and no defined arterial pulsations.

Outcome: The patient was emergently treated with hyperbaric oxygenation therapy, followed by admission to the hospital for further neurologic and ophthalmologic evaluation.

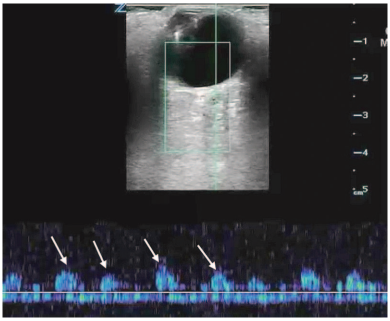

Figure 11-18. Ocular ultrasound of noninvolved eye with Doppler flow. WA = normal arterial pulsations of the central retinal artery

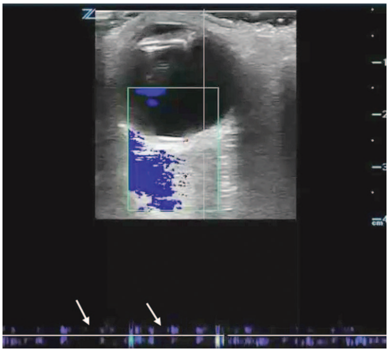

Figure 11-19. Ocular ultrasound of involved eye with doppler flow. WA = absent normal pulsations of the central retinal artery

Key Learning Points:
- There is substantial recent literature on the utility of ED ocular ultrasound for diagnosis of retinal detachment, vitreous hemorrhage, lens dislocation, foreign body, and central retinal artery occlusion.
- Hyperbaric oxygenation therapy for central retinal artery occlusion holds promise as an initial therapeutic intervention for this disease with a previously uniformly poor outcome.

Further Reading:

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CHAPTER 12 Orthopedics

Case 12-1

Osteogenesis imperfecta

Patient Presentation: A 7-year-old fell from a low height while playing on monkey bars. The patient was complaining of low back pain. The patient had a history of three previous fractures: a tibial fracture, distal femur fracture, and a metatarsal fracture. Blue sclera had been noted in past physical examinations, but no formal diagnosis of osteogenesis imperfecta had been made.

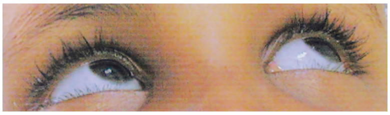

Figure 12-1. Blue sclera

Clinical Features: The patient had focal tenderness to palpation of the lower thoracic and upper lumbar spine with no deformity noted. Neurologic examination revealed intact sensation and motor function to the lower extremities. Of note, the sclera had a bluish tinge.

Differential Dx:

- Musculoskeletal injury to the axial skeleton, including fractures, contusions, and sprain

Emergency Care: X-ray with lateral view of the lumbar spine revealed compression fractures to T12, L1, and L2. The patient's pain was managed with analgesics.

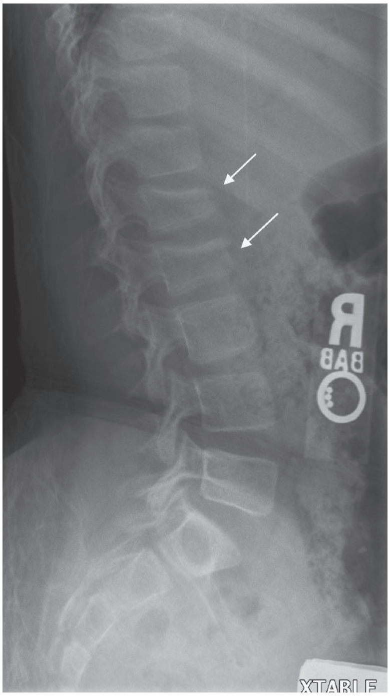

Figure 12-2. Lumbar spine x-ray. WA = compression fractures

Outcome: The patient was admitted to the hospital. The fractures were thought to be stable, and the patient was fitted with a TLSO brace. The patient was then referred to an outside institution for genetic testing and counseling for osteogenesis imperfecta.

Key Learning Points:

- The patient had a history of three fractures following relatively minor injuries, and now presented with vertebral compression fractures at 7 years of age. Blue

sclera, coupled with the fracture history, makes the clinical diagnosis of osteogenesis imperfecta likely.
- There are other diseases that can lead to multiple fractures in children, including child abuse, rickets, osteomalacia, and numerous other skeletal syndromes causing bone fragility.

Further Reading:

Forlino A, Marini JC. Osteogenesis imperfecta [Review]. *Lancet.* 2016;387(10028):1657-1671.

Harrington J, Sochett E, Howard A. Update on the evaluation and treatment of osteogenesis imperfecta [review]. *Pediatr Clin North Am.* 2014;61(6):1243-1257.

Korula S, Titmuss AT, Biggin A, Munns CF. A practical approach to children with recurrent fractures [review]. *Endocr Dev.* 2015;28:210-225.

Case 12-2

Osteopoikilosis

Patient Presentation: A young patient presented with lower leg trauma.

Clinical Features: There was focal tenderness to palpation of the anterior lower tibia associated with mild swelling but without skin abnormalities or bony deformity.

Differential Dx:
- Tibial fracture
- Lower leg contusion

Emergency Care: A tibia-fibula radiograph did not show any acute bony injury, but it did demonstrate an incidental finding of punctate sclerotic foci consistent with osteopoikilosis. The patient was treated symptomatically for a contusion.

Outcome: No further follow-up was obtained.

Key Learning Points:
- Buschke-Ollendorff syndrome is a rare, autosomal-dominant disorder characterized by the presence of sclerotic bone lesions (osteopoikilosis).
- The sclerotic bone lesions are foci of thickened trabeculae of lamellar bone. It is similar to that of bone islands.
- Connective tissue nevi may or may not be associated with this syndrome.
- It is important to differentiate this from osteoblastic bone metastasis.
- No therapy is required.

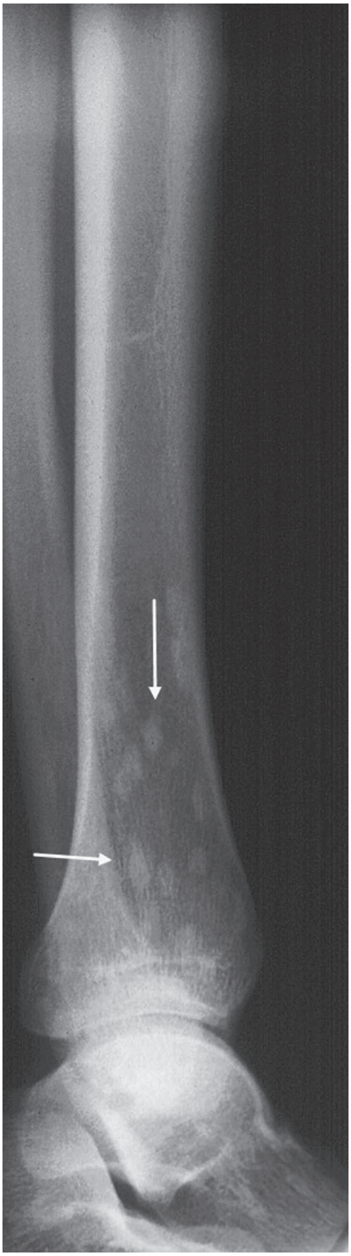

Figure 12-3. Tibia x-ray. WA = punctate sclerotic foci

Further Reading:

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Enokihara MM, Seize MB, Marcassi AP, Piazza CA, Cestari SD. Elastoma: clinical and histopathological aspects of a rare disease. *An Bras Dermatol*. 2016;91(5 suppl 1): 39-41.

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Case 12-3

Vacuum sign

Patient Presentation: Young adult presented with right shoulder pain after a fall.

Clinical Features: The patient was in mild painful distress, with tenderness to palpation over the humeral head. There were no open wounds, no bony deformity, but range of motion was decreased secondary to pain.

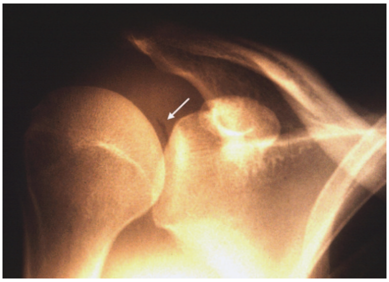

Figure 12-4. Shoulder x-ray. WA = vacuum sign

Differential Dx:

- Fracture
- Dislocation
- Soft tissue injury including rotator cuff
- Contusion

Emergency Care: A right shoulder radiograph was obtained. An incidental finding of curvilinear air in the glenohumeral joint space consistent with a "vacuum sign" was discovered. The patient was treated symptomatically for a contusion.

Outcome: No further follow-up was obtained.

Key Learning Points:

- The "vacuum sign" of the glenohumeral joint is a relatively common variant finding.
- It needs to be recognized as a normal variant and not as an indication of joint pathology such as abnormal intra-articular air from a penetrating joint injury or septic process.

Further Reading:

Ito H, Yoshikawa T, Hayashi N, et al. MDCT demonstration of intraarticular gas in the glenohumeral joint and sternoclavicular joint with reference to arm position. *Radiat Med.* 2008;26(7):422-426.

Patten RM. Vacuum phenomenon: a potential pitfall in the interpretation of gradient-recalled-echo MR Figures of the shoulder. *AJR Am J Roentgenol.* 1994;162(6):1383-1386.

Case 12-4

Severe pelvic injury and fetal demise

Patient Presentation: A young woman presented after a motor vehicle crash.

Clinical Features: This patient presented with multiple traumatic injuries and was unable to provide any history.

Differential Dx:

- Multiple traumatic injuries

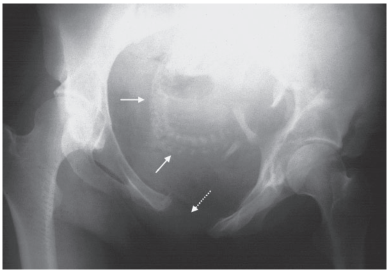

Figure 12-5. Pelvis x-ray. WA = fetus, WDA = widened symphysis pubis

Emergency Care: The patient had a pelvis radiograph that demonstrated a fetus and a pelvic ring injury with an associated widened symphysis pubis.

Outcome: Unfortunately, the mother suffered a spontaneous abortion due to blunt trauma to the pelvis.

Key Learning Points:

- A part of the focused assessment with sonography in trauma (FAST) assessment, the uterus should be imaged in all women of childbearing age.

Further Reading:

Ali J, Yeo A, Gana TJ, McLellan BA. Predictors of fetal mortality in pregnant trauma patients. *J Trauma*. 1997;42(5):782-785.

Amorosa LF, Amorosa JH, Wellman DS, Lorich DG, Helfet DL. Management of pelvic injuries in pregnancy. *Orthop Clin North Am*. 2013;44(3):301.

Lo BM, Downs EJ, Dooley JC. Open-book pelvic fracture in late pregnancy. *Pediatr Emerg Care*. 2009;25(9):586-587.

Occelli B, Depret-Mosser S, Renault B, Therby D, Codaccioni X, Monnier JC. Pelvic trauma and pregnancy. Literature review and case report [in French]. *Contracept Fertil Sex*. 1998;26(12):869-875.

Pape HC, Pohlemann T, Gänsslen A, Simon R, Koch C, Tscherne H. Pelvic fractures in pregnant multiple trauma patients. *J Orthop Trauma*. 2000;14(4):238-244.

Case 12-5

Talus dislocation

Patient Presentation: A young man involved in a motor vehicle crash presented with ankle pain.

Clinical Features: The patient was in moderate to severe painful distress and had a closed deformity of the right ankle with no associated vascular compromise.

Differential Dx:

- Fracture, dislocation, or both

Emergency Care: The patient received analgesia, and an ankle radiograph demonstrated a closed talus dislocation.

Outcome: This patient was lost to follow-up.

Key Learning Points:

- Closed dislocation of the talus without fracture is a rare injury and may be complicated by talar avascular necrosis.

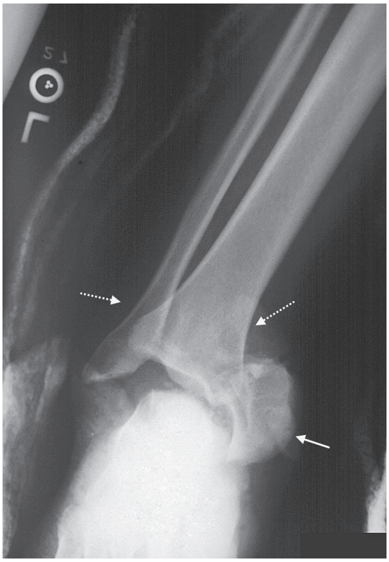

Figure 12-6. Ankle x-ray. WA = talus, WDA = tibia and fibula

Further Reading:

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Rhanim A, Zanati RE, Younes O, Hassani ZA, Kharmaz M, Berrada MS. Nonoperative treatment of closed total talus dislocation without fracture: a case report and literature review. *J Clin Orthop Trauma*. 2014;5(3):172-175.

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Case 12-6

Fat embolism

Patient Presentation: This patient presented after a motor vehicle crash complaining of thigh pain.

Clinical Features: The patient was in moderate painful distress with a closed deformity of the mid-thigh. Distal vascular examination was normal.

Figure 12-7. Photo of abdomen. RA = reddish-brown petechial rash

Differential Dx:
- Femur fracture
- Soft tissue injury
- Vascular, tendon, ligament, or nerve injury

Emergency Care: The patient had hare traction splinting of his femur and was admitted to the orthopedic service for definitive treatment.

Outcome: Two days after admission the patient had a sudden alteration in mental status associated with significant hypoxia. A reddish-brown petechial rash developed over large areas of his skin. The patient was clinically diagnosed with a fat embolism syndrome and received supportive care with resolution within several days.

Key Learning Points:
- Fat embolism is most commonly associated with long bone and pelvic fractures.
- The exact etiology and mechanism is unknown.
- The classic presentation is respiratory distress, neurologic abnormality, and a petechial rash appearing 48 hours post injury, on average.
- There is no specific treatment.
- Most patients spontaneously recover within a week.

Further Reading:

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Tsai I, Hsu CJ, Chen YH, Fong YC, Hsu HC, Tsai CH. Fat embolism syndrome in long bone fracture—clinical experience in a tertiary referral center in Taiwan. *J Chin Med Assoc*. 2010;73(8):407-410.

Case 12-7

Air in the knee joint

Patient Presentation: A 13-year-old presented for evaluation of a laceration over her knee.

Clinical Features: There was a 2 cm laceration over the anteromedial patella. No joint fluid was visualized within the laceration.

Differential Dx:

- Joint involvement of the laceration, bony, ligamentous, or tendon injury

Emergency Care: A lateral knee radiograph demonstrated the knee joint perfectly outlined with intra-articular air, indicative of laceration extension into the knee joint.

Outcome: The patient was taken to the operating room for a washout procedure of her knee joint with laceration repair. The patient recovered without complication.

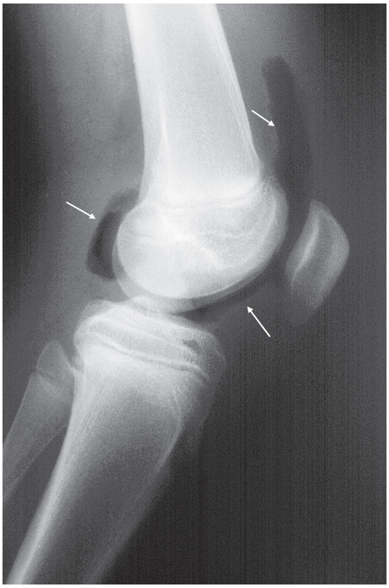

Figure 12-8. Knee x-ray. WA = air outlining the knee joint

Key Learning Points:

- Joint involvement of penetrating injury can be difficult to diagnosis clinically, especially with small lacerations making local exploration difficult.
- Any amount of air found in the joint by medical imaging is diagnostic for articular involvement in the setting of penetrating injury.
- The saline load test, ie, injecting the knee joint and looking for extravasation out of the laceration has been used historically for diagnosis.
- A knee computed tomography (CT) scan appears to be a more sensitive test for diagnosis of traumatic arthrotomies than the saline load test.

Further Reading:

Konda SR, Davidovitch RI, Egol KA. Computed tomography scan to detect traumatic arthrotomies and identify periarticular wounds not requiring surgical intervention: an improvement over the saline load test. *J Orthop Trauma*. 2013;27(9):498-504.

Konda SR, Davidovitch RI, Egol KA. Open knee joint injuries—an evidence-based approach to management. *Bull Hosp Joint Dis*. 2014;72(1):61-69.

Metzger P, Carney J, Kuhn K, Booher K, Mazurek M. Sensitivity of the saline load test with and without methylene blue dye in the diagnosis of artificial traumatic knee arthrotomies. *J Orthop Trauma*. 2012;26(6):347-349.

Nord RM, Quach T, Walsh M, Pereira D, Tejwani NC. Detection of traumatic arthrotomy of the knee using the saline solution load test. *J Bone Joint Surg*. 2009;91(1):66-70.

Case 12-8

Soft tissue chondroma with an unusual aspiration

Patient Presentation: A 42-year-old presented with a swollen and painful foot. Onset of symptoms was several months prior with gradual worsening, and there had been no trauma.

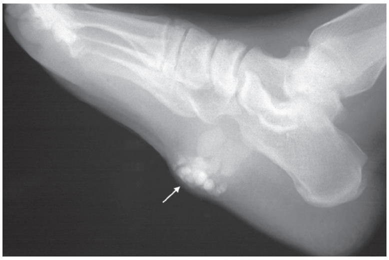

Figure 12-9. Foot x-ray. WA = multiple calcific densities

Clinical Features: The medial plantar instep was swollen and extremely tender to palpation. There was no erythema or warmth, but there was fluctuance.

Differential Dx:

- Abscess
- Cellulitis
- Foreign body
- Occult trauma

Emergency Care: A lateral foot radiograph demonstrated a soft tissue mass with multiple calcific densities. During needle aspiration of the fluctuant area, a thick, white, nonpurulent, milk-like substance was found. Magnetic resonance imaging (MRI) was obtained that revealed a well-contained lesion extrinsic to the plantar fascia, muscles, and bony contours of the left foot. This was felt to represent a benign soft tissue chondroma with inflammation.

Outcome: The patient was referred to an outside specialty center and was lost to follow-up.

Key Learning Points:

- A chondroma is a slow-growing, benign, cartilaginous tumor that is almost always associated with bone.
- Chondromas not associated with bone are quite rare and are called soft tissue chondromas.
- Treatment of a soft tissue chondroma is total excision.

Further Reading:

Ando K, Goto Y, Hirabayashi N, Matsumoto Y, Ohashi M. Cutaneous cartilaginous tumor. *Dermatol Surg.* 1995;21(4):339-341.

Batalla A, Suh-Oh HJ, Pardavila R, de la Torre C. True cutaneous chondroma: a case report. *J Cutan Pathol*. 2015;42(9):657-659.

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Hsueh S, Santa Cruz DJ. Cartilaginous lesions of the skin and superficial soft tissue. *J Cutan Pathol*. 1982;9(6):405-416.

Case 12-9

Unusual complication of a prosthetic hip dislocation reduction

Patient Presentation: A 76-year-old presented with hip pain. The patient had a history of a right total hip arthroplasty 1 year prior to presentation.

Clinical Features: The patient was in moderate painful distress. The right leg was shortened and internally rotated with inability to actively move the hip joint.

Differential Dx:
- Dislocated prosthetic hip
- Fracture

Emergency Care: A pelvic radiograph demonstrated a dislocation of the right hip prosthesis with the prosthetic femoral head and taper component connected but outside of the acetabular component. The patient underwent conscious sedation and reduction of the hip without difficulty. A postreduction radiograph revealed separation of the prosthetic femoral head from the taper component. The taper component appeared to be within the acetabular component. The patient was taken to the operating room for revision of her prosthesis.

Outcome: The patient made an uneventful recovery.

Key Learning Points:
- Fractures of the shaft prosthesis are most often attributed to loosening of the cement; they are infrequently due to a manufacturing fault in the prosthetic shaft.

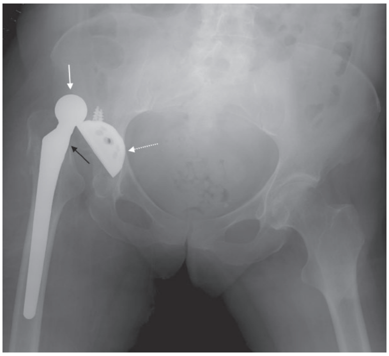

Figure 12-10. Pelvis x-ray with dislocation of prosthetic joint. BA = taper component, WA = femoral head, WDA = acetabular cup

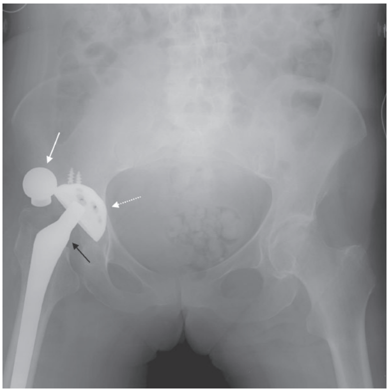

Figure 12-11. Pelvis x-ray post reduction attempt. BA = taper component in acetabular cup, WA = femoral head separated from taper component, WDA = acetabular cup

Further Reading:

Drobniewski M, Sibiński M, Plebański R, Synder M. Breakage of the prosthesis steam as a rare complication of total hip replacement [in Polish]. *Chir Narzadow Ruchu Ortop Pol*. 2010;75(1):53-56.

Von Salis-Soglio G, Thomas W, Haasters J, Bensmann G. Hip endoprosthesis shaft fractures—a clinical and technological material study [in German]. *Z Orthop Ihre Grenzgeb*. 1983;121(1):74-80.

Case 12-10

Rudimentary pelvic rib

Patient Presentation: A young patient presented complaining of hip and pelvic pain after being in a motor vehicle crash.

Clinical Features: The patient was awake with minor pain.

Differential Dx:

- Traumatic injury to the pelvis, hip, or proximal femur

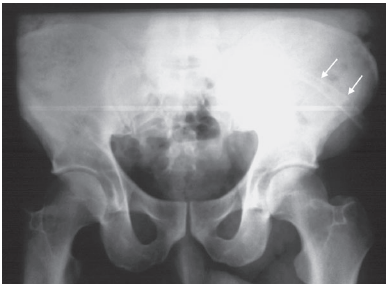

Figure 12-12. Pelvis x-ray. WA = rudimentary pelvic rib

Emergency Care: A pelvis radiograph was performed that demonstrated no acute traumatic injury but did have an unusual finding of a rudimentary pelvic rib.

Outcome: The patient was treated symptomatically for a minor contusion.

Key Learning Points:

- Variant rib locations include the cervical spine and pelvis.
- Pelvic accessory ribs are rare.
- Accessory ribs are most often discovered as incidental radiographic findings, although they can elicit symptoms depending on size and location.

Further Reading:

Apaydin M, Sarsilmaz A, Varer M. Third accessory (supernumerary) intrathoracic right rib. *Surg Radiol Anat*. 2009;31(8):641-643.

Bohutova J, Kolár J, Vítovec J, Vyhnánek L. Accessory caudal axial and pelvic ribs. *Rofo*. 1980;133(6):641-643.

Dunaway CL, Williams JP, Brogdon BG. Case report 222. Sacral and coccygeal supernumerary ribs (pelvic ribs). *Skeletal Radiol*. 1983;9(3):212-214.

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Case 12-11

Dislocated shoulder prosthesis and mid-shaft humeral fracture

Patient Presentation: A 71-year-old with extensive comorbid medical conditions presented with right arm pain after a fall. The patient had a history of right humeral fracture and subsequent right shoulder prosthesis.

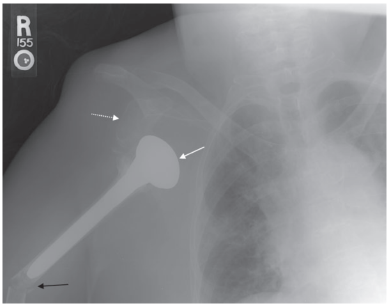

Figure 12-13. Shoulder x-ray. BA = fracture of humerus, WA = anterior dislocation of shoulder joint prosthesis, WDA = empty glenoid fossa

Clinical Features: The patient was in moderate painful distress. Vascular and neurologic function was intact distally, with marked decrease in range of motion secondary to pain. There was a closed deformity of the right mid-upper arm.

Differential Dx:
- Fracture
- Dislocation
- Soft tissue injury

Emergency Care: A shoulder radiograph demonstrated a shoulder prosthesis that was known to be chronically dislocated from the glenoid as well as a new fracture of the humerus adjacent to the inferior tip of humeral prosthesis.

Outcome: The patient was not a surgical candidate due to comorbid medical conditions. The chronic dislocation was not intervened upon, and the new fracture was treated in closed fashion.

Key Learning Points:
- Fractures immediately below medullary prosthetic shafts are relatively common.
- Chronic native shoulder dislocations are also common.
- Humerus fractures below the stem in a chronically dislocated shoulder prosthesis are uncommon.

Further Reading:
Goga IE. Chronic shoulder dislocations. *J Shoulder Elbow Surg*. 2003;12(5):446-450.

Rowe CR, Zarins B. Chronic unreduced dislocations of the shoulder. *J Bone Joint Surg Am*. 1982;64(4):494-505.

Zych GA, Montane I. Acute fracture of the proximal humerus superimposed on a chronic posterior dislocation of the humeral head. *South Med J*. 1987;80(10):1307-1308.

Case 12-12

Scapular osteochondroma

Patient Presentation: A 28-year-old presented complaining of a painful lump on her back. No recent or remote trauma had occurred.

Clinical Features: The patient had a mass involving her right scapula that was mildly tender to palpation. There was no erythema or warmth.

Differential Dx:
- Benign or malignant tumor
- Abscess
- Cyst

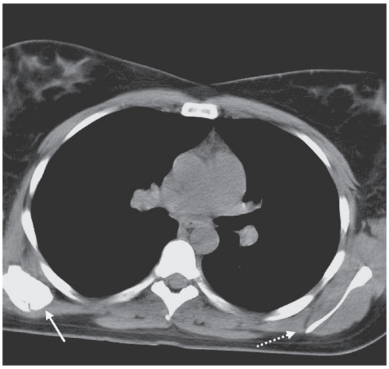

Figure 12-14. Noncontrast chest CT scan. WA = osteochondroma of the right scapula, WDA = normal scapula

Emergency Care: A noncontrast chest CT scan demonstrated a benign osteochondroma arising from the anterior surface of the right scapula, compared to the normal left scapula.

Outcome: The patient was treated conservatively with orthopedic follow-up.

Key Learning Points:
- Osteochondromas are common benign tumors arising from cartilage associated with bone.
- The distal femur and proximal humerus are the two most common locations.
- The presence of multiple chondromas may indicate the diagnosis of hereditary multiple exostosis.

Further Reading:

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Case 12-13

Lisfranc dislocation

Patient Presentation: A 17-year-old fell approximately 30 feet.

Clinical Features: The patient was awake with a normal neurologic examination and was in moderate to severe painful distress. The patient had an obvious traumatic injury to the face and foot. Examination of the foot revealed a significant closed deformity.

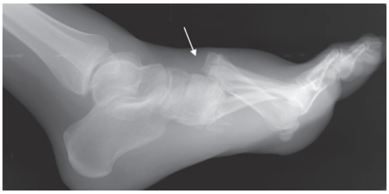

Figure 12-15. Foot x-ray. WA = Lisfranc dislocation

Differential Dx:

- Multiple traumatic blunt injuries

Emergency Care: A lateral foot radiograph demonstrated an impressive Lisfranc dislocation with multiple metatarsals dislocated dorsally relative to the tarsal bones.

Outcome: The patient underwent open reduction and internal fixation of his Lisfranc dislocation with an uncomplicated recovery.

Key Learning Points:

- Lisfranc injuries occur at the tarsometatarsal joint.
- These injuries are frequently initially misdiagnosed and can result in significant long-term morbidity.
- Weight-bearing plain radiographs are useful in the diagnosis, but injuries to this joint may require a CT or MRI scan for definitive diagnosis.
- A patient with a fracture of the base of the second or third metatarsal should be strongly suspected of having a Lisfranc injury.

Further Reading:

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Van Rijn J, Dorleijn DM, Boetes B, Wiersma-Tuinstra S, Moonen S. Missing the Lisfranc fracture: a case report and review of the literature. *J Foot Ankle Surg*. 2012;51(2):270-274.

Welck MJ, Zinchenko R, Rudge B. Lisfranc injuries. *Injury*. 2015;46(4):536-541.

Case 12-14

Multiple carpometacarpal dislocations

Patient Presentation: A 26-year-old presented with hand pain after punching a stationary object.

Clinical Features: The patient was in moderate painful distress, with a closed deformity of the dorsum of the proximal hand.

Differential Dx:
- Fracture or dislocation of the hand or wrist

Emergency Care: A hand radiograph demonstrated dorsal carpometacarpal dislocations of the second, third, fourth, and fifth joints. The patient underwent conscious sedation and closed reduction with splint application.

Outcome: The patient had percutaneous pinning of his dislocations 5 days post injury with subsequent recovery.

Key Learning Points:
- Dislocations of the carpometacarpal joints can be radiographically subtle and therefore challenging to diagnose.
- Open reduction and internal fixation after closed reduction is the standard management of these injuries.

Further Reading:
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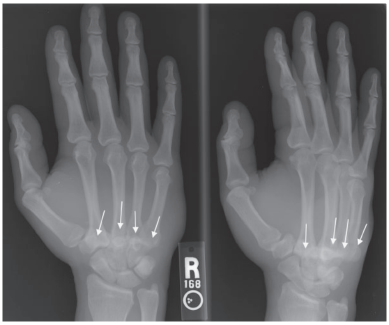

Figure 12-16. Hand x-ray (anterior and oblique view). WA = multiple carpometacarpal dorsal dislocations

Figure 12-17. Hand x-ray (lateral view). WA = multiple carpometacarpal dorsal dislocations

Case 12-15

Subtle pediatric lateral epicondylar fracture

Patient Presentation: A 3-year-old presented with right elbow pain after falling.

Clinical Features: The child was in moderate painful distress. There was swelling and marked tenderness to palpation of the right lateral elbow over the epicondyle. Distal sensory and vascular function was intact, but there was limited range of motion secondary to pain.

Differential Dx:
- Fracture
- Dislocation
- Soft tissue injury
- Ligamentous or tendon injury

Emergency Care: An elbow radiograph demonstrated a subtle lateral epicondylar fracture. An MRI scan revealed a Salter-Harris IV fracture that extended through the cartilage and was intra-articular and displaced.

Outcome: The patient had a percutaneous pinning of the fracture and subsequent uncomplicated recovery.

Key Learning Points:
- Despite the unimpressive appearance of this fracture, proper diagnostic and therapeutic intervention is important in preventing long-term morbidity.
- Plain radiographs are not as accurate as MRI in determining the degree of fracture displacement.
- Nondisplaced or minimally displaced (<2.0 mm) fractures of the lateral humeral condyle in children can be treated nonsurgically with cast application. However, the fracture site needs to be followed carefully

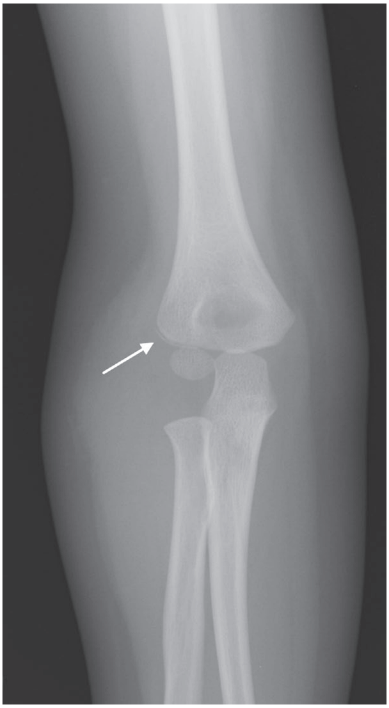

Figure 12-18. Elbow x-ray. WA = fracture of lateral epicondyle

Figure 12-19. Elbow MRI. WA = fracture of lateral epicondyle

with subsequent radiographs to determine if the initial displacement has worsened.

- Fractures displaced >2.0 mm should be percutaneously pinned. Nondisplaced or minimally displaced fractures in children where follow-up or close observation are not guaranteed should undergo open reduction and internal fixation as well.

Figure 12-20. Elbow x-ray after operative reduction

Further Reading:

Bakarman KA, Alsiddiky AM, Alzain KO, et al. Humeral lateral condyle fractures in children: redefining the criteria for displacement. *J Pediatr Orthop B.* 2016;25(5):429-433.

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Case 12-16

Osteoid osteoma

Patient Presentation: A 43-year-old presented with atraumatic medial right thigh pain. The pain started slowly 6 months ago but increased in severity over the past 3 weeks.

Clinical Features: The patient appeared to be in moderate painful distress. Thigh inspection was unremarkable without erythema, swelling, or warmth. The thigh was severely tender to palpation, and the patient would not walk.

Figure 12-21. Femur x-ray (lateral view). WA = a central radiolucent nidus

Differential Dx:

- Infection such as abscess
- Necrotizing fasciitis
- Bone tumor
- Muscle strain or hemorrhage
- Bone fracture
- Osteomyelitis

Emergency Care: Femur radiographs demonstrated an area of eccentric cortical thickening and sclerosis with a central radiolucent nidus at the mid-portion of the femoral shaft medially. This was thought to be an osteoid osteoma. The patient was treated with opioid and nonsteroidal anti-inflammatory medication and was referred to the interventional radiology service for radiofrequency ablation.

Outcome: The patient did not follow-up in clinic.

Key Learning Points:

- Osteoid osteoma is a benign bone tumor that has a central lucency or nidus.
- Prostaglandins are secreted by this tumor, and the pain is effectively treated with aspirin or nonsteroidal anti-inflammatory medications.
- Treatment may include surgical resection or radiofrequency ablation. Many spontaneously resolve without therapy over several years.

Further Reading:

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Ramos-Pascua LR, Martínez-Valderrábano V, Santos-Sánchez JA, Tijerín Bueno M, Sánchez-Herráez S. Radiofrequency thermal ablation of osteoid osteomas of the proximal femur. Usefulness of ultrasound guidance in selected cases. *Rev Esp Cir Ortop Traumatol*. 2015;59(5):326-332.

Rimondi E, Bianchi G, Malaguti MC, et al. Radiofrequency thermoablation of primary non-spinal osteoid osteoma: optimization of the procedure. *Eur Radiol*. 2005;15(7):1393-1399.

Figure 12-22. Femur x-ray (anterior view). WA = eccentric cortical thickening and sclerosis

Case 12-17

Thumb dislocation with skin dimples

Patient Presentation: A young patient presented with thumb pain after a fall.

Clinical Features: The patient was in mild to moderate painful distress. There was a deformity of the left thumb and the thenar eminence. Of note, there are dimples in the skin of the thenar eminence.

Differential Dx:

- Fracture or dislocation

Emergency Care: A hand radiograph demonstrated a posterior dislocation of the thumb metacarpophalangeal (MCP) joint. Of note, there are two sesamoid bones that appear to have entered the joint space. The movement of these sesamoid bones in this dislocation likely caused the dimpling effect. The dislocation was reduced in a closed fashion.

Outcome: The patient was subsequently lost to follow-up.

Key Learning Points:

- Complex dislocations of the thumb MCP joint occur when anatomical structures become entrapped within the joint, including the volar plate, sesamoid bones, bony fracture fragments, or the flexor pollicis longus tendon.
- These complex dislocations may be irreducible by closed methods and require open reduction and internal fixation. One initial attempt at closed reduction should be performed as some are reducible by closed methods and obviate the need for surgical reduction.

Figure 12-23. RA = dimpling of the thumb caused by dislocation of the metacarpal-phalangeal joint

Figure 12-24. Hand x-ray. WA = sesamoid bones within the dislocated metacarpal-phalangeal joint

Further Reading:

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Case 12-18

Osteochondromatosis

Patient Presentation: This male patient presented with an acute exacerbation of chronic right knee pain without recent trauma.

Clinical Features: The patient was in mild painful distress. Examination of the knee revealed a swollen joint with an effusion present, without erythema or warmth.

Differential Dx:
- Osteoarthritis
- Inflammatory arthritis
- Fracture
- Ligament
- Cartilage injury

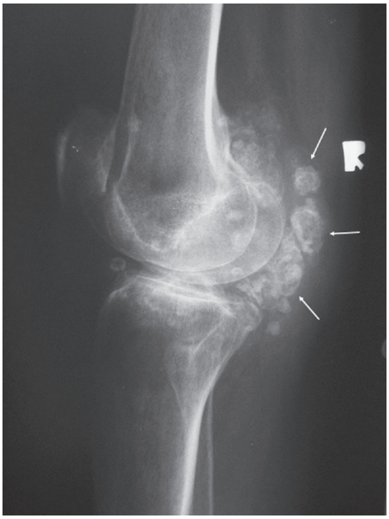

Figure 12-25. Knee x-ray (lateral view). WA = intra-articular bodies

Emergency Care: A lateral knee radiograph demonstrated multiple intra-articular bodies consistent with osteochondromatosis. The patient was treated symptomatically.

Outcome: The patient was lost to follow-up.

Key Learning Points:
- Osteochondromatosis is a benign condition with rare malignant transformation to a sarcoma.
- The synovium becomes nodular, and these nodules become independent, loose, cartilaginous foreign bodies within the joint space that calcify over time.
- Symptoms are related to joint injury, subsequent osteoarthritis, and mechanical disruption of the joint by the loose bodies.

Further Reading:

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Case 12-19

Bilateral hip dislocations

Patient Presentation: A 15-year-old was involved in a high-speed motor vehicle crash.

Clinical Features: The patient was in moderate to severe painful distress but was awake, alert, and hemodynamically stable. Both hips were slightly flexed, with the right internally rotated and the left externally rotated. Color, motor, and sensory examination was unremarkable.

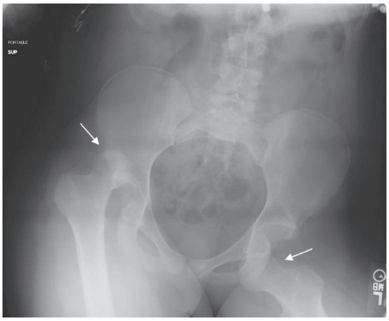

Figure 12-26. Pelvis x-ray. WA = bilateral posterior hip dislocations with a right acetabular fracture

Differential Dx:

- Multiple traumatic injuries, including pelvic fracture, hip fracture, and hip dislocation

Emergency Care: A pelvis radiograph revealed bilateral posterior hip dislocations with a fracture of the posterior superior right acetabulum. Conscious sedation and closed reductions were performed without difficulty. The patient was admitted for further management.

Outcome: Subsequent examination under anesthesia revealed stable hip joints not requiring open reduction and internal fixation of the right acetabulum. The patient made an uneventful recovery.

Key Learning Points:

- It is extremely important to reduce hip dislocations as soon as possible to prevent the development of avascular necrosis. Avascular necrosis is more likely to develop in patients with hip dislocation that were reduced greater than 6 hours from the time of injury.
- Proper sedation and reduction technique improves the chances of successful reduction, while reducing complications to the patient and preventing provider injuries (most notably lumbar strain).

Further Reading:

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Buckwalter J, Westerlind B, Karam M. Asymmetric bilateral hip dislocations: a case report and historical review of the literature. *Iowa Orthop J.* 2015;35:70-91.

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Case 12-20

Obturator incarcerated anterior-inferior hip dislocation

Patient Presentation: A 16-year-old was ejected from a motor vehicle during a crash. He was critically ill on presentation.

Clinical Features: The patient was unresponsive and hemodynamically unstable.

Differential Dx:

- Multiple blunt traumatic injuries

Emergency Care: Rapid sequence intubation was performed. Bedside ultrasound revealed a hemoperitoneum, and a pelvis radiograph demonstrated an obturator incarcerated anterior-inferior hip dislocation with an empty acetabulum. A brief attempt at reduction of this hip dislocation was unsuccessful, and the patient was transferred to the operating room for an exploratory laparotomy.

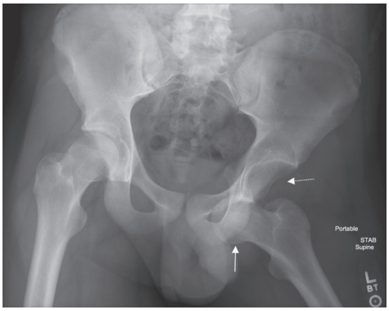

Figure 12-27. Pelvis x-ray. WA = obturator anterior-inferior hip dislocation, WDA = empty acetabulum

Outcome: While in the operating room several attempts at closed reduction under fluoroscopy were unsuccessful. The patient remained hemodynamically unstable from a splenic injury requiring splenectomy. The patient had several other injuries requiring attention, including likely traumatic brain injury. As a result, a distal femur traction pin was placed with the plan of reduction after the patient became stable. The patient was taken back to the operating room approximately 8 hours later, and the obturator-incarcerated anterior hip dislocation was successfully reduced with difficulty using fluoroscopy.

The patient had a long and complicated hospital course and was eventually discharged to a long-term rehabilitation facility. No further management of his hip dislocation was required.

Key Learning Points:

- Traumatic anterior-inferior obturator hip dislocations are rare.
- As with other hip dislocation types, rapid reduction is required to decrease the likelihood of avascular necrosis of the femoral head.

Further Reading:

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Case 12-21

Extraperitoneal bladder rupture and bilateral subtrochanteric femur fractures

Patient Presentation: A 3-year-old girl fell out of a moving vehicle.

Clinical Features: The patient was awake, alert, and hemodynamically stable in moderate to severe painful distress. There were closed deformities of her upper thighs, and there was blood at the urethral meatus.

Differential Dx:

- Multiple traumatic injuries including femur fractures, pelvic fracture, bladder and/or urethral injury

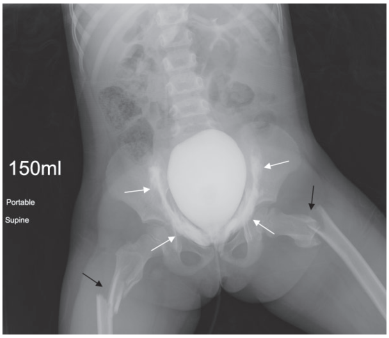

Figure 12-28. Pelvis x-ray and cystogram. BA = bilateral subtrochanteric femur fractures, WA = extraperitoneal bladder rupture

Emergency Care: The patient received analgesia. An indwelling bladder catheter was gently placed without difficulty. A cystogram revealed bilateral subtrochanteric femur fractures and contrast outside the urinary bladder consistent with an extraperitoneal bladder rupture.

Outcome: The patient was placed in pin traction, followed by intraoperative placement of a bilateral spica cast. Her extraperitoneal bladder rupture healed with prolonged use of an indwelling bladder catheter. Her bilateral spica cast was removed after 8 weeks, and the patient was noted to have a normal gait at 12 weeks.

Key Learning Points:

- Bilateral closed subtrochanteric fractures in a 3-year-old child are rare.
- The fact this child had a normal gait 12 weeks after this injury is a testimony to the recuperative powers of children.
- The treatment of extraperitoneal bladder rupture is typically conservative with an indwelling bladder catheter left in place until resolution.

Further Reading:

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Case 12-22

Talonavicular dislocation

Patient Presentation: A 41-year-old man was assaulted and presented with severe right foot and ankle pain.

Clinical Features: The patient was in moderate to severe painful distress. There was a significant closed deformity about the midfoot.

Differential Dx:

- Fracture and/or dislocation

Emergency Care: An ankle radiograph demonstrated a subtalar dislocation. Closed reduction, facilitated by conscious sedation, was successful, and the patient was placed in a splint and non–weight-bearing status.

Outcome: The patient failed orthopedic clinic follow-up and presented to the emergency department (ED) 2 weeks after the initial injury having been walking on his non–weight-bearing splint. He requested his splint be removed because he wanted to return to work.

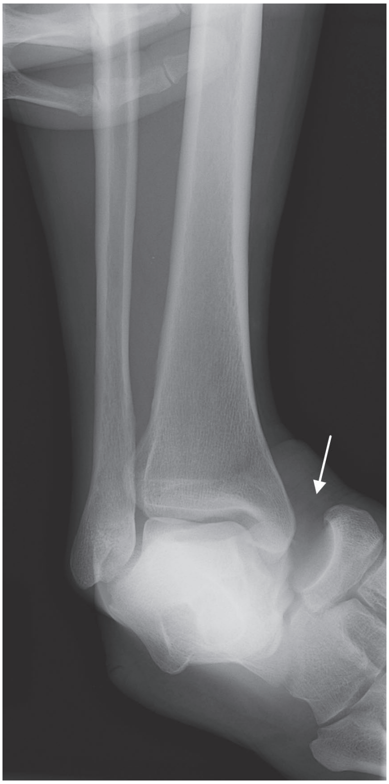

Figure 12-29. Ankle x-ray. WA = talonavicular dislocation

Key Learning Points:

- Isolated subtalar dislocations are uncommon, with lateral dislocations being rare.
- Treatment is closed reduction and immobilization. Postreduction CT imaging is recommended in order to diagnose associated fractures.
- Long-term prognosis is good, but subsequent osteoarthritis of the talonavicular joint is common.

Further Reading:

Azarkane M, Boussakri H, Alayyoubi A, Bachiri M, Elibrahimi A, Elmrini A. Closed medial total subtalar joint dislocation without ankle fracture: a case report. *J Med Case Rep*. 2014;8:313.

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Case 12-23

Multiple hereditary osteochondromas

Patient Presentation: A 52-year-old presented with an acute exacerbation of chronic knee pain. He was complaining of "bumps" on his bones.

Clinical Features: The patient was in mild painful distress. There was no warmth, erythema, or joint effusion. There were two hard and fixed masses involving his posterior knee and anterior tibia.

Differential Dx:
- Fracture
- Tumor
- Infection

Emergency Care: A knee radiograph demonstrated multiple exostoses. This was thought to represent multiple hereditary osteochondromas. The patient was treated symptomatically and discharged with follow-up in the orthopedics clinic.

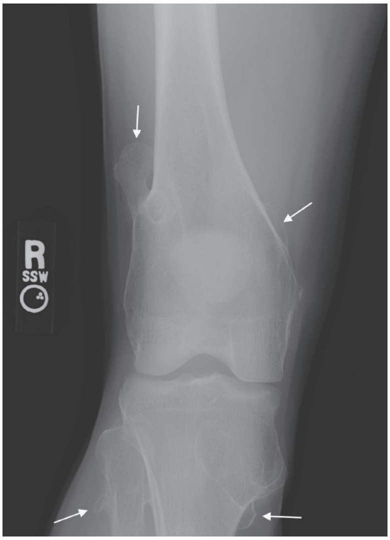

Figure 12-30. Knee x-ray. WA = multiple exostoses

Outcome: No further workup was recommended.

Key Learning Points:
- Multiple hereditary osteochrondroma usually affects young males with the distal femur representing the most common site.
- Functional problems such as mechanical loss of range of motion and fractures can occur.
- These exostoses are treated symptomatically.
- Malignant transformation is possible and is associated with sudden increase in pain.
- Associated pseudoaneurysms of the popliteal artery have been reported.

Further Reading:

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Case 12-24

Tillaux fracture

Patient Presentation: A 15-year-old presented with ankle pain after a wrestling injury.

Clinical Features: The patient was in mild painful distress. The ankle was diffusely swollen without deformity or open wound.

Differential Dx:
- Fracture and/or dislocation
- Soft tissue injury to ligaments or tendons

Emergency Care: An ankle radiograph demonstrated a Salter-Harris III fracture of the lateral distal tibial physis, otherwise known as a Tillaux fracture. A splint was applied, and patient follow-up in the orthopedics clinic was arranged.

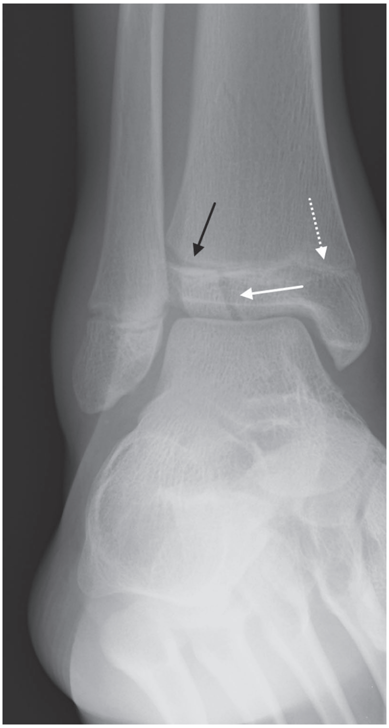

Figure 12-31. Ankle x-ray. BA = fracture through the open lateral physis, WA = fracture through the epiphysis, WDA = partially closed medial physis

Outcome: The patient underwent percutaneous pinning of the fracture without complication.

Key Learning Points:
- A partially-fused, medial, distal tibial physis explains the pathogenesis of the Tillaux fracture.
- The fracture is located medially at the junction of the partially closed medial physis and the open lateral physis.
- CT scanning is useful in the accurate diagnosis of the Salter-Harris fracture classification.

Further Reading:

Choudhry IK, Wall EJ, Eismann EA, Crawford AH, Wilson L. Functional outcome analysis of triplane and tillaux fractures after closed reduction and percutaneous fixation. *J Pediatr Orthop*. 2014;34(2):139-143.

Gourineni P, Gupta A. Medial joint space widening of the ankle in displaced Tillaux and Triplane fractures in children. *J Orthop Trauma*. 2011;25(10):608-611.

Liporace FA, Yoon RS, Kubiak EN, et al. Does adding computed tomography change the diagnosis and treatment of Tillaux and triplane pediatric ankle fractures? *Orthopedics*. 2012;35(2):e208-e212.

Nenopoulos A, Beslikas T, Gigis I, Sayegh F, Christoforidis I, Hatzokos I. The role of CT in diagnosis and treatment of distal tibial fractures with intra-articular involvement in children. *Injury*. 2015;46(11):2177-2180.

Wuerz TH, Gurd DP. Pediatric physeal ankle fracture. *J Am Acad Orthop Surg*. 2013;21(4):234-244.

Case 12-25

Giant cell tumor

Patient Presentation: A 23-year-old presented with left wrist pain. The pain started 4 months ago after a minor injury while playing volleyball.

Clinical Features: The patient was in no painful distress. The distal medial forearm over the distal ulna was enlarged, deformed but without tenderness to palpation, erythema, warmth, or overlying skin changes.

Differential Dx:

- Nonunion of ulna fracture
- Benign or malignant bone tumor
- Soft tissue calcification
- Soft tissue malignancy

Emergency Care: A wrist radiograph demonstrated an expansile lesion of the distal ulna with a narrow zone of transition extending to distal articular surface and a normal radius. A subsequent MRI scan demonstrated a giant cell tumor next to a normal radius.

Outcome: The patient was referred to an outside orthopedic specialty center and was lost to follow-up.

Key Learning Points:

- Although technically listed as a benign bone tumor, giant cell tumors of bone are osteolytic and invasive. They can recur locally after treatment and can even have pulmonary "metastatic" lesions.
- Treatment varies depending on location, invasiveness, and response to prior therapy. Local resection, intralesional curettage, radiation therapy, and denosumab are the mainstays of treatment.

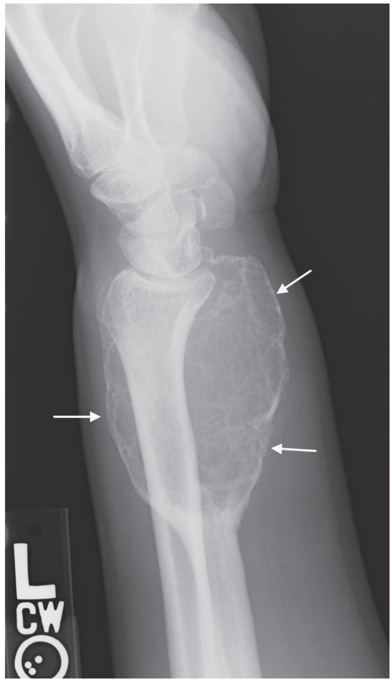

Figure 12-32. Wrist x-ray. WA = expansile lesion of the distal ulna

Figure 12-33. Wrist x-ray. WDA = normal distal radius

Further Reading:

Boye K, Jebsen NL, Zaikova O, et al. Denosumab in patients with giant-cell tumor of bone in Norway: results from a nationwide cohort. *Acta Oncol*. 2017;56(3):479-483.

Deveci MA, Paydaş S, Gönlüşen G, Özkan C, Biçer ÖS, Tekin M. Clinical and pathological results of denosumab treatment for giant cell tumors of bone: prospective study of 14 cases. *Acta Orthop Traumatol Turc*. 2017;51(1):1-6.

Kamal AF, Simbolon EL, Prabowo Y, Hutagalung EU. Wide resection versus curettage with adjuvant therapy for giant cell tumour of bone. *J Orthop Surg (Hong Kong)*. 2016;24(2):228-231.

Zhang S, Zhang J, Wang X. Comparison of tumor curettage and resection for treatment of giant cell tumor of the bone around the knee joint. *Pak J Med Sci*. 2016;32(3):662-666.

Figure 12-34. Wrist MRI. BA = giant cell tumor, WA = normal distal radius

Case 12-26

Chondrocalcinosis of the wrist and knee (two patients)

Patient Presentation: These are two separate patients who presented with nontraumatic joint pain (wrist and knee).

Clinical Features: Both patients were in mild painful distress. The wrist examination on the first patient revealed no effusion, swelling, or erythema, but there was tenderness to palpation just distal to the ulnar styloid process as well as mild warmth. The knee examination of the second patient revealed a small effusion and mild warmth but no erythema.

Differential Dx:
- Fracture
- Soft tissue contusion
- Ligamentous or tendinous strain
- Infection or inflammatory process
- Tenosynovitis

Emergency Care: Radiographs of the two different patients demonstrated a calcification involving the triangular fibrocartilaginous complex of the wrist and the medial and lateral meniscal cartilages of the knee. Both patients were treated symptomatically.

Outcome: Both patients were lost to follow-up.

Key Learning Points:
- Calcium pyrophosphate (CPP) crystal deposition, commonly referred to as "pseudogout" leads to chondrocalcinosis, or the calcification of cartilage. It frequently involves the knee, shoulder, and wrist joints.
- It is diagnosed by arthrocentesis and the presence of positively birefringent CPP crystals.
- Mainstays of treatment include nonsteroidal anti-inflammatory medication and/or joint aspiration and intra-articular injection of steroids.

Figure 12-35. First patient. Wrist x-ray. WA = chondrocalcinosis involving the triangular fibrocartilaginous complex

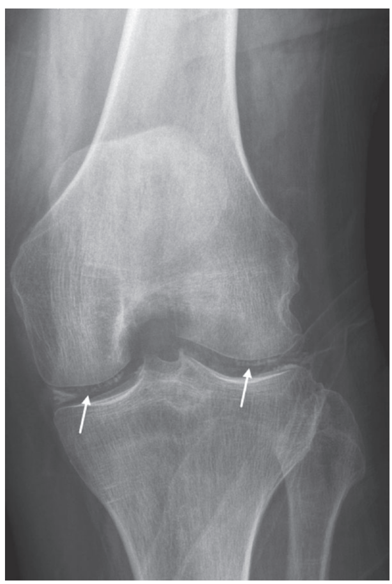

Figure 12-36. Second patient. Knee x-ray. WA = Chondrocalcinosis of the medial and lateral meniscal cartilages

Further Reading:

Abhishek A. Calcium pyrophosphate deposition disease: a review of epidemiologic findings. *Curr Opin Rheumatol*. 2016;28(2):133-139.

Doumas C, Vazirani RM, Clifford PD, Owens P. Acute calcific periarthritis of the hand and wrist: a series and review of the literature. *Emerg Radiol*. 2007;14(4):199-203.

Genant HK. Roentgenographic aspects of calcium pyrophosphate dihydrate crystal deposition disease (pseudogout). *Arthritis Rheum*. 1976;(19 suppl 3):307-328.

Skeete K, Hess EP, Clark T, Moran S, Kakar S, Rizzo M. Epidemiology of suspected wrist joint infection versus inflammation. *J Hand Surg Am*. 2011;36(3):469-474.

Terkeltaub RA. Clinical trials review: crystal deposition diseases. *Curr Rheumatol Rep*. 1999;1(2):97-100.

Case 12-27

Salter-Harris type I fracture of the distal knee

Patient Presentation: A 13-year-old injured his knee playing football.

Clinical Features: The patient was in moderate to severe painful distress. There was a significant closed deformity about the left knee. Distal color, motor, and sensory examination of the left leg was unremarkable.

Differential Dx:

- Fracture
- Dislocation
- Ligamentous injury
- Cartilage injury
- Vascular injury

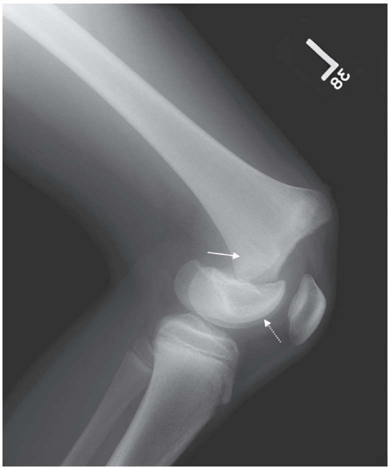

Figure 12-37. Knee x-ray. WA = distal metaphysis, WDA = epiphysis

Emergency Care: A knee radiograph demonstrated a Salter-Harris type I fracture with marked posterior and rotary displacement of the distal femoral epiphysis. Following closed reduction under ketamine sedation, residual posterior displacement of the epiphysis on the metaphysis was seen.

Outcome: The patient was taken to the operating room where closed pin reduction was performed. The patient had an uneventful recovery.

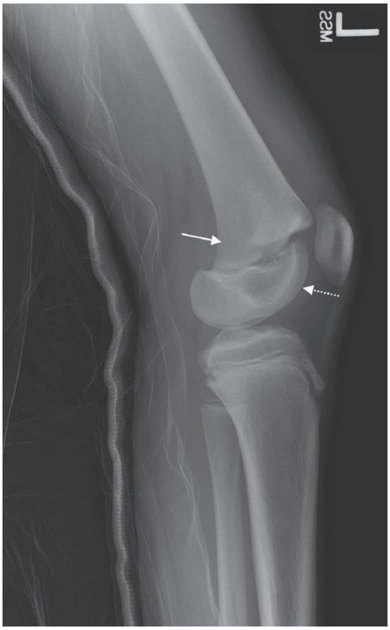

Figure 12-38. Knee x-ray after closed reduction. WA = distal metaphysis, WDA = epiphysis

Key Learning Points:

- Distal femur fractures involving the physis need to be followed closely for at least one year post injury to monitor for bone growth arrest.
- Roughly 50% of pediatric patients with fractures involving the distal femur growth plate develop growth disturbances, and about one in four have a leg length difference of greater than 1.5 cm.

Further Reading:

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Eid AM, Hafez MA. Traumatic injuries of the distal femoral physis. Retrospective study on 151 cases. *Injury*. 2002;33(3):251-255.

Persiani P, Ranaldi FM, Formica A, et al. Apophyseal and epiphyseal knee injuries in the adolescent athlete. *Clin Ter*. 2016;167(6):e155-e161.

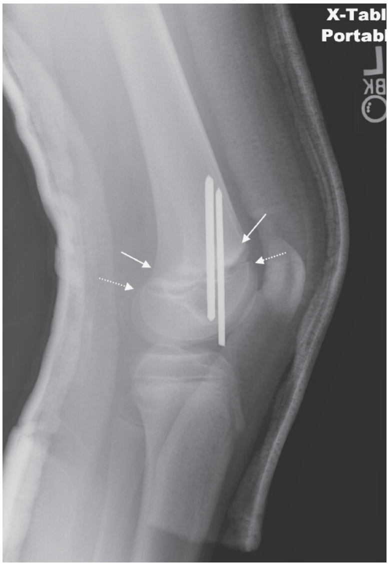

Figure 12-39. Knee x-ray after operative reduction. WA = distal metaphysis, WDA = epiphysis

Case 12-28

Lunate dislocation

Patient Presentation: A 45-year-old long-boarding down a hill collided with a turning car.

Clinical Features: The patient was in moderate painful distress. A palpable bony deformity was evident on the volar wrist directly anterior to the distal radius. The injury was closed.

Differential Dx:
- Fracture
- Dislocation
- Ligamentous injury

Emergency Care: A wrist radiograph demonstrated an impressive volar dislocation of the lunate.

Outcome: The patient was taken to the operating room where open reduction and internal fixation with a wire was performed. The patient made an uneventful recovery.

Key Learning Points:
- Complications of lunate dislocation include median nerve entrapment or injury, carpal tunnel syndrome, and avascular necrosis of the lunate.

Further Reading:

Bhatia M, Sharma A, Ravikumar R, Maurya VK. Lunate dislocation causing median nerve entrapment. *Med J Armed Forces India*. 2107; 73(1):88-90.

Cansü E, Heydar AM, Elekberov A, Ünal MB. Neglected lunate dislocation presenting as carpal tunnel syndrome. *Case Reports Plast Surg Hand Surg*. 2015;2(1):22-24.

Mourkus H, Hasjmi F, Stanislas MC. Spontaneous isolated lunate dislocation with migration into the forearm. *J Hand Surgery*. 2014;39(3): 324-325.

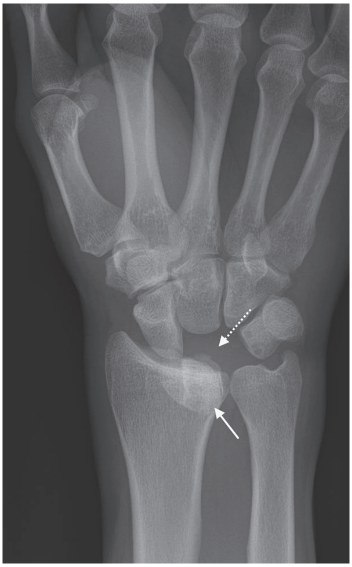

Figure 12-40. Wrist x-ray. WA = volar dislocation of the lunate, WDA = normal location of the lunate

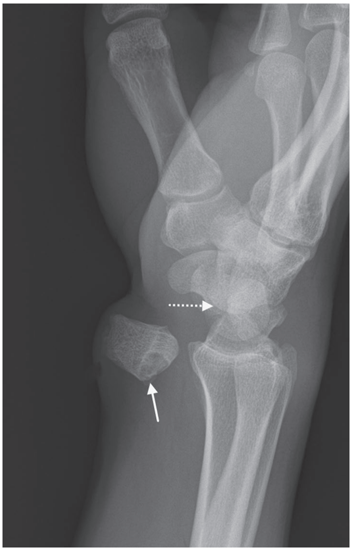

Figure 12-41. Wrist x-ray. WA = volar dislocation of the lunate, WDA = normal location of the lunate

Scalcione LR, Gimber LH, Ho AM, Johnston SS, Sheppard JE, Taljanovic MS. Spectrum of carpal dislocations and fracture-dislocations: imaging and management. *AJR Am J Roentgenol*. 2014;203(3):541-550.

Zonoozi E, Gimber LH, Ho AM, Johnston SS, Sheppard JE, Taljanovic MS. Bilateral volar lunate dislocation—a rare case report. *J Res Med Sci*. 2009; 14(3):187-190.

Case 12-29

Scapulothoracic dissociation

Patient Presentation: A 27-year-old fell approximately 8 ft from a ladder and presented complaining of left shoulder pain.

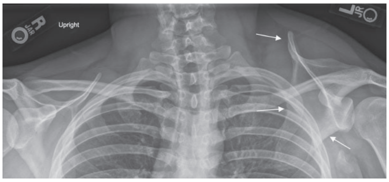

Figure 12-42. Chest x-ray (coned down). WA = outward winging of the scapula

Clinical Features: The patient was in moderate painful distress. There was swelling over the left scapula, with no range of motion of the shoulder possibly secondary to pain. The left scapula was noted to be elevated and winged outwards. There were some sensory deficits and motor loss to his left little finger.

Differential Dx:
- Fracture
- Dislocation
- Soft tissue injury
- Brachial plexus injury

Emergency Care: A chest radiograph demonstrated an elevated scapula with outward winging and an associated fracture of the left coracoid process. A CT angiogram revealed no vascular injuries. The patient was admitted for observation and pain management.

Outcome: This is a scapulothoracic dissociation. The patient was treated nonoperatively with a sling. The patient was lost to further follow-up of his lower brachial plexus injury.

Key Learning Points:
- Traumatic scapulothoracic dissociation is rare.
- Severe injury to upper extremity vascular structures and to the brachial plexus are associated with this injury.

Further Reading:

Katsamouris AN, Kafetzakis A, Kostas T, Tsetis D, Katonis P. The initial management of scapulothoracic dissociation: a challenging task for the vascular surgeon. *Eur J Vasc Endovasc Surg*. 2002;24(6):547-549.

Landge V, Vaishya R, Aggarwal A. Scapular dislocation from trivial trauma: a rare case. *Chin J Traumatol*. 2012;15(1):62-64.

Lovejoy J, Ganey TM, Ogden JA. Scapulothoracic dissociation secondary to major shoulder trauma. *J Pediatr Orthoped B*. 2009;18(3):131-134.

Nagi ON, Dhillon MS. Traumatic scapulothoracic dissociation. A case report. *Arch Orthop Trauma Surg*. 1992;111(6):348-349.

Verma N, Linnau KF. Core curriculum illustration: scapulothoracic disassociation. *Emerg Radiol*. 2015;22(4):437-439.

Case 12-30

Intra-articular fat/fluid level

Patient Presentation: A 22-year-old fell while playing basketball after trying to dunk the ball.

Clinical Features: The patient was in mild painful distress. Range of motion of the shoulder was decreased secondary to pain, and his distal color, motor, and sensory examination was unremarkable.

Differential Dx:
- Fracture
- Dislocation
- Soft tissue injury
- Rotator cuff injury
- Contusion

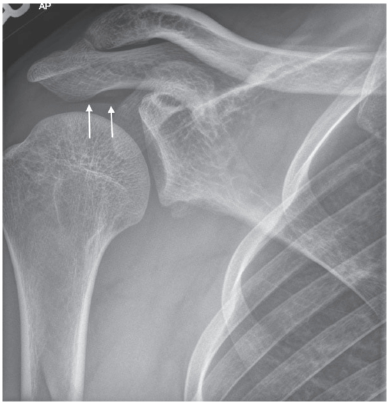

Figure 12-43. Shoulder x-ray. WA = fat/fluid level

Emergency Care: A shoulder radiograph demonstrated a subtle fat/fluid level, but no dislocation or specific fracture was identified.

Outcome: The patient was treated symptomatically with a sling and made an uneventful recovery.

Key Learning Points:
- A fat/fluid level within a joint signifies the presence of an intra-articular fracture, with the fat extruding into the joint from the bone marrow. Its absence does not exclude a fracture.
- The presence of abnormal fat in the surrounding soft tissues outside of an injured joint may indicate an intra-articular fracture with extension of fat contents into those soft tissues.

Further Reading:

Czuczman GJ, Mandell JC, Khurana B. Iliopsoas bursal extension of lipohemarthrosis: a novel imaging finding associated with hip fracture. *Skeletal Radiol*. 2017;46(2):253-257.

Le Corroller T, Parratte S, Zink JV, Argenson JN, Champsaur P. Floating fat in the wrist joint and in the tendon sheaths. *Skeletal Radiol*. 2010;39(9):931-933.

Lee JH, Weissman BN, Nikpoor N, Aliabadi P, Sosman JL. Lipohemarthrosis of the knee: a review of recent experiences. *Radiology*. 1989;173(1):189-191.

Case 12-31

Anterior sternoclavicular dislocation

Patient Presentation: This is a young patient who presented with anterior lower neck and upper chest wall pain after a fall.

Clinical Features: The patient was in mild to moderate painful distress. There was focal swelling and a bony deformity at the right sternoclavicular joint.

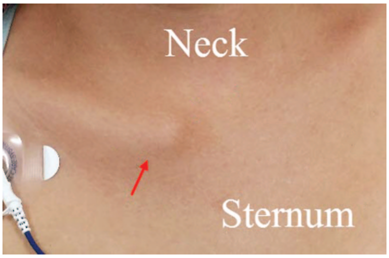

Figure 12-44. RA = bony deformity of sternoclavicular joint

Differential Dx:
- Clavicular fracture
- Sternal fracture
- Sternoclavicular dislocation

Emergency Care: A plain radiograph series did not demonstrate any fractures, and this was diagnosed as a sternoclavicular dislocation. The dislocation was reduced with conscious sedation and local anesthesia.

Outcome: The patient tolerated the procedure well and was lost to further follow-up.

Key Learning Points:
- Anterior and posterior sternoclavicular dislocations occur infrequently.
- Posterior dislocations can be associated with major vascular and nerve injury and can be life-threatening if they involve compression of mediastinal structures such as the trachea.
- Ultrasound, CT, or MRI are common imaging modalities for a suspected sternoclavicular dislocation as the sternoclavicular joint is hard to image with plain radiography.
- Many sternoclavicular dislocations are not stable after closed reduction and require open reduction and internal fixation.

Further Reading:

Bengtzen RR, Petering RC. Point-of-care ultrasound diagnosis of posterior sternoclavicular joint dislocation. *J Emerg Med*. 2017;52(4):513-515.

Ernberg LA, Potter HG. Radiographic evaluation of the acromioclavicular and sternoclavicular joints. *Clin Sports Med*. 2003;22(2):255-275.

Kirby JC, Edwards E, Kamalimoaveni A. Management and functional outcomes following sternoclavicular joint dislocation. *Injury*. 2015;46(10):1906-1913.

Kuzak N, Ishkanian A, Abu-Laban RB. Posterior sternoclavicular joint dislocation: case report and discussion. *CJEM*. 2006;8(5):355-357.

Li M, Wang B, Zhang Q, et al. Figureological measurement of the sternoclavicular joint and its clinical application. *Chin Med J*. 2012;125(2):230-235.

Morell DJ, Thyagarajan DS. Sternoclavicular joint dislocation and its management: a review of the literature. *World J Orthop*. 2016;7(4):244-250.

Case 12-32

Monteggia fracture/dislocation

Patient Presentation: A 19-year-old presented with severe arm pain after a football injury.

Clinical Features: The patient was in moderate to severe painful distress. There was a closed deformity of the right elbow with significant swelling. The patient was unable to extend his thumb or other fingers, but otherwise had a normal motor, sensory, and vascular examination.

Figure 12-45. Elbow x-ray. WA = radial head dislocation, WDA = proximal ulna fracture

Differential Dx:

- Fracture and/or dislocation
- Vascular injury
- Nerve injury

Emergency Care: A lateral elbow radiograph revealed a Monteggia fracture/dislocation. The Monteggia fracture/dislocation involves a proximal ulnar fracture coupled with a radial head dislocation. Closed reduction under conscious sedation was completed in the ED.

Outcome: The patient underwent open reduction and internal fixation of his Monteggia fracture/dislocation. After rehabilitation, he recovered full motor function.

Key Learning Points:

- A Monteggia fracture/dislocation is a fracture of the proximal third of the ulna with a dislocation of the radial head. This should not be confused with a Galeazzi fracture, namely a fracture of the distal third of the radius with a dislocation of the distal radioulnar joint. The mnemonic MUGR (Monteggia Ulnar fracture/Galeazzi Radial fracture) is useful in remembering the distinction.
- There is a relatively high rate of unsatisfactory results of initial operative intervention in adults with a Monteggia fracture/dislocation.
- Pediatric Monteggia injuries have a higher rate of successful closed reduction with better outcomes than adults.

Further Reading:

Beutel BG. Monteggia fractures in pediatric and adult populations. *Orthopedics*. 2012;35(2):138-144.

Konrad GG, Kundel K, Kreuz PC, Oberst M, Sudkamp NP. Monteggia fractures in adults: long-term results and prognostic factors. *J Bone Joint Surg Br*. 2007:89(3):354-360.

Llusa Perez M, Lamas C, Martínez I, Pidemunt G, Mir X. Monteggia fractures in adults. Review of 54 cases. *Chir Main*. 2002;21(5):293-297.
Matar HE, Akimau PI, Stanley D, Ali AA. Surgical treatment of Monteggia variant fracture dislocations of the elbow in adults: surgical technique and clinical outcomes. *Eur J Orthop Surg Traumatol*. 2017.
Perron AD, Hersh RE, Brady WJ, Keats TE. Orthopedic pitfalls in the ED: Galeazzi and Monteggia fracture-dislocation. *Am J Emerg Med*. 2001;19(3):225-228.

Case 12-33

Locked knee joint secondary to intra-articular loose body

Patient Presentation: A 34-year-old patient presented with knee pain after a fall. The patient stated he was unable to walk.

Clinical Features: The patient was in mild painful distress. There was a small effusion without erythema, warmth, or deformity. Ligamentous examination was unremarkable. However, the patient was unable to fully extend his leg either actively or passively with a firm locking endpoint noted.

Differential Dx:
- Fracture
- Dislocation
- Meniscal injury
- Ligamentous injury

Emergency Care: A knee radiograph demonstrated two calcified masses. One calcification was thought to be in soft tissues or muscle, representing myositis ossificans. The white arrows point to an intra-articular calcification representing a chronic loose body that was the etiology for the patient's acute range of motion limitation.

Outcome: The patient went to the operating room for removal of the intra-articular calcified loose body with return of full knee function.

Key Learning Points:
- An acute mechanically locked knee is generally the result of a meniscal (medial bucket handle) tear or a loose intra-articular body.
- MRI scanning effectively diagnoses the etiology for the locked knee and is a therapeutic guide.

Figure 12-46. Knee x-ray (anterior view). WA = intra-articular calcified loose body, WDA = myositis ossificans

Figure 12-47. Knee x-ray (lateral view). WA = intra-articular calcified loose body, WDA = myositis ossificans

- Mechanical manipulation can result in unlocking the knee in a small percentage of patients, but operative intervention is often required for acute unlocking and preventing recurrence.

Further Reading:

Beers LR, Mabry LM, Sullivan RT. Osseous fragment in a patient with knee pain. *J Orthop Sports Phys Ther*. 2015;45(4):323.

Critchley IJ, Bracey DJ. The acutely locked knee—is a manipulation worth while? *Injury*. 1985;16(4):281-283.

Helmark IC, Neergaard K, Krogsgaard MR. Traumatic knee extension deficit (the locked knee): can MRI reduce the need for arthroscopy? *Knee Surg Sports Traumatol Arthrosc*. 2007;15(7):863-868.

McNally EG, Nasser KN, Dawson S, Goh LA. Role of magnetic resonance imaging in the clinical management of the acutely locked knee. *Skeletal Radiol*. 2002;31(10):570-573.

Stamatoukou A, Haslam P, Wilton T, Geutjens G. Locked knee caused by a loose body in the fabellofemoral joint. *Am J Sports Med*. 2002;30(1):128-129.

Case 12-34

Simultaneous left anterior and right posterior glenohumeral dislocations

Patient Presentation: A 24-year-old was the driver in a single-car, low-speed motor vehicle crash. He had a generalized tonic-clonic seizure at the scene. The patient had no prior history of seizure.

Clinical Features: The patient presented awake and alert but was amnestic to the event.

Differential Dx:

- Multiple traumatic injuries including closed head trauma precipitating a seizure, or alternatively a first-time seizure causing the motor vehicle crash leading to multiple traumatic injuries

Emergency care: A chest radiograph was obtained as part of his trauma evaluation, which revealed an anterior shoulder dislocation on the left and a suspected posterior shoulder dislocation on the right. The chest/abdomen/pelvis CT scan demonstrated the abnormal position of the humeral heads with the empty glenoid fossas. Under conscious sedation, both shoulder dislocations were reduced without difficulty.

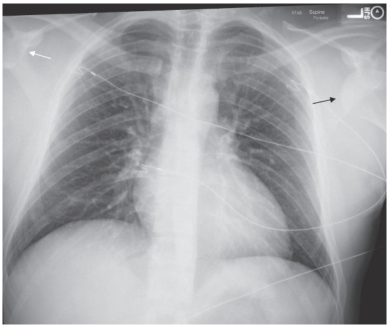

Figure 12-48. Chest x-ray. BA = anterior shoulder dislocation, WA = posterior shoulder dislocation

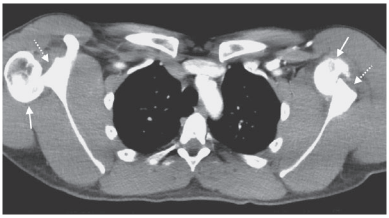

Figure 12-49. Chest CT scan. WA = abnormal posterior and anterior humeral head locations, WDA = empty glenoid fossas

Outcome: No additional injuries were discovered. It was thought that the seizure caused both the shoulder dislocations as well as the minor motor vehicle crash. A full seizure evaluation with MRI and electroencephalogram did not reveal an etiology for the seizure.

Key Learning Points:

- Generalized tonic-clonic seizures can cause both anterior and posterior shoulder dislocations.
- Posterior shoulder dislocations are classically caused by seizure activity.
- Posterior shoulder dislocations in the absence of known trauma raises suspicion of an unwitnessed seizure as the etiology.
- Posterior shoulder dislocations can be very subtle and, consequently, undiagnosed.

Further Reading:

Azizpour M, Suder PA, Fonnesbaek R. Traumatic bilateral posterior shoulder dislocation after a seizure [in Danish]. *Ugeskr Laeger*. 2016;178:48.

Betz ME, Traub SJ. Bilateral posterior shoulder dislocations following seizure. *Int Emerg Med*. 2007;2(1):63-65.

Jansen H, Frey SP, Doht S, Meffert RH. Simultaneous posterior fracture dislocation of the shoulder following epileptic convulsion. *J Surg Case Rep*. 2012;2012(11). pii: rjs017.

Mackenzie DC, Liebmann O. Point-of-care ultrasound facilitates diagnosing a posterior shoulder dislocation. *J Emerg Med*. 2013;44(5):976-978.

Martin AN, Tsekes D, White WJ, Rossouw D. Chloroquine-induced bilateral anterior shoulder dislocation: a unique aetiology for a rare clinical problem. *BMJ Case Rep*. 2016;2016. pii: bcr2015214292.

Pushpakumara J, Sivathiran S, Roshan L, Gunatilake S. Bilateral posterior fracture-dislocation of the shoulders following epileptic seizures: a case report and review of the literature. *BMC Res Notes*. 2015;8:704.

Case 12-35

Luxatio erecta humeri

Patient Presentation: This is a patient who presented complaining of right shoulder pain after falling down the last four steps of a stairway.

Clinical Features: The patient was in moderate painful distress. His right arm was in an awkward position.

Differential Dx:

- Dislocation of the glenohumeral joint
- Fracture of humerus

Emergency Care: A shoulder radiograph demonstrated an inferior glenohumeral dislocation with the humerus reaching over the patient's chest and head. The clinical appearance and radiographs were consistent with luxatio erecta. The patient underwent conscious sedation and reduction of the dislocation without difficulty.

Outcome: The patient was lost to subsequent follow-up.

Key Learning Points:

- Rotator cuff tears, greater tuberosity fractures, and axillary nerve injuries are common with inferior glenohumeral dislocations, occurring substantially more often than all other types of shoulder dislocation.
- Long-term outcome, including the repair of associated injuries, is generally good.

Figure 12-50. Right upper arm locked in abnormal position

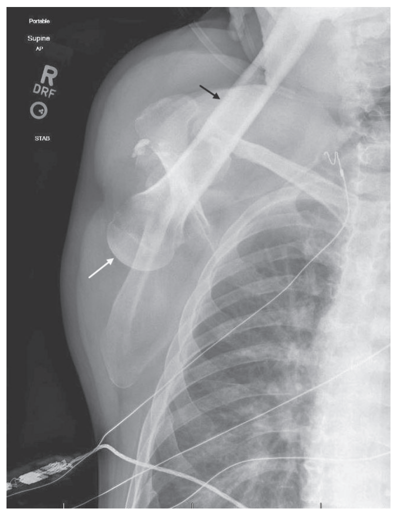

Figure 12-51. Shoulder x-ray. BA = humerus, WA = an inferior glenohumeral dislocation

Further Reading:

Bister V, Sandelin H, Lahdeoja T. Luxatio erecta: two case reports and review of the literature [in Finnish]. *Duodecim*. 2016;132(13-14):1287-1292.

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CHAPTER 13 Dermatology

Case 13-1

Neurofibromatosis

Patient Presentation: An adult male presented complaining of a skin infection.

Clinical Features: Confluent lesions of neurofibromatosis were present. One of these fleshy and pedunculated tumors on his anterior abdominal wall was erythematous and warm.

Differential Dx:
- Bacterial cellulitis
- Abscess
- Fungal infection

Emergency Care: The patient was treated with an antibiotic on an outpatient basis.

Outcome: This patient was lost to follow-up.

Figure 13-1. Innumerable fleshy and pedunculated tumors

Key Learning Points:
- There are three clinically and genetically different forms of neurofibromatosis, with neurofibromatosis type 1 being the most common.
- It is an autosomal dominant disease with 100% penetrance but highly variable expressivity.
- Patients with neurofibromatosis type 1 are at an increased risk for optic and central nervous system neoplasms, soft tissue sarcomas, bony lesions, and neurologic manifestations such as seizures, cognitive deficits, and peripheral neuropathy.
- As illustrated, neurofibromatosis can be a severely disfiguring disease. Rare face transplants have been performed in these patients.

Further Reading:

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Lantieri L, Grimbert P, Ortonne N, et al. Face transplant: long-term follow-up and results of a prospective open study. *Lancet*. 2016;388(10052)1398-1407.
Ma JE, Hand JL. What's new with common genetic skin disorders? *Minerva Pediatr*. 2017;69(4):288-297.
Ullrich NJ. Neurocutaneous syndromes and brain tumors. *J Child Neurol*. 2016;31(12):1399-1411.

Case 13-2

Educated vascular access for intravenous drug abuse

Patient Presentation: This is a young adult patient with a history of intravenous drug abuse. Three months before this visit, the patient presented comatose from an opioid overdose requiring positive pressure ventilation while an external jugular catheter was placed for naloxone administration. At that time, his external jugular did not have any track marks. When he returned for this visit three months later, examination of his right external jugular showed significant scarring due to healed track marks. The patient had apparently learned from his initial visit how to access his own external jugular vein.

Figure 13-2. RA = Scarred needle track marks over the external jugular vein

Key Learning Points:

- External jugular, internal jugular and subclavian veins have been used by intravenous drug abusers after inadvertently being "taught" the anatomy by unsuspecting health care professionals accessing these sites during medical care.
- Using deep neck veins for intravenous illicit drug administration is known as the "pocket shot." There are two "pockets" that are utilized. The first lies in a triangle formed by the bellies of the sternocleidomastoid (SCM) muscle and the clavicle. The second is completely lateral to the SCM and above the clavicle. This patient used the latter pocket.

Further Reading:

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Mark F, Williams MD, David W, Eisele MD, Susan H, Wyatt MD. Neck needle foreign bodies in intravenous drug abusers. *Laryngoscope*. 1993;103(1 pt 1):59-63.

Case 13-3

Psychogenic excoriation disorder

Patient Presentation: Young adult presented with a forehead and scalp wound. This lesion started as a skin irritation almost 2 years prior to presentation. Due to repetitive cleaning, washing, and scrubbing of the area, the wound enlarged.

Clinical Features: The patient was in no painful distress. Examination revealed a chronic appearing wound without signs of infection. The depth of the wound extends to the exposed skull. In one area of the wound erosion through the inner skull table resulted in a cerebral spinal fluid (CSF) leak.

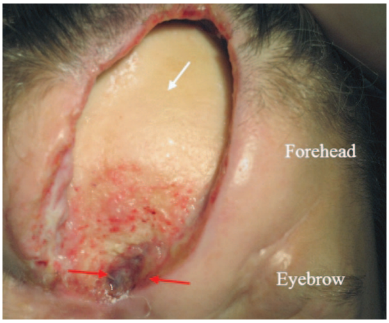

Figure 13-3. Large self-inflicted excoriation wound of forehead and scalp. RA = erosion through the inner skull table with a cerebral spinal fluid leak, WA = exposed skull

Differential Dx:
- Obsessive-compulsive disorder
- Psychogenic excoriation
- Dermatotillomania
- Low-grade indolent infection

Emergency Care: Neurosurgery was consulted given the CSF leak. The patient was admitted to the hospital.

Outcome: The patient was lost to follow-up.

Key Learning Points:
- Excoriation disorder, psychogenic excoriation disorder, neurotic excoriation, compulsive skin picking, and dermatotillomania are the names attached to this pathology, and can all be associated with obsessive-compulsive disorder.
- Psychiatric treatment includes selective serotonin reuptake inhibitors, as well as behavioral technique called "habit reversal."

Further Reading:
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Arnold LM, Auchenbach MB, McElroy SL. Psychogenic excoriation. Clinical features, proposed diagnostic criteria, epidemiology and approaches to treatment. *CNS Drugs*. 2001;15(5):351-359.

Bain MA, Vincent J. Management of a complex excoriation disorder-induced wound with a viable cryopreserved placental membrane. *Plast Reconst Surg Glob Open*. 2016;4(12):e1132.

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Van Dijk E, Van Voorst Vader PC. Dermatotillomania. *Dermatologica*. 1979;158(1):65-71.

Case 13-4

Erythema migrans


Figure 13-4. Erythema migrans on the forearm

Patient Presentation: A young adult presented with a rash on his forearm. No other symptoms were elicited.

Clinical Features: The patient was well appearing. Erythema migrans, the classic rash of Lyme disease, was noted on the patient's forearm.

Differential Dx:
- Lyme disease
- Fungal infection
- Contact dermatitis
- Erythema multiforme
- Pattern contusion

Emergency Care: The patient was treated for Lyme disease with doxycycline.

Outcome: The patient was lost to follow-up.

Key Learning Points:
- There are three phases to Lyme disease. The first phase (early localized) is characterized by erythema migrans that occurs within 1 month of exposure. In the second phase, occurring months after exposure, patients present with dissemination of the skin lesions, as well as with neurologic and cardiac manifestations. The final stage is characterized by arthritis, encephalopathy, or neuropathy occurring months to years after exposure.
- Treatment regimens vary depending on the stage of disease and are tailored to the patient's presentation.
- It is extremely important for emergency medicine physicians to have a high index of suspicion for this disease, especially in endemic areas, given the significant latent pathophysiology and delayed sequelae.
- Serologic testing for Lyme disease is complicated and depends on the stage of infection.

Further Reading:

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Miraglia CM. A review of the centers for disease control and prevention's guidelines for the clinical laboratory diagnosis of Lyme disease. *J Chiropr Med*. 2016; 15(4):272-280.

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Sanchez JL. Clinical manifestations and treatment of Lyme disease. *Clin Lab Med*. 2015;35(4):765-778.

Waddell LA, Greig J, Mascarenhas M, Harding S, Lindsay R, Ogden N. The accuracy of diagnostic tests for Lyme disease in humans, a systematic review and meta-analysis of North American research. *PLoS One*. 2016;11(12):e0168613.

Case 13-5

Kaposi sarcoma

Patient Presentation: A young male patient presented with a rash.

Clinical Features: The patient was ill appearing, cachectic, and in mild respiratory distress. Of note was his rash, described as purplish in color and raised and palpable, but nontender to palpation.

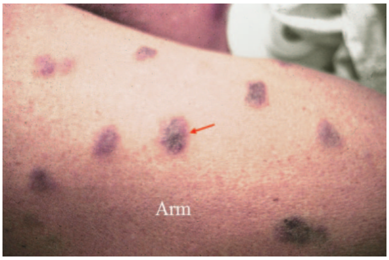

Figure 13-5. RA = Kaposi sarcoma lesion on the arm

Differential Dx:

- Kaposi sarcoma
- Malignant melanoma

Emergency Care: The patient was admitted for further diagnostic evaluation and therapy.

Outcome: This patient died of complication related to AIDS.

Key Learning Points:

- Reports in 1981 concerning clusters of patients with Kaposi sarcoma and *Pneumocystis* pneumonia in New York City and San Francisco led to the belief in an immunodeficiency syndrome of unknown but likely infectious etiology.
- There were 270 case reports by the end of 1981, with 121 of those patients having died.
- In 1984, a retrovirus initially named HTLV-III was announced as the cause of AIDS.

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Carr ER. HIV- and AIDS-associated cancers. *Clin J Oncol Nursing.* 2013;17(2):201-204.

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Haverkos HW, Curran JW. The current outbreak of Kaposi's sarcoma and opportunistic infections. *CA Cancer J Clin.* 1982;32(6):330-339.

Jaskolski M, Miller M, Mohana Rao JK, Gustchina A, Wlodawer A. Elucidation of the structure of retroviral proteases: a reminiscence. *FEBS J.* 2015;282(21):4059-4066.

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Vatanoglu EE, Ataman AD. A sexually transmitted disease: history of AIDS through philately. *J Turk Ger Gynecol Assoc.* 2011;12(3):192-196.

Case 13-6

Facial poison ivy

Patient Presentation: A 7-year-old presented with a facial rash. A friend had rubbed leaves on her face 6 days ago. A rash developed 2 days after the exposure, and she was treated with prednisone for contact dermatitis from poison ivy and cephalexin for possible cellulitis. She continued to worsen and presented to our facility.

Figure 13-6. Facial rash

Clinical Features: The patient was afebrile. There was an impressive facial rash with swelling.

Differential Dx:
- Contact dermatitis from poison ivy
- Bacterial cellulitis

Emergency Care: The patient was started on intravenous cephazolin, prednisone, and hydroxyzine and was admitted to the hospital.

Outcome: The patient was discharged in 2 days after marked improvement in her clinical condition.

Key Learning Points:
- The poison ivy plant is from the genus *Toxicodendron* and causes a contact dermatitis. The genus *Toxicodendron* also includes poison oak and poison sumac.
- Urushiol is the allergenic compound in poison ivy.
- Approximately 50% of people will react to urushiol in the natural setting.
- Contact dermatitis from poison ivy is a type IV hypersensitivity (cell-mediated) allergic reaction.
- Severe or facial contact dermatitis from poison ivy should be treated with oral prednisone. A 3-week course with a tapering dose is recommended to prevent rebound dermatitis.

Further Reading:

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Vaught CK, Mold JW. Poison ivy: How effective are available treatments? *J Fam Pract*. 2016;65(11):801-809.

Case 13-7

Exploding spray paint can

Patient Presentation: A young patient was lighting an aerosol stream of spray paint on fire when an explosion occurred.

Clinical Features: The patient presented with what initially appeared to be significant facial burns as well as adhered paint.

Differential Dx:

- Blunt trauma
- Ocular injury
- Facial skin injury
- Airway or inhalation injury

Emergency Care: Gentle scrubbing removed the layer of adherent paint product and revealed that the underlying skin was not burned.

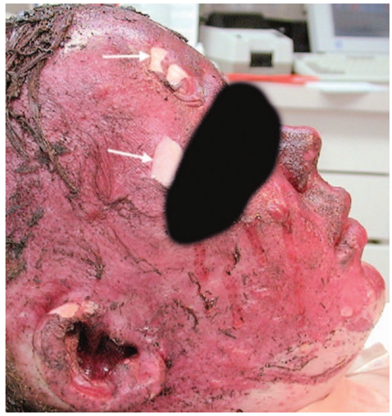

Figure 13-7. Face covered in spray paint. WA = paint that was rubbed away revealing normal, nonburned, skin

Outcome: Fortunately, the initial visual impression was much worse than the injury as there were virtually no facial burns.

Key Learning Points:

- Don't light aerosol spray paint cans on fire.

Further Reading:

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Case 13-8

Coining

Patient Presentation: A young patient of Southeast Asian descent presented feeling generally ill.

Clinical Features: Examination of the patient's back revealed linear, symmetric ecchymotic lesions without open wounds or signs of infection, consistent with coining.

Figure 13-8. Coining

Differential Dx:

- Medicinal practice
- Physical abuse

Emergency Care: No data available.

Outcome: Lost to follow-up.

Key Learning Points:

- Coining, cupping, and moxibustion are Asian medicinal practices and should not be confused with physical abuse.
- Coining is the practice of rubbing coins on skin covered with oil.
- Cupping is placing suction cups with heated air on the skin that draws out the ailment and can cause a burn.
- Moxibustion is placing heated or burning pieces of moxa herb on the skin causing small circular burns.

Further Reading:

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Buchwald D, Panwala S, Hooton TM. Use of traditional health practices by Southeast Asian refugees in a primary care clinic. *West J Med*. 1992;156(5):507-511.

Lilly E, Kundu RV. Dermatoses secondary to Asian cultural practices. *Int J Dermatol*. 2012;372-379.

Case 13-9

Hydrofluoric acid burn

Patient Presentation: Young adult patient presented after a topical exposure to industrial strength 48% hydrofluoric acid.

Clinical Features: The patient was in severe pain on the day of exposure, out of proportion to the initial benign-appearing lesion.

Differential Dx:
- Hydrofluoric acid burn
- Compartment syndrome
- Necrotizing fasciitis

Emergency Care: The patient was medically managed with an emphasis on adequate analgesia. Local infiltration of 5% calcium gluconate was also performed.

Outcome: The tissue injury progressed substantially between presentation and 6 days after exposure. At two months post exposure, there was a large unsightly scar (no image). After employing tissue expanders for several months, a cosmetic excision was accomplished at 17 months post injury.

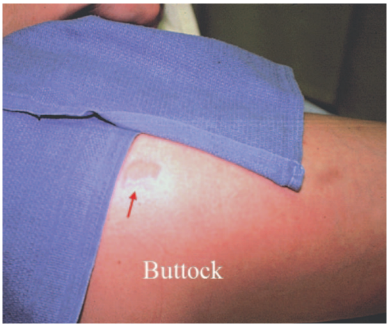

Figure 13-9. Hydrofluoric acid burn on the day of exposure

Figure 13-10. Hydrofluoric acid burn 2 days after exposure

Figure 13-11. Hydrofluoric acid exposure 6 days after exposure

Key Learning Points:
- Patients with hydrofluoric acid burns will typically present with severe pain that is out of proportion to the external appearance of the involved skin.
- Hydrofluoric acid penetrates deeply and binds with calcium and magnesium, leading to hypocalcemia and hypomagnesemia. Both hypokalemia and hyperkalemia are possible. These electrolyte imbalances can lead to life-threatening cardiac arrhythmias.
- Treatment is complex and includes copious water irrigation as well as calcium to help bind the hydrofluoric acid.
- Calcium can be administered in various formulations depending of the location and extent of the burn. Calcium can be applied directly to the skin in a 2.5% calcium gel, or injected into the affected and adjacent tissues as 5% calcium gluconate.

Calcium gluconate can be infused into an end artery supplying the affected limb, for example, the radial artery for a finger exposure. Calcium gluconate is also used for any systemic toxicity related to hypocalcemia.

- Hydrofluoric acid is used for industrial purposes such as glass etching, metal cleaning, and electronics manufacturing. It is also found in some home rust removers.

Further Reading:

Akdemir O, Lineaweaver WC. Comparison of skin effects of immediate treatment modalities in experimentally induced hydrofluoric acid skin burns. *Int Wound J.* 2015;12(6):716-723.

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Miyamoto K, Shimizu M, Tanaka K, et al. Case of continuous trans-arterial calcium gluconate infusion using a direct arterial sphygmomanometry line that exhibited dramatic improvement of chemical burns on the fingers caused by hydrofluoric acid. *Chudoku Kenkyu*. 2014;27(4):343-347.

Yuanhai Z, Liangfang N, Xingang W, et al. Clinical arterial infusion of calcium gluconate: the preferred method for treating hydrofluoric acid burns of distal human limbs. *Int J Occup Med Environ Health.* 2014;27(1):104-113.

Case 13-10

Vohwinkel syndrome

Patient Presentation: A 17-year-old presented with atraumatic right little toe pain.

Clinical Features: The patient was in mild painful distress. The right little toe was swollen distal to a circumferential constriction at the base. There was minimal yellow drainage. Examination of the hands demonstrated chronic appearing skin changes with dorsal hyperkeratosis of the fingers.

Differential Dx:
- Vohwinkel syndrome
- Palmoplantar keratoderma
- Hair tourniquet

Emergency Care: A plain radiograph of the foot demonstrates marked bony thinning and destruction, with an apparent fracture through the thinned proximal phalanx. The patient was treated with Keflex and pain management with immobilization of the fifth toe.

Outcome: The patient was lost to follow-up.

Key Learning Points:
- Vohwinkel syndrome (keratoderma hereditaria mutilans) is a rare autosomal dominant condition that leads to characteristic hand and foot skin changes.
- Constriction bands lead to digital auto-amputation, as demonstrated in this case, where the right fifth toe was close to auto-amputation.
- Treatment is symptomatic to help ameliorate the keratoderma and prevent auto-amputation. Emollients, topical keratolytics, and systemic retinoids are used with varying success.
- A case report on this patient is the first reference listed.

Figure 13-12. RA = circumferential constriction at base of little toe

Reproduced with permission from Dodd EM, Dodd KW, Bart B, et al. Vohwinkel Syndrome: A rare cause of toe pain in an adolescent male. *Minn Med.* 2016 July/August; 99(4):46-47.

Figure 13-13. Foot x-ray. WA = marked bony thinning and destruction of proximal little toe phalanx

Reproduced with permission from Dodd EM, Dodd KW, Bart B, et al. Vohwinkel Syndrome: A rare cause of toe pain in an adolescent male. *Minn Med.* 2016 July/August; 99(4):46-47.

Further Reading:

Avshalumova L, Fabrikant J, Koriakos A. Overview of skin diseases linked to connexin gene mutations. *Int J Dermatol.* 2014;53(2):192-205.

Dodd EM, Dodd KW, Bart B, Brunette D. Vohwinkel syndrome: a rare cause of toe pain in an adolescent male. *Minn Med.* 2016;July/August, 99(4):46-47.

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Ul Bari A. Keratoderma hereditarium mutilans (Vohwinkel syndrome) in three siblings. *Dermatol Online J*. 2006;12(7):10.

Zhang M, Song K, Ding N, Shu C, Wang Y. Using a distant abdominal skin flap to treat digital constriction bands: a case report for Vohwinkel syndrome. *Medicine*. 2016;95(6):e2762.

Figure 13-14. Hyperkeratosis of the fingers

Reproduced with permission from Dodd EM, Dodd KW, Bart B, et al. Vohwinkel Syndrome: A rare cause of toe pain in an adolescent male. *Minn Med*. 2016 July/August; 99(4):46-47.

Case 13-11

Scrofula

Patient Presentation: A 25-year-old presented with swelling of the left neck for the past 3 months. The patient stated he was prescribed levofloxacin overseas and has been taking this medication for approximately 2 months with no improvement. He also endorsed fevers, chills, night sweats, and weight loss.

Clinical Features: There was a large, erythematous mass that was tender to palpation. There were no oropharyngeal abnormalities.

Figure 13-15. Large and erythematous neck mass

Differential Dx:

- Scrofula
- Necrotic lymphadenopathy
- Lymphoma
- Lymphangioma
- Abscess
- Tumor

Emergency Care: A CT scan demonstrated a multilocular necrotic neck mass.

Outcome: The patient was admitted for further diagnostic evaluation. The patient tested positive for the human immunodeficiency virus (HIV) and received a new diagnosis of acquired immune deficiency syndrome (AIDS), given the CD 4 count of 6 cells/mm^3. Aspiration of the neck mass revealed *Mycobacterium tuberculosis*, and his sputum was positive for *M tuberculosis*. He was also suffering from *Pneumocystis jiroveci (carinii)* pneumonia. He was treated for all of these infections and was discharge after a 19-day hospital stay.

Key Learning Points:

- Scrofula is tuberculous lymphadenitis of the neck and is a common presentation of tuberculosis in the developing world.
- Tuberculous lymphadenitis is generally a reactivation of dormant mycobacteria.
- Simultaneous tuberculosis and HIV disease have additive negative impacts. HIV disease increases the susceptibility to developing tuberculosis. Tuberculosis infection increases the rate of progression of HIV-infected patients to developing AIDS.

Further Reading:

Deleyiannis FW, Ramirez Ronda CH. The re-emergence of scrofula with HIV infection: a review of epidemiology, pathogenesis, diagnosis and treatment. *Bol Assoc Med P R.* 1991;83(11):487-488.

Fitzpatrick EL, Lejeune FE. Mycobacterial cervical lymphadenitis: a review. *J La State Med Soc.* 1996;148(11):451-454.
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Ibekwe AO, Al Shareef Z, Al Kindy S. Diagnostic problems of tuberculous cervical adenitis (scrofula). *Am J Otolaryngol.* 1997:18(3)202-205.

Case 13-12

Koplik spots

Patient Presentation: A 15-year-old presented with a fever, cough, and facial rash. He had recently immigrated to the United States.

Clinical Features: The patient was febrile and mildly ill appearing. He had signs of conjunctivitis. His rash was limited to his forehead and was erythematous, macular-papular, and blanching. On the buccal mucosa opposite his molar teeth there were white lesions consistent with Koplik spots, which are pathognomonic for rubeola.

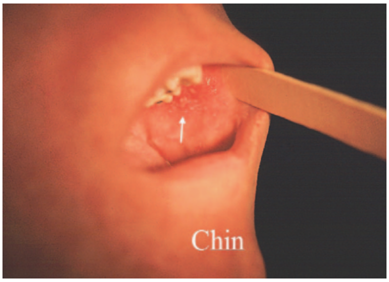

Figure 13-16. WA = Koplik spots pathognomonic for rubeola

Differential Dx:
- Viral exanthem from a large host of upper respiratory viruses
- Roseola
- Rubella
- Erythema infectiosum
- Varicella
- Kawasaki disease

Emergency Care: The patient was mildly ill appearing and did not exhibit any signs or symptoms of complications related to measles. Supportive care, notification of health authorities, and isolation of the patient were advised and performed.

Outcome: The patient was lost to follow-up.

Key Learning Points:
- Complications of measles include pneumonia, encephalitis, acute disseminated encephalomyelitis, subacute sclerosing panencephalitis, and severe diarrhea.
- Pregnant women, immunocompromised patients, and patients with vitamin A deficiency have a much greater risk of development of complications from measles. Pregnant women are at risk for both maternal and fetal complications.
- Certain patient populations have a decreased rate of measles vaccination because of the perceived link to autism.
- There is no scientific evidence of a causal link between measles-mumps-rubella vaccination and autism.

Further Reading:
Bahta L, Ashkir A. Addressing MMR vaccine resistance in Minnesota's Somali community. *Minn Med*. 2015;98(10):33-36.

Bester JC. Measles and measles vaccination: a review. *JAMA Pediatr*. 2016;170(12):1209-1215.

Goin-Kochel RP, Mire SS, Dempsey AG, et al. Parental report of vaccine receipt in children with autism spectrum disorder: do rates differ by pattern of ASD onset? *Vaccine*. 2016;34(11):1335-1342.

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Levine DA. Vaccine-preventable diseases in pediatric patients: a review of measles, mumps, rubella, and varicella. *Pediatr Emerg Med Pract*. 2016;13(12):1-20.

Smith M. Vaccine safety: medical contraindications, myths, and risk communication. *Pediatr Rev*. 2015;36(6):227-238.

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Turville C, Golden I. Autism and vaccination: the value of the evidence base of a recent meta-analysis. *Vaccine*. 2015;33(42):5494-5496.

Case 13-13

Id reaction

Patient Presentation: A 42-year-old presented with a pruritic rash on his hands. There was no prior history of a similar rash. He denied any new allergen exposures.

Clinical Features: The patient had a papulovesicular rash without signs of bacterial infection. Of note, the patient had a severe tinea pedis infection involving all toes on both feet.

Figure 13-17. Id reaction

Differential Dx:
- Contact dermatitis
- Dyshidrotic eczema
- Id reaction
- Fungal infection
- Chemical exposure

Emergency Care: This patient was diagnosed with tinea pedis and a resultant Id reaction as the etiology for his bilateral hand rash. He was treated with oral fluconazole and topical lotrimin cream on his feet.

Outcome: The patient had resolution of his tinea pedis and Id reaction.

Key Learning Points:
- Dermatophytid (Id) reactions are autoeczematization reactions usually related to primary fungal skin infections such as tinea pedis, tinea cruris, and tinea capitus. Unusual Id reactions have been attributed to scabies, pediculosis, and molluscum contagiosum.
- Id reactions are generally distant from the site of the primary fungal infection and frequently involve the hands.
- Treatment is aimed at the primary fungal skin infection. Id reactions may transiently worsen at the outset of treatment of the offending fungal infection. Topical steroids and antipruritic medications may be used for the Id reaction itself.

Further Reading:

Brenner S, Wolf R, Landau M. Scabid: an unusual id reaction to scabies. *Int J Dermatol.* 1993;32(2):128-129.

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Derebery J, Berliner KI. Foot and ear disease—the dermatophytid reaction in otology. *Laryngoscope*. 1996;106(2 pt 1):181-186.

Mayser P. Dermatophyte: Current situation [in German]. *Hautarzt*. 2017;68(4): 316-323.

Rocamora V, Romaní J, Puig L, de Moragas JM. Id reaction to molluscum contagiosum. *Pediatr Dermatol.* 1996;13(4):349-350.

Case 13-14

Tophaceous gout

Patient Presentation: A 72-year-old presented with a chief complaint unrelated to the pathology displayed in this case.

Clinical Features: The patient had the classic appearance of tophaceous gout with large tophi.

Figure 13-18. Large tophi

Differential Dx:
- Rheumatoid arthritis
- Osteoarthritis
- Pseudogout
- Sarcoidosis
- Psoriatic arthritis

Emergency Care: There was no sign of acute complication of her tophaceous gout, and the patient was treated symptomatically for her unrelated complaint.

Outcome: The patient was discharged from the ED.

Key Learning Points:
- Chronic tophaceous gout can be identified from collections of solid urate that can cause destructive changes of surrounding tissues such as articular bone, cartilage, tendons, ligaments, and joints.
- Typically, the lesions of chronic tophaceous gout are not painful but can be debilitating.
- Chronic open wounds associated with tophaceous gout lesions are difficult to heal.
- Effective treatment of tophaceous gout requires long-term urate-lowering therapy aimed at achieving a serum urate concentration of <5 mg/dL (300 μmol/L).
- There are new medical therapies available for this condition.

Further Reading:

Chhana A, Dalbeth N. The gouty tophus: a review. *Curr Rheumatol Rep*. 2015;17(3):19.

Deeks ED. Lesinurad. A review in hyperuricaemia of gout. *Drugs Aging*. 2017;34(5):401-410.

Kasper IR, Juriga MD, Giurini JM, Shmerling RH. Treatment of tophaceous gout: when medication is not enough. *Semin Arthritis Rheum*. 2016;45(6):669-674.

Lam G, Ross FL, Chiu ES. Nonhealing ulcers in patients with tophaceous gout: a systematic review. *Adv Skin Wound Care*. 2017;30(5):230-237.

Poratt D, Rome K. Surgical management of gout in the foot and ankle a systematic review. *J Am Podiatr Med Assoc*. 2016;106(3):182-188.

Case 13-15

Sporotrichosis

Patient Presentation: A young adult presented with a painful sore on his wrist. The patient worked outdoors as a landscaper. The lesion started 4 weeks prior to presentation.

Clinical Features: There was an open, circular sore approximately 3 cm in diameter on his dorsal wrist over his radius.

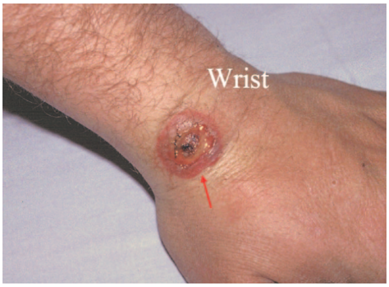

Figure 13-19. RA = open ulcer on wrist without surrounding cellulitis

Differential Dx:
- Community-acquired methicillin-resistant *Staphylococcus aureus*
- Foreign body
- Infected insect bite
- Infection related to intravenous drug abuse
- *Mycobacterium*
- Fungal infection
- Leishmaniasis

Emergency Care: The patient was treated for presumptive sporotrichosis with a prolonged course of oral itraconazole.

Outcome: The patient was lost to follow-up.

Key Learning Points:
- Lymphocutaneous sporotrichosis, caused by the fungus Sporothrix schenckii, is the most common form of this disease.
- Sporotrichosis has a worldwide distribution and has been associated with outbreaks of disease.
- Deep tissue, pulmonary, joint, central nervous system, and disseminated infections can occur requiring complex management.
- Treatment of simple cutaneous disease consists of antifungal medication for 3 to 6 months.

Further Reading:
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Bonifaz A, Vazquez-Gonzalez D. Sporotrichosis: an update. *G Ital Dermatol Venereol.* 2010;145(5):659-673.

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Schubach A, Barros ML, Wanke B. Epidemic sporotrichosis. *Curr Opin Infect Dis.* 2008;21(2):129-133.

Case 13-16

Henoch-Schonlein purpura

Patient Presentation: A 12-year-old presented with a rash, arm pain, intermittent joint pain, and abdominal pain.

Figure 13-20. RA = palpable purpura on the lower extremities

Clinical Features: The patient was in no painful distress and was well appearing. Skin examination revealed palpable purpura predominantly involving the lower extremities. The forearms were notable for painful subcutaneous nodules on the extensor surfaces. The abdominal examination revealed mild tenderness to palpation without any concerning clinical features. Despite the complaint of intermittent joint pain, none of the patient's joints were erythematous, swollen, warm, or tender to palpation.

Differential Dx:
- Septicemia
- Immune thrombocytopenia
- Hemolytic uremic syndrome
- Leukemia
- Coagulopathies
- Leukocytoclastic vasculitis
- Hypersensitivity vasculitis

Emergency Care: The diagnosis of Henoch-Schonlein purpura (HSP) was made clinically. A normal urinalysis and serum creatinine ruled out renal involvement. The patient was treated symptomatically.

Outcome: The patient was lost to follow-up.

Key Learning Points:
- HSP is an IgA vasculitis.
- The dominant clinical features (and associate prevalence) of HSP are cutaneous purpura (100%), arthritis (82%), abdominal pain (63%), gastrointestinal bleeding (33%), and nephritis (40%).
- Diagnosis is usually made on the clinical findings of palpable purpura, arthritis, abdominal pain, and no laboratory evidence for a coagulopathy such as thrombocytopenia or prolonged prothrombin time.
- The disease is usually self-limited in children and is treated symptomatically.
- Renal involvement is relatively common and can result in significant nephritis that may progress to end-stage renal disease in a small minority of patients.

Further Reading:

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Saulsbury FT. Henoch-Schonlein purpura in children. Report of 100 patients and review of the literature. *Medicine*. 1999;78(6):395-409.

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Case 13-17

Unusual ecchymoses from blunt trauma (two patients)

Patient Presentation: These are two adult patients who presented after being assaulted in unrelated incidents. Can you guess what object was utilized as a weapon resulting in the injuries shown to the shoulder of the first patient and to the face of the second patient?

Clinical Features: Skin examination revealed characteristic ecchymotic lesions.

Differential Dx:

- Blunt force traumatic injuries

Emergency Care: The first patient was assaulted using a golf club. The second patient in Fig. 13-22 was kicked in the face by an assailant wearing Nike shoes or sneakers.

Outcome: Both patients were treated symptomatically.

Key Learning Points:

- Forensic pathologists are trained to analyze patterns of ecchymosis to help determine mechanism and intent of injury.

Figure 13-21. First patient. Ecchymosis on the shoulder

Figure 13-22. Second patient. RA = ecchymosis on the forehead

Further Reading:

Carson HJ. Patterns of ecchymoses caused by manner of death and collateral injuries sustained in bruising incidents: decedent injuries, profiles, comparisons, and clinicopathologic significance. *J Forensic Sci*. 2010;55(6):1534-1542.

Dedouit F, Guilbeau-Frugier C, Capuani C, et al. Child abuse: practical application of autopsy, radiological, and microscopic studies. *J Forensic Sci*. 2008;53(6):1424-1429.

Zeyfeoglu Y, Uluçay T, Yavuz MS, Aşirdizer M. Incorrect identification in forensic medicine (wrong conclusion): a case report [in Turkish]. *Ulusal Trav Acil Cerrahi Derg*. 2010;16(2):185-188.

Case 13-18

Pruritic urticarial papules and plaques of pregnancy

Patient Presentation: A young female at 38 weeks' gestation presented with a pruritic rash that had been present for 2 days.

Clinical Features: The rash was most pronounced on the anterior abdominal wall, consisting of erythematous papules within striae. Similar lesions were also located on her back and extremities.

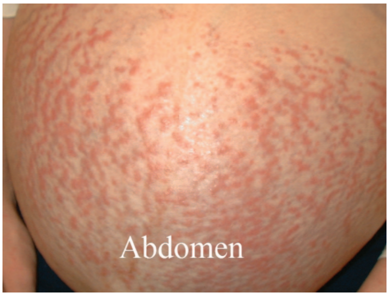

Figure 13-23. Erythematous papules within striae

Figure 13-24. Erythematous papules within striae (close up)

Differential Dx:
- Erythema multiforme
- Pemphigoid gestationis
- Drug reactions
- Viral syndromes
- Infestations such as scabies

Emergency Care: The diagnosis of pruritic urticarial papules and plaques of pregnancy (PUPPP) was made. The patient was treated symptomatically with triamcinolone acetonide 0.1% cream and loratadine.

Outcome: The patient was lost to follow-up.

Key Learning Points:
- PUPPP, or polymorphic eruption of pregnancy, generally occurs in the last few weeks of gestation and is characterized by an intensely pruritic eruption.
- It is self-limited and treated symptomatically with topical steroids and oral antihistamines.
- The five dermatoses occurring during pregnancy include pruritic urticarial papules and plaques of pregnancy, atopic eruption of pregnancy, pemphigoid gestationis, intrahepatic cholestasis of pregnancy, and pustular psoriasis of pregnancy.

Further Reading:

Alcalay J, Ingber A, David M, Hazaz B, Sandbank M. Pruritic urticarial papules and plaques of pregnancy. A review of 21 cases. *J Reprod Med*. 1987;32(4):315-316.

Lehrhoff S, Pomeranz MK. Specific dermatoses of pregnancy and their treatment. *Dermatol Ther*. 2013;26(4):274-284.

Scheinfeld N. Pruritic urticarial papules and plaques of pregnancy wholly abated with one week twice daily application of fluticasone propionate lotion: a case report and review of the literature. *Dermatol Online J*. 2008;14(11):4.

Case 13-19

Septic arthritis of the sternoclavicular joint

Patient Presentation: A young adult presented with pain in her anterior upper chest wall. The patient used intravenous drugs but denied "pocket shooting."

Figure 13-25. RA = erythematous left sternoclavicular joint

Clinical Features: There was swelling, erythema, warmth, and tenderness to the left sternoclavicular joint. No needle puncture sites were in the vicinity.

Differential Dx:
- Trauma to the sternoclavicular (SC) joint
- Arthritis
- SC joint infection
- Overlying cellulitis

Emergency Care: This was clinically diagnosed as a septic arthritis of her left sternoclavicular joint.

Outcome: The care of this patient was lost to follow-up.

Key Learning Points:
- MRI and/or aspiration of the sternoclavicular joint may be utilized to definitively diagnose septic arthritis.
- Intravenous drug abuse is a known risk factor for septic sternoclavicular arthritis.
- Treatment includes antimicrobial therapy and surgical intervention.

Further Reading:

Abu Arab W, Khadragui I, Echavé V, Deshaies A, Sirois C, Sirois M. Surgical management of sternoclavicular joint infection. *Eur J Cardiothorac Surg.* 2011;40(3):630-634.

Bodker T, Tøttrup M, Petersen KK, Jurik AG. Diagnostics of septic arthritis in the sternoclavicular region: 10 consecutive patients and literature review. *Acta Radiol.* 2013;54(1):67-74.

Ghasemi Barghi R, Mirakbari SM. Septic arthritis of sternoclavicular joint: a case report of a rare finding in injecting drug users. *Arch Iran Med.* 2010;13(3):248-250.

Johnson MC, Jacobson JA, Fessell DP, Kim SM, Brandon C, Caoili E. The sternoclavicular joint: can imaging differentiate infection from degenerative change? *Skeletal Radiol.* 2010;39(6):551-558.

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Case 13-20

Condyloma acuminata

Patient Presentation: A 42-year-old presented with rectal bleeding and pain.

Clinical Features: The patient was in mild painful distress. There was a large mass that had focal irritation with minor bleeding.

Differential Dx:

- Condyloma acuminatum
- Rectal cancer

Figure 13-26. RA = large rectal mass

Emergency Care: This lesion had previously been diagnosed as a condyloma measuring 15 cm in size and deemed at high risk for malignant transformation. This patient had been seen several times in the ED and surgery clinic for this problem.

Outcome: The patient failed follow-up in clinic, and it is likely he had this removed at an outside hospital.

Key Learning Points:

- The etiology of a condyloma acuminatum is human papilloma virus.
- Condyloma may resolve spontaneously, remain stable, or enlarge and progress.
- There are many possible therapeutic interventions; therefore, management should be individualized. Surgical excision is an option for lesions this large.
- Malignant transformation of giant condylomas is a well-described complication.

Further Reading:

Bowman IA, Parra A, Arriaga Y. Metastatic giant condyloma acuminata (Buschke-Löwenstein tumor). *J Oncol Pract*. 2016;12(10):951-953.

Gormley RH, Kovarik CL. Dermatologic manifestations of HPV in HIV-infected individuals. *Curr HIV/AIDS Rep*. 2009;6(3):130-138.

Papapanagiotou IK, Migklis K, Ioannidou G, et al. Giant condyloma acuminatum-malignant transformation. *Clin Case Rep*. 2017;5(4):537-538.

Rodriguez O, Kovarik CL. Spectrum and progression of disease from condyloma to aggressive anogenital squamous cell carcinoma in 3 HIV-positive patients. *JAAD Case Rep*. 2016;2(1):47-50.

Sir E, Gungor M, Ucer O, Kebat T. Invasive squamous cell carcinoma originating from a giant penile condyloma. *Int J STD AIDS*. 2017;28(6):619-622.

Case 13-21

Peau d'orange

Patient Presentation: A 38-year-old woman presented for evaluation of skin changes on her left breast.

Clinical Features: The patient had peau d'orange skin changes associated with inflammatory breast cancer. There is also a color change in the overlying skin. A mass was palpable deep to the abnormal skin.

Figure 13-27. RA = peau d'orange of the right breast

Differential Dx:
- Cellulitis
- Cancer
- Abscess

Emergency Care: The patient was referred to the surgery clinic.

Outcome: A fine-needle biopsy revealed infiltrating ductal breast cancer. Operative removal with mastectomy, lymph node dissection, and chemotherapy resulted in 8 years of remission.

Key Learning Points:
- Peau d'orange is caused by cutaneous lymphatic edema often seen with inflammatory breast cancer.

Further Reading:

Ballesio L, D'Ambrosio, Ravazzolo N, et al. Skin thickening as unique pathologic sign of an inflammatory breast cancer: a case report and review of the literature. *Clin Ter.* 2011;162(4):351-354.

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Singletary SE, Cristofanilli M. Defining the clinical diagnosis of inflammatory breast cancer. *Semin Oncol.* 2008;35(1):7-10.

Woodward WA, Cristofanilli M. Inflammatory breast cancer. *Semin Radiat Oncol.* 2009;19(4):256-265.

Case 13-22

Hepatic injury and tire marks

Patient Presentation: A young adult presented for evaluation after being run over by a car.

Clinical Features: The patient was in moderate to severe painful distress and was hemodynamically unstable. There were tread marks of the tire that ran over her right flank and upper abdomen.

Differential Dx:
- Multiple traumatic thoracoabdominal injuries

Emergency Care: The patient was resuscitated. A contrast-enhanced abdominal CT scan revealed a significant hepatic injury with foci of active extravasation.

Outcome: The patient was taken to interventional radiology where active hepatic hemorrhagic extravasation was confirmed and treated successfully with endovascular coiling. The patient had a subsequent laparotomy demonstrating her liver injury. She made a full recovery.

Key Learning Points:
- Blunt liver injury is graded I to VI depending on the extent, size, and depth of the liver lacerations; a higher grade is associated with increased mortality.
- Endovascular management with angiography and embolization has decreased the need for operative intervention.
- Complications related to nonoperative management include bile leak and subsequent ascites, biloma, abscess, or hepatic necrosis related to angioembolization.

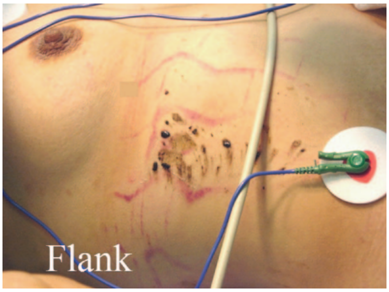

Figure 13-28. Tire marks over the right flank and upper abdomen

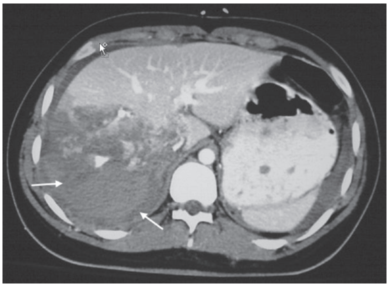

Figure 13-29. Contrast-enhanced abdominal CT scan. WA = hepatic injury

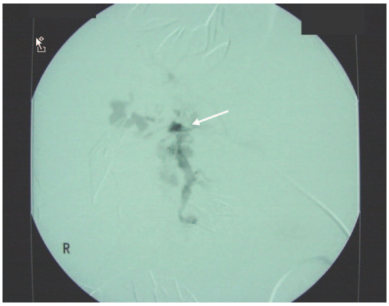

Figure 13-30. Interventional angiography. WA = active contrast extravasation from hemorrhage

Further Reading:

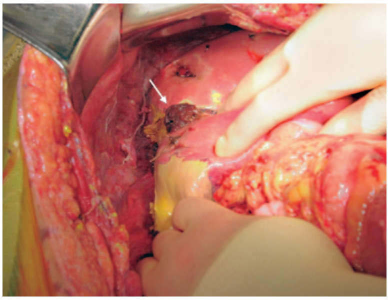

Figure 13-31. Intraoperative photo. WA = hepatic injury

Christmas AB, Wilson AK, Manning B, et al. Selective management of blunt hepatic injuries including nonoperative management is a safe and effective strategy. *Surgery*. 2005;138(4):606-610.

Kozar RA, McNutt MK. Management of adult blunt hepatic trauma. *Curr Opin Crit Care*. 2010;16(6):596-601.

Kutcher ME, Weis JJ, Siada SS, et al. The role of computed tomographic scan in ongoing triage of operative hepatic trauma: A Western Trauma Association multicenter retrospective study. *J Trauma Acute Care Surg*. 2015;79(6):951-956.

Peitzman AB, Ferrada P, Puyana JC. Nonoperative management of blunt abdominal trauma: have we gone too far? *Surg Infect (Larchmt)*. 2009;10(5):427-433.

Misselbeck TS, Teicher EJ, Cipolle MD, et al. Hepatic angioembolization in trauma patients: indications and complications. *J Trauma*. 2009;67(4):769-773.

Case 13-23

Allergic reaction to a henna tattoo

Patient Presentation: A young female presented with bilateral hand and forearm pain after receiving a temporary henna tattoo.

Clinical Features: Vesicles and fluid-filled bullae with cutaneous erythema were present in the skin stained with the henna.

Differential Dx:
- Allergic contact dermatitis
- Thermal injury
- Foreign body
- Caustic injury

Emergency Care: The patient was treated for contact dermatitis with a topical corticosteroid and oral antihistamine.

Outcome: The patient was lost to follow-up.

Key Learning Points:
- Temporary henna tattoos have increased in popularity.
- Temporary black henna tattoo is created by adding red henna, a plant-derived substance, to paraphenylenediamine (PPD). Application of temporary black henna tattoo can result in allergic contact dermatitis.
- Topical or oral corticosteroids with antihistamines have been used for treatment.

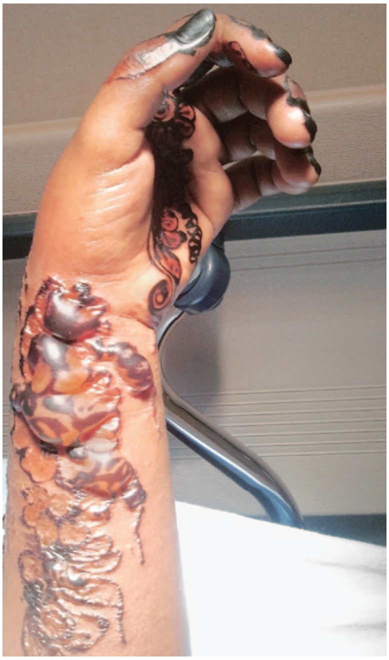

Figure 13-32. Allergic reaction to a henna tattoo

Figure 13-33. Allergic reaction to a henna tattoo

Further Reading:

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Calogiuri G, Di Leo E, Butani L, et al. Hypersensitivity reactions due to black henna tattoos and their components: are the clinical pictures related to the immune pathomechanism? *Clin Mol Allergy.* 2017;15:8.

De Groot AC. Side-effects of henna and semi-permanent 'black henna' tattoos: a full review. *Contact Dermatitis*. 2013;69(1):1-25.

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Case 13-24

Epidermolysis bullosa pruriginosa

Patient Presentation: This patient presented with itching of the back.

Clinical Features: The patient's back had a significant number of hypertrophic, lichenified, prurigo-like plaques and nodules. There were some newer lesions with bullae present.

Figure 13-34. Epidermolysis bullosa pruriginosa

Differential Dx:

- Acquired inflamed dermatosis

Emergency Care: The patient was treated symptomatically for pruritis.

Outcome: The patient was referred to the dermatology clinic.

Key Learning Points:

- Epidermolysis bullosa pruriginosa is an inherited clinical variant of dystrophic epidermolysis bullosa.
- Cryotherapy, immunosuppressant therapy including cyclosporine, and thalidomide have all been used for treatment.

Future Reading:

Ee HL, Liu L, Goh CL, McGrath JA. Clinical and molecular dilemmas in the diagnosis of familial epidermolysis bullosa pruriginosa. *J Am Acad Dermatol.* 2007;56 (5 suppl):S77-S81.

Horn HM, Tidman MJ. The clinical spectrum of dystrophic epidermolysis bullosa. *Br J Dermatol.* 2002;146(2):267-274.

Kim WB Alavi A, Pope E, Walsh S. Epidermolysis bullosa pruriginosa: case series and review of the literature. *Int J Low Extrem Wounds.* 2015;14(2):196-199.

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Ozanic Bulic S, Fassihi H, Mellerio JE, McGrath JA, Atherton DJ. Thalidomide in the management of epidermolysis bullosa pruriginosa. *Br J Dermatol.* 2005;152(6):1332-1334.

Case 13-25

Home remedy for skin tags

Patient Presentation: A 50-year-old presented for evaluation of a skin lesion. The patient stated he looked on the internet and discovered a method of removing these lesions. The method was to tightly tie dental floss around the base of the lesion, which he did 2 days prior to this presentation. The patient was seeking reassurance.

Figure 13-35. RA = skin tag, WA = dental floss

Clinical Features: There was dental floss tied tightly around the base of a single skin tag that had turned dark and necrotic. There were no signs of cellulitis or abscess.

Differential Dx:

- Melanoma
- Neurofibromas
- Pedunculated dermal nevus

Emergency Care: The patient was assured that his treatment was working and the skin tag would fall off soon.

Outcome: The patient was discharged from the ED and lost to follow-up.

Key Learning Points:

- Acrochordons, (skin tags) are an outgrowth of normal skin. They are pedunculated lesions on narrow stalks.
- The number of skin tags tends to increase with aging.
- Surgical removal of skin tags is straightforward.
- Application of an adhesive patch with removal in 3 to 6 days has also been described.

Further Reading:

Farley A. How to get rid of skin tags with dental floss. Available at: http://www.livestrong.com/article/24919-remove-skin-tags-using-dental/. Accessed June 4, 2018.

Fredriksson CH, Ilias M, Anderson CD: New mechanical device for effective removal of skin tags in routine health care. *Dermatol Online J*. 2009;15(2):9.

Skin Tags Gone. How to get rid of skin tags with dental floss in 7 days. Available at: https://www.skintagsgone.com/get-rid-skin-tags-dental-floss/. Accessed June 4, 2018.

Case 13-26

Hit by lightning while fishing

Patient Presentation: A young adult male presented after the small fishing boat he was riding in on a lake was struck by lightning.

Clinical Features: The patient was awake and hemodynamically stable and in mild to moderate painful distress. His right hand had been holding his fishing pole; he sustained a thermal burn from melted graphite and plastic material from the fishing pole. Both of the patient's sneakers appeared to have exploded.

Figure 13-36. Thermal burn from melted fishing pole handle

Differential Dx:

- Injuries sustained from lightning strike

Emergency Care: The patient had local burn wound management in the ED. Additional diagnostic workup did not reveal any other significant injury.

Figure 13-37. Sneaker of the patient had significant damage from the lightning strike

Outcome: The patient was admitted to the hospital for observation. His second-degree hand burns were managed by the burn service and did not require any additional interventions after the initial debridement.

Key Learning Points:

- Injuries from lightning strikes include cardiac arrhythmias, renal injury from rhabdomyolysis, central and peripheral nervous system injury, skin and muscle injury, inner and middle ear trauma, and vascular injury.
- Cardiac arrest can occur because lightning strikes are huge voltage and huge amperage currents. In this circumstance, the presenting rhythm is generally asystole and not ventricular fibrillation or ventricular tachycardia.
- Diagnostic evaluation needs to be detailed and thorough as many potential injuries can occur.
- Close initial observation is warranted.

Further Reading:

Cherington M. Lightning and transportation. *Semin Neurol.* 1995;15(4):362-366.

Davis C, Engeln A, Johnson EL, et al. Wilderness Medical Society practice guidelines for the prevention and treatment of lightning injuries: 2014 update. *Wilderness Environ Med.* 2014;25(4 suppl):S86-S95.

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Ritenour AE, Morton MJ, McManus JG, Barillo DJ, Cancio LC. Lightning injury: a review. *Burns*. 2008;34(5):585-594.

Thomson EM, Howard TM. Lightning injuries in sports and recreation. *Curr Sports Med Rep*. 2013;12(2):120-124.

Case 13-27

Severe anemia

Patient Presentation: A 31-year-old presented with weakness. She complained about nausea and one black stool on the day of admission.

Clinical Features: The patient appeared moderately ill and hypotension and tachycardia were noted. The patient was extremely pale. She was guaiac positive with black stool.

Differential Dx:

- Gastrointestinal bleeding
- Anemia from decreased red blood cell production
- Occult trauma

Figure 13-38. Markedly pale hand from anemia (hemoglobin 2.4 g/dL)

Emergency Care: The patient's initial hemoglobin was 2.4 g/dL. Her mean red blood cell volume (MCV) was 70.7 fL. The patient was transfused packed red blood cells with improvement in her hemodynamics. The patient was admitted for further evaluation of likely chronic gastrointestinal bleeding.

Outcome: An extensive workup revealed esophageal varices and portal gastropathy as the etiology for her blood loss. The esophageal varices were banded, and the patient started on pantoprazole. The etiology of the portal hypertension was alcohol abuse.

Key Learning Points:

- Undifferentiated anemia can be caused by red blood cell loss, decreased red blood cell production, or red blood cell destruction. The workup of anemia falls into these three categories.
- This patient had severe anemia as a chronic process with adaptive physiologic changes. A patient with acute blood loss anemia and a hemoglobin of 2.4 g/dL would be profoundly hypovolemic and hemodynamically unstable. Her MCV of 70.7 fL is indicative of a microcytic anemia from iron deficiency and a chronic, slow blood loss.
- Survival without sequela have been reported with a hemoglobin concentration of less than 1 g/dL.
- A quick bedside check for signs of anemia is examination of the color of the conjunctiva.

Further Reading:

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Case 13-28

Scombroid poisoning

Patient Presentation: A young adult patient presented after the sudden onset of an intensely pruritic rash. The patient had no difficulty with breathing and no intraoral or throat swelling. This rash started shortly after ingesting tuna at a restaurant.

Clinical Features: The patient was well appearing with stable vital signs. Skin examination revealed a diffuse, coalesced, and raised erythematous rash. Examination of the oropharynx and lungs was unremarkable.

Figure 13-39. Diffuse, coalesced, and raised erythematous rash

Differential Dx:
- Allergic reaction
- Scombroid poisoning
- Systemic mastocytosis

Emergency Care: The patient was treated with both diphenhydramine and ranitidine.

Outcome: The patient had an excellent response to ED therapy.

Key Learning Points:
- Scombroid is associated with the ingestion of improperly stored dark meat fish such as tuna, mackerel, skip-jack, bonito, marlin, and mahi-mahi among several others.
- When fish is stored above 4°C (40°F), bacterial overgrowth occurs causing histadine, via histadine decarboxylase, to convert to histamine and other active bioamines.
- The ingested fish may not have an unusual appearance or odor, but the affected individual may describe a “peppery” taste.
- Clinical manifestations are diverse and include erythematous or urticarial rash, nausea, vomiting, abdominal cramping, headache, tachycardia or hypotension, and dizziness.
- Respiratory distress is rare.
- Kounis syndrome, a complex of cardiovascular signs and symptoms including coronary artery spasm and EKG changes suggestive of acute myocardial infarction, has been associated with scombroid poisoning.
- Treatment is with H1 and/or H2 antihistamine medications.

Further Reading:

Anastasius M, Yiannikas J. Scombroid fish poisoning illness and coronary artery vasospasm. *Australas Med J.* 2015 Mar 31;8(3):96-99.

Angelo KM, Nisler AL, Hall AJ, Brown LG, Gould LH. Epidemiology of restaurant-associated foodborne disease outbreaks, United States, 1998-2013. *Epidemiol Infect*. 2017;145(3):523-534.

Colombo FM, Cattaneo P, Confalonieri E, Bernardi C. Histamine food poisonings: a systematic review and meta-analysis. *Crit Rev Food Sci Nutr*. 2018;58(7):1131-1151.

De Gennaro L, Brunetti ND, Locuratolo N, et al. Kounis syndrome following canned tuna fish ingestion. *Acta Clin Belg*. 2017;72(2):142-145.

Feng C, Teuber S, Gershwin ME. Histamine (scombroid) fish poisoning: a comprehensive review. *Clin Rev Allergy Immunol*. 2016;50(1):64-69.

Kounis NG, Giannopoulos S, Soufras GD, Kounis GN, Goudevenos J. Foods, drugs and environmental factors: novel Kounis syndrome offenders. *Intern Med*. 2015;54(13):1577-1582.

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Case 13-29

Large hand blister

Patient Presentation: A young adult with a history of diabetes was seen at an outside healthcare facility complaining of hand pain. The patient denied any recent trauma. She was transferred to our facility for treatment of suspected necrotizing fasciitis due to the availability of hyperbaric oxygen.

Figure 13-40. Large hand blister

Clinical Features: The patient was afebrile, hemodynamically stable, and in mild painful distress. The patient had a large hand blister that was semitransparent containing relatively clear fluid. The blister was surrounded by erythema and warmth. There was no subcutaneous crepitance palpated.

Differential Dx:
- Cellulitis
- Necrotizing fasciitis
- Abscess
- Foreign body
- Traumatic injury
- Frostbite injury

Emergency Care: The large blister was opened, and the skin representing the full area of the blister was debrided and removed. Beneath the blister was a second-degree burn injury with viable and nonnecrotic-appearing tissue. The patient was admitted for further therapy.

Outcome: The patient received intravenous antibiotics for treatment of cellulitis and was discharged with eventual full recovery without any additional surgical intervention or hyperbaric oxygen therapy.

Key Learning Points:
- Necrotizing fasciitis can be associated with hemorrhagic skin bullae. However, it is also generally accompanied by moderate to severe pain and a fever within an ill-appearing, septic patient.
- Type I necrotizing fasciitis is polymicrobial and caused by mixed aerobic and anaerobic organisms. It is frequently associated comorbidities such as diabetes or vascular disease. Type II is monomicrobial and often due to group A streptococcus.
- Treatment of necrotizing fasciitis includes extensive surgical debridement and broad- spectrum antimicrobial therapy, and there may be a role for hyperbaric oxygen therapy.

Further Reading:

Hassan Z, Mullins RF, Friedman BC, et al. Treating necrotizing fasciitis with or without hyperbaric oxygen therapy. *Undersea Hyperb Med.* 2010;37(2):115-123.

Kaide CG, Khandelwal S. Hyperbaric oxygen: applications in infectious disease. *Emerg Med Clin North Am*. 2008;26(2):571.

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Shaw JJ, Psoinos C, Emhoff TA, Shah SA, Santry HP. Not just full of hot air: hyperbaric oxygen therapy increases survival in cases of necrotizing soft tissue infections. *Surg Infect (Larchmt)*. 2014;15(3):328-335.

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Weaver LK. Hyperbaric oxygen in the critically ill. *Crit Care Med*. 2011;39(7):1784-1791.

Case 13-30

Hot asphalt tar injury

Patient Presentation: A 24-year-old presented with a hot asphalt tar injury.

Clinical Features: The patient was in mild painful distress with asphalt tar densely adhered to his hand and forearm.

Figure 13-41. Asphalt tar densely adhered to skin

Differential Dx:

- Degree of underlying burn injury

Emergency Care: Mayonnaise was liberally applied to the asphalt tar and left on for 10 minutes followed by a slow and gentle scrub removal using a sponge wet with sterile saline. Second-degree burns were noted after tar removal, and they were covered with antibiotic ointment and nonadherent gauze dressing.

Figure 13-42. RA = mayonnaise used for tar removal revealing second-degree thermal burns

Outcome: The patient was followed in the burn clinic with complete healing of his burns.

Key Learning Points:

- Prior to the advent of commercially available medical adhesive removers, several substances were utilized to successfully remove hot tar including household butter, sunflower oil, olive oil, baby oil, topical antibiotics, and mayonnaise.

Further Reading:

Baruchin AM, Schraf S, Rosnberg L, Sagi AA. Hot bitumen Burns: 92 hospitalized patients. *Burns.* 1997;23(5):438-441.

Bosse GM, Wadia SA, Padmanabhan P. Hot asphalt burns: a review of injuries and management options. *Am J Emerg Med.* 2014;32(7):820.e1-e3.

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Shea PC, Fannon P. Mayonnaise and hot tar burns. *J Med Assoc Ga.* 1981;70(9):659-660.

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CHAPTER 14 Genitalia

Case 14-1

Penoscrotal entrapment

Patient Presentation: A young male presented to the emergency department (ED) complaining of scrotal and penile pain. He had placed his penis and scrotum through a thick metallic ring approximately 48 hours before presentation.

Clinical Features: The patient's penis and scrotum were markedly swollen and edematous with a thick metallic ring around the base of his penis and scrotum. There were no external signs of vascular insufficiency or necrosis and no open wounds or ulcers. Abdominal examination was unremarkable, and the bladder was not distended.

Figure 14-1. WA = thick metallic ring at base of scrotum and penis

Differential Dx:

- Several concerns were extant, including vascular insufficiency of either scrotal contents or of the penis.
- Urinary retention was not present per patient history and not evident on examination.

Emergency Care: The patient was in moderate painful distress. The patient received 1 mg of intravenous hydromorphone for pain. Deliberations as to how to remove this metallic ring ensued. The initial thought was to place the patient into Trendelenberg position, apply ice to the genitalia, and manually compress the scrotum and penis slowly to reduce the edema and slip the scrotum backwards through the ring. This did not seem like a viable plan given the degree of swelling and concern for vascular injury. The decision was made to cut the metal ring under conscious sedation. Ketamine 1 mg/kg was administered IV. A hand-held rotary tool with a metal cutting disk was utilized for ring removal. The flat blade of an army/navy surgical retractor was slipped between the metal ring and the skin to prevent the cutting disk from causing injury as it cut through the metal ring. Cold water was continuously poured over the metal ring and flat blade of the retractor to prevent the metal from heating and causing burns. Two separate cuts on opposite sides of the metal ring were required for removal. It should be noted that our ED has both a battery powered and 120 V hand-held rotary cutting tool for such a case.

Outcome: The ketamine sedation abated, and the patient had a significant reduction in his pain level. He was observed over several hours, with the edema rapidly resolving. He was able to urinate with no signs of any other complication, and he was discharged home.

Key Learning Points:

- Management of uncommon and novel clinical scenarios often require utilization of novel and innovative procedures. A high-speed, hand-held, rotary tool is one of the nonstandard pieces of equipment emergency physicians will find useful.
- When using a powered rotary cutter, continuous application of cooling fluid (generally water) to prevent heating of the metal and subsequent patient burns is extremely important.
- Lock and bolt cutters have also been successful in similar presentations by clipping both sides of the metallic ring. The surrounding tissues must not be so swollen as to preclude the cutting edges of the bolt cutter to extend across the entire metallic ring.

Further Reading:

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Wu X, Batra R, Al-Akraa M, Seneviratne LN. Penoscrotal entrapment: a safe, innovative technique for removing metal constricting devices. *BMJ Case Rep*. 2012; 2012. pii: bcr2012006466.

Case 14-2

Thermometer in the bladder

Patient Presentation: A 22-year-old woman presented to the ED complaining of a misplaced thermometer. The exact mechanism of how and why this occurred was not well delineated by history taking, nor was the intended site of temperature measurement known.

Clinical Features: The patient was in no painful distress and had a benign abdominal examination.

Differential Dx:
- Retained thermometer in the rectum or vagina

Emergency Care: An abdominal radiograph demonstrated the thermometer to be completely within the urinary bladder.

Outcome: The thermometer was removed via cystoscopy without difficulty.

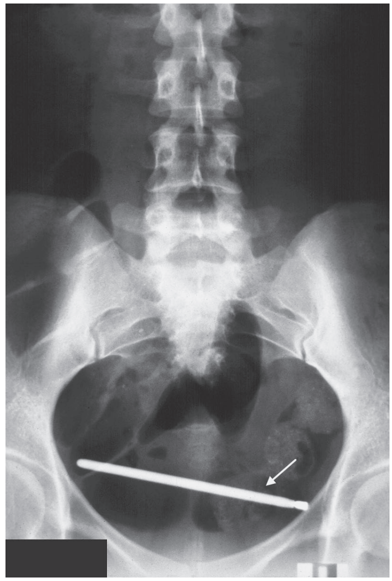

Figure 14-2. Pelvis x-ray. WA = thermometer in the urinary bladder

Key Learning Points:
- Perhaps surprisingly, published case reports exist describing similar scenarios.

Further Reading:

Allen D, Glass J. Transvaginal contraception—avoid the bladder. *Int J Clin Pract Suppl*. 2005;(147):87-88.

Dardamanis M, Balta L, Zacharopoulos V, Tatsi V, Tzima H. An unexpected foreign body (a thermometer) in the bladder: a case report. *Urol Case Rep*. 2014;2(2):65-66.

Lansman HH, Rizzi JN. Delivery complicated by a foreign body (thermometer) in the bladder: a case report. *Obstet Gynecol*. 1960;15(188-190).

Nie J, Zhang B, Duan YC, et al. Intestinal obstruction due to migration of a thermometer from bladder to abdominal cavity: a case report. *World J Gastroenterol*. 2014;20(9):2426-2428.

Case 14-3

Imperforate hymen with hematometrocolpos

Patient Presentation: A 13-year-old girl presented with severe abdominal pain. The patient had not yet started menstruating and gave a recent history of recurrent monthly abdominal pain.

Clinical Features: The patient was in moderate painful distress. Abdominal examination revealed moderate lower abdominal tenderness to palpation, and vaginal examination revealed a bulging bluish membrane at the vaginal introitus.

Differential Dx:
- Imperforate hymen
- Tumor
- Foreign body
- Vascular malformation
- Menarche

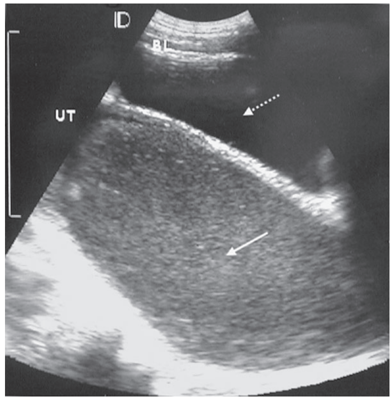

Figure 14-3. Pelvic ultrasound. WA = enlarged uterus with homogeneous echogenic material, WDA = urinary bladder

Emergency Care: An ED bedside transabdominal ultrasound demonstrated an enlarged uterus filled with homogeneous echogenic material posterior to her urinary bladder. The patient was diagnosed with an imperforate hymen with hematocolpometra and was taken to the operating room.

Outcome: The patient underwent hymenectomy and recovered uneventfully.

Key Learning Points:
- Hematocolpometra is an accumulation of blood in the uterus and vagina as a complication of an imperforate hymen.
- An imperforate hymen is a relatively common obstruction of the vagina. If it is not diagnosed at birth, it may remain asymptomatic until menarche.
- Serial dilation is a novel technique that can be substituted for the traditional incisional hymenectomy in cases of microperforate hymens.

Further Reading:
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Fischer JW, Kwan CW. Emergency point-of-care ultrasound diagnosis of hematocolpometra and imperforate hymen in the pediatric emergency department. *Pediatr Emerg Care*. 2104;30(2):128-130.

Makris GM, Macchiella D, Vaidakis D, Chrelias C, Battista MJ, Siristatidis C. Abdominal tumor in a 14-year-old adolescent: imperforate hymen, resulting in hematocolpos—a case report and review of the literature. *Case Rep Obstet Gynecol*. 2015;2015:429740.

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Segal TR, Fried WB, Krim EY, Parikh D, Rosenfeld DL. Treatment of microperforate hymen with serial dilation: a novel approach. *J Pediatr Adolesc Gynecol*. 2015;28(2):e21-e22.

Case 14-4

Money bills pinned to the scrotum

Patient Presentation: A young man was involved in a high-speed motor vehicle crash.

Clinical Features: The patient had multiple significant traumatic injuries. During his evaluation, his clothes were removed revealing numerous $1 and $5 bills attached to his scrotum and penis with safety pins.

Figure 14-4. BA = penis, RA = safety pins, WA = money attached to his penis and scrotum

Differential Dx:
- Multiple traumatic injuries.

Emergency Care: The safety pins with the attached money were carefully released and removed from his genitalia. Further details of this case are not available.

Outcome: Unknown.

Key Learning Points:
- Be prepared for the unexpected.
- When removing clothes from patients, be careful as you do not know what you might find in, on, or under the clothing.
- No similar case reports could be found related to this case. However, Klingsor syndrome is self-mutilation in the setting of psychosis, frequently involving self-castration or penile amputation and is well reported in the literature.

Further Reading:
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Jindal T, Ghosh N, Kamal M, et al. Surgical reconstruction of penile stump in a patient with Klingsor syndrome. *Ghana Med J*. 2012;46(4):251-253.

Schweitzer I. Genital self-amputation and the Klingsor syndrome. *Aust N Z J Psychiatry*. 1990;24(4):566-569.

Veeder TA, Leo RJ. Male genital self-mutilation: a systematic review of psychiatric disorders and psychosocial factors. *Gen Hosp Psychiatry.* 2017;44:43-50.

Case 14-5

Foreign bodies traversing the urethra into the bladder (two patients)

Patient Presentations: These are two male patients with unique presentations having a similar complaint of a foreign body placed in the urethra that was subsequently unable to be removed.

Clinical Features: The first patient placed a necklace through his penis into his bladder. The second patient had a lamp chain entering his penis and terminating in the bladder.

Differential Dx:

- Urethral foreign bodies with possible urethral or bladder injury

Emergency Care: Both patients received analgesia and underwent cystoscopy with successful removal. The second patient required first-stage urethroplasty and suprapubic catheter placement secondary to difficulties removing the lamp chain.

Outcome: Both patients recovered from their incidents.

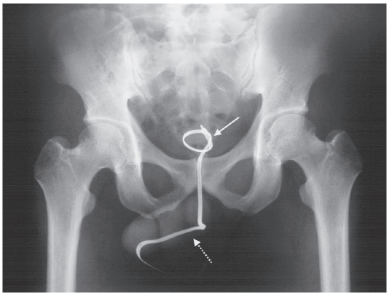

Figure 14-5. First patient. Pelvis x-ray. WA = necklace in the bladder, WDA = penis

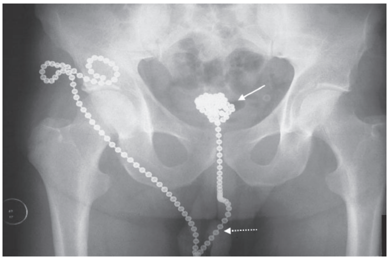

Figure 14-6. Second patient. Pelvis x-ray. WA = lamp chain in the bladder, WDA = penis

Key Learning Points:

- It is possible to feed a long flexible object into the male bladder. Removal of such objects by transurethral cystoscopy might fail if the object has become tangled or knotted within the bladder, necessitating a suprapubic approach.

Further Reading:

Ahn H, Son H. Successful removal of an intravesical electrical wire cable. *World J Mens Health*. 2014;32(2):120-122.

Gupta S, Jain P, Pal DK, Banerjee M. An unusually long electric wire in a urethra and bladder. *Int J Adolesc Med Health*. 2016. pii: /j/ijamh.ahead-of-print/ijamh-2016-0071/ijamh-2016-0071.xml.

Hashmi S, Khan I. Foreign body in urinary bladder: an unusual presentation. *J Ayub Med Coll Abbottabad*. 2015;27(2):494-495.

Ratkal JM, Raykar R, Shirol SS. Electric wire as foreign body in the bladder and urethra-a case report and review of literature. *Indian J Surg*. 2015;77(suppl 3): 1323-1325.

Sokmen D, Törer BD, Kargı T, Yavuzsan AH, Şahin S, Tuğcu V. Unusual foreign body in the vesico-urethral; 195 cm liquid pipe. *Turk J Urol*. 2014;40(4):248-250.

Stamatiou K, Moschouris H. A rubber tube in the bladder as a complication of auto-erotic stimulation of the urethra. *Arch Ital Urol Androl*. 2016;88(3):239-240.

Case 14-6

Heterotopic pregnancy

Patient Presentation: A young female presented with abdominal pain.

Clinical Features: The patient was in mild painful distress with stable vital signs. Abdominal examination revealed bilateral lower quadrant tenderness to palpation without peritoneal signs. There was no vaginal bleeding.

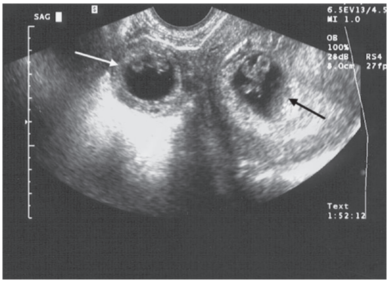

Figure 14-7. Pelvic ultrasound. BA = intrauterine pregnancy, WA = ectopic pregnancy

Differential Dx:

- Cystitis
- Pelvic inflammatory disease
- Appendicitis
- Ectopic pregnancy
- Threatened spontaneous miscarriage
- Bowel obstruction, inflammatory bowel disease
- Diverticular disease
- Urinary tract infection

Emergency Care: A urine pregnancy test was positive. Pelvic ultrasound demonstrated a heterotopic pregnancy with fetal cardiac activity in both the ectopic pregnancy and the intrauterine pregnancy.

Outcome: The patient went to the operating room for removal of the ectopic pregnancy.

Key Learning Points:

- The rate of heterotopic pregnancies has increased significantly as the result of assisted reproductive techniques such as super-ovulation, intrauterine insemination, and in vitro fertilization.
- A delayed diagnosis of heterotopic pregnancy is a known complication of assisted reproductive techniques.
- A systematic approach to pregnancy resulting from assisted reproductive techniques and incorporating point-of-care ultrasound are important in the timely diagnosis of heterotopic pregnancy.

Further Reading:

Baron KT, Babagbemi KT, Arleo EK, Asrani AV, Troiano RN. Emergent complications of assisted reproduction: expecting the unexpected. *Radiographics.* 2013;33(1):229-244.

Chadee A, Rezai S, Kirby C, et al. Spontaneous heterotopic pregnancy: dual case report and review of literature. *Case Rep Obstet Gynecol.* 2016;2016:2145937.

Clayton HB, Schieve LA, Peterson HB, Jamieson DJ, Reynolds MA, Wright VC. A comparison of heterotopic and intrauterine-only pregnancy outcomes after assisted reproductive technologies in the United States from 1999 to 2002. *Fertil Steril.* 2007;87(2):303.

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Tal J, Haddad S, Gordon N, Timor-Tritsch I. Heterotopic pregnancy after ovulation induction and assisted reproductive technologies: a literature review from 1971 to 1993. *Fertil Steril.* 1996;66(1):1.

Wang L, Chen X, Ye DS, et al. Misdiagnosis and delayed diagnosis for ectopic and heterotopic pregnancies after in vitro fertilization and embryo transfer. *J Huazhong Univ Sci Technolog Med Sci.* 2014;34(1):103-107.

Case 14-7

Perineal laceration with extruded testicle

Patient Presentation: A 7-year-old was struck by a car.

Clinical Features: The patient was awake, alert, and in moderate painful distress. Abdominal examination was benign, but there was considerable tenderness of the entire pelvis. The patient had a normal right testicle, but no left testicle was palpated. There was a large inguinal laceration, and his left testicle and spermatic cord appeared to be herniating through this laceration.

Figure 14-8. RA = extruded testicle in a large perineal laceration

Differential Dx:
- Multiple traumatic injuries including pelvic and genital injury

Emergency Care: Given the degree of pain the patient was experiencing and the multiple diagnostic studies that needed to be performed, the patient underwent deep sedation after rapid sequence intubation. The patient was noted to have a right sacroiliac joint separation with right superior and inferior pubic rami fractures. There was blood at the urethral meatus, but a transurethral bladder catheter was gently and successfully placed. The patient was taken to the operating room.

Outcome: The patient had a left orchiectomy with repair of his inguinal laceration. He eventually had open reduction and internal fixation of his pelvic fracture and went on to an uneventful recovery.

Key Learning Points:
- Blood at the male urethral meatus is not an absolute contraindication for indwelling bladder catheter placed via the penis.
- A retrograde urethrogram can assess for partial or complete urethral disruption when urethral meatal blood is visualized. Complete urethral disruption, where no contrast is seen in the bladder, is a contraindication for transurethral bladder catheter placement, and a suprapubic catheter is indicated. Partial urethral injuries, where there is contrast both in the bladder as well as extravasation from the urethra, can have a gentle attempt at a transurethral bladder catheter placement. If any resistance is encountered, the procedure should be aborted.

Further Reading:

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Rodriguez Costa A, Romeo C, López G, De Viedma A, Agra Cadarso B. Traumatic amputation of the testicle. Successful reimplantation using microsurgery (author's transl) [in Spanish]. *An Esp Pediatr*. 1978;11(12):865-867.

Case 14-8

Polyembolokoilamania

Patient Presentation: A 52-year-old man placed a machine screw into his urethra and was unable to remove it. He complained of penile pain, a weak urinary stream, and dysuria.

Clinical Features: The patient was in mild painful distress. The tip of the penis at the urethra was slightly swollen and irritated. A pelvis radiograph was obtained showing the machine screw in relation to the penis. The machine screw was visualized by gently opening the urethral meatus. There was no bleeding.

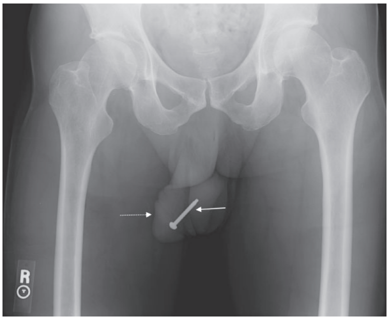

Figure 14-9. Pelvis x-ray. WA = machine screw, WDA = penis

Differential Dx:
- Foreign body
- Urethral injury
- Urinary tract infection

Emergency Care: The machine screw was grabbed by a hemostat and gently removed without difficulty.

Outcome: The patient had no complications and was discharged home.

Key Learning Points:
- Polyembolokoilamania is the name of a disease in which a person inserts objects into body orifices.
- One case report details 11 separate urethral objects found in one patient: 4 metallic screws and 7 sewing needles.

Further Reading:

Gonzalgo ML, Chan DY. Endoscopic basket extraction of a urethral foreign body. *Urology*. 2003;62(2):352.

Hatipoglu N, Yucel M, Hatipoglu N, Yentur S, Semercioz A. An unusual foreign body in urethra: nail clippers. *Cent European J Urol*. 2011;64(2):92-93.

Prasad Ray R, Ghosh B, Pal DK. Urethral foreign body in an adolescent boy: report of two rare cases and review of literature. *Int J Adolesc Med Health*. 2015;27(4):463-465.

Singh I, Pal AK, Gautam L. Multiple impacted urethral metallic needles and screws (foreign bodies) associated with polyembolokoilamania. *Indian J Surg*. 2015;77(suppl 1):106-108.

Case 14-9

Summer penile syndrome

Patient Presentation: A 46-year-old man presented with penile swelling. He had urinated outside and later the same day discovered and removed a tick from his penis.

Clinical Features: The patient had no pain. The patient had a pale, edematous penis without open wounds. The penis was warm and erythematous but minimally tender to palpation. There was a small scab on the shaft of his penis where the tick had been attached. His glans was visible.

Figure 14-10. Pale edema of the penis

Differential Dx:
- Cellulitis
- Tick-borne transmitted disease
- Angioedema

Emergency Care: The patient was treated with 2 g of intravenous cephazolin and ranitidine. He was discharged on cephalexin, ranitidine, and diphenhydramine.

Outcome: The patient returned the following day with continued swelling and a new complaint of itching. Examination showed no significant change in the swelling. The overall appearance favored allergic reaction and/or angioedema rather than cellulitis. He was given a one-time dose of doxycycline for prevention of Lyme disease and started on oral steroids. The patient was subsequently lost to follow-up.

Key Learning Points:
- Summer penile syndrome is an acute hypersensitivity reaction to the bites of chiggers and mites.
- It is characterized by penile swelling and pruritis with a mean duration of 4 days.
- Treatment includes oral antihistamines, cold compresses, and steroids if signs or symptoms are severe.
- Penile bites from humans, snakes, ticks, scorpions (sting), and brown recluse spiders are well reported in the medical literature.

Further Reading:

Broughton G 2nd. Management of the brown recluse spider bite to the glans penis. *Mil Med.* 1996;161(10):627-629.

Crane DB, Irwin JS. Rattlesnake bite of glans penis. *Urology*. 1985;26(1):50-52.

Garcia AS, De Freitas DG, De Freitas FO. Penis wound by scorpion sting. *Sao Paulo Med J.* 1999;117(2):85-86.

Nishi M, Matsumoto K, Sawamura M, et al. Tick-bite in penile skin: a case report [in Japanese]. *Hinyokika Kiyo.* 2010;56(3):185-187.

Okahashi K, Oiso N, Yano Y, Kawada A. Tick attachment cement with a feeding cavity in the deep dermis of the penis. *Acta Derm Venereol.* 2015;95(6):741-742.

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Thachil RT, Tony JC, Sridhar CB. Snake bite on the penis. *Trop Doct.* 1991;21(4):179.

Yamada Y, Dekio S, Jidoi J, Isobe A, Shiwaku K, Yamane Y. A case of tick bite from *Amblyomma testudinarium* on the glans penis. *J Dermatol*. 1996;23(2):136-138.

Case 14-10

Fractured penis

Patient Presentation: A 28-year-old man presented with penile pain, bruising, and swelling. The patient states he felt the injury occur during sex.

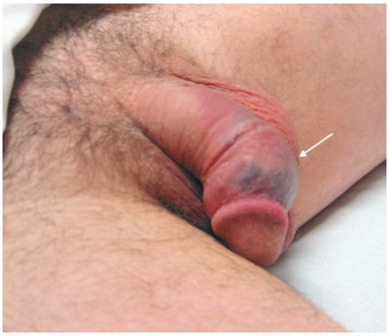

Figure 14-11. WA = fractured penis

Clinical Features: The patient had a penile deformity with associated ecchymosis, swelling, and tenderness to palpation.

Differential Dx:
- Penile contusion
- Penile fracture

Emergency Care: Analgesia.

Outcome: The patient underwent operative repair of his fractured penis with return of erectile function.

Key Learning Points:
- Penile fracture occurs when the erect penis is forcefully bent, causing one or both tunica albugenia to rupture.
- Urethral injury can accompany penile fracture.

Further Reading:
Amer T, Wilson R, Chlosta P, et al. Penile fracture: a meta-analysis. *Urol Int.* 2016;96(3):315-329.
Dell'Atti L. The role of ultrasonography in the diagnosis and management of penile trauma. *J Ultrasound*. 2016;19(3):161-166.
Gunes M, Ozkol H, Pirincci N, Gecit I, Bilici S, Yildirim S. Beneficial influence of topical extra virgin olive oil application on an experimental model of penile fracture in rats. *Toxicol Ind Health*. 2015;31(8):704-711.
Pariser JJ, Pearce SM, Patel SG, Bales GT. National patterns of urethral evaluation and risk factors for urethral injury in patients with penile fracture. *Urology*. 2015;86(1):181-185.
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Case 14-11

Entrapped penis

Patient Presentation: A young male patient presented complaining of severe pain. He had placed a lengthy metal clamp on the base of his penis.

Clinical Features: A metal clamp was tightly wrapped around the base of his penis with marked swelling, ecchymosis, and apparent necrosis of his distal penis.

Differential Dx:

- Ischemia and necrosis of the penis
- Marked vascular congestion without necrosis

Emergency Care: The patient was taken to the dental department and placed in a dental chair. The tools used to remove the metal clamp included a high-speed dental cutting disk and an orthopedic cast splitter.

Outcome: A subsequent photo of his penis is shown. Whether or not penile erectile function was preserved is unknown.

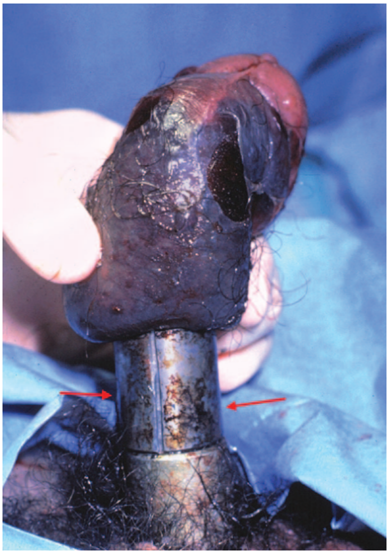

Figure 14-12. RA = thick metallic clamp on base of penis

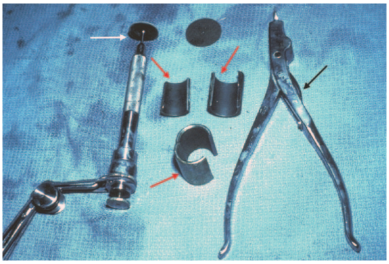

Figure 14-13. BA = orthopedic cast splitter, RA = removed metal clamp, WA = high-speed dental cutting disk

Key Learning Points:

- The initial examination looks consistent with penile necrosis, but looks were deceiving.
- This case occurred before the advent of portable high-speed rotary tools, hence the utilization of high-speed dental equipment. Today this could be accomplished in the ED under conscious sedation with a high-speed portable rotary tool.
- Many approaches to releasing a penis entrapped in a constricting device have been described; the method chosen will depend on the availability of tools and operator skill, as well as the nature of the constricting device and the current condition of the patient and his penis.

Further Reading:

Agu TC, Obiechina N. Post coital penile ring entrapment: a report of a non-surgical extrication method. *Int J Surg Case Rep*. 2016;18:15-17.

Li C, Xu YM, Chen R, Deng CL. An effective treatment for penile strangulation. *Mol Med Rep*. 2013;8(1):201-204.

Paonam S, Kshetrimayum N, Rana I. Penile strangulation by iron metal ring: a novel and effective method of management. *Urology Ann*. 2017;9(1):74-76.

Sathesh-Kumar T, Hanna-Jumma S, De Zoysa N, Saleemi A. Genitalia strangulation—fireman to the rescue! *Ann R Coll Surg Engl*. 2009;91(4):W15-W16.

Talib RA, Canguven O, Al Ansari A, Shamsodini A. Treatment of penile strangulation by the rotating saw and 4-needle aspiration method: two case reports. *Arch Ital Urol* Androl. 2014;86(2):138-139.

Wu X, Batra R, Al-Akraa M, Seneviratne LN. Penoscrotal entrapment: a safe, innovative technique for removing metal constricting devices. *BMJ Case Rep*. 2012;2012. pii: bcr2012006466.

Figure 14-14. Subsequent photo of penis

Case 14-12

Fournier gangrene

Patient Presentation: A male diabetic presented with scrotal swelling and pain.

Figure 14-15. RA = markedly swollen scrotum, WA = tip of penis

Clinical Features: The patient was in moderate to severe painful distress and was febrile and tachycardic. The patient's scrotum was markedly swollen and painful with areas of necrosis and palpable subcutaneous emphysema. The retracted penis was difficult to visualize.

Differential Dx:
- Necrotizing fasciitis
- Fournier gangrene

Emergency Care: The patient emergently received analgesia and antibiotic therapy.

Outcome: The patient was admitted for surgical intervention and hyperbaric oxygen therapy. Final outcome is unknown.

Key Learning Points:
- Fournier gangrene is a necrotizing fasciitis involving the perineum.
- Treatment consists of aggressive and early surgical debridement, antibiotics, and hyperbaric oxygen, if available.

Further Reading:

Faria SN, Helman A. Deep tissue infection of the perineum: case report and literature review of Fournier gangrene. *Can Fam Physician.* 2016;62(5):405-407.

Pernetti R, Palmieri F, Sagrini E, et al. Fournier's gangrene: clinical case and review of the literature. *Arch Ital Urol Androl.* 2016;88(3):237-238.

Rosa I, Guerreiro F. Hyperbaric oxygen therapy for the treatment of Fournier's gangrene: a review of 34 cases. *Acta Med Port*. 2015;28(5):619-623.

Singh A, Ahmed K, Aydin A, Khan MS, Dasgupta P. Fournier's gangrene. A clinical review. *Arch Ital Urol Androl*. 2016;88(3):157-164.

Case 14-13

Thrombosis of the right corpus cavernosum

Patient Presentation: A 42-year-old man presented with perineal pain. He was recently diagnosed with diabetes. His pain started 3 days ago, was increasing in severity, and was worsened with sitting.

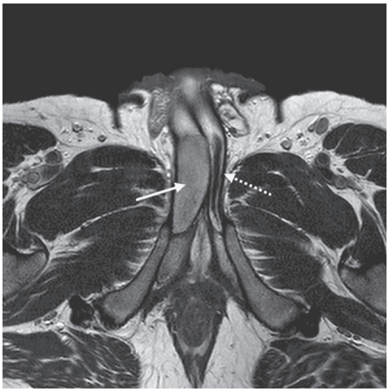

Figure 14-16. Pelvis MRI. WA = thrombosis of right corpus cavernosum, WDA = normal left corpus cavernosum

Clinical Features: The patient was in mild to moderate painful distress. He was afebrile and nontoxic appearing. The perineum had focal exquisite tenderness at the attachment of the corpora cavernosum to the pubic bone with a fullness felt. Rectal examination was without evidence for perirectal or perianal abscess. The prostate was normal and nontender.

Differential Dx:
- Abscess
- Prostatitis
- Cellulitis
- Necrotizing fasciitis (Fournier gangrene)

Emergency Care: A bedside ED ultrasound did not demonstrate a discrete fluid collection. An abdominal and pelvic computed tomography scan was unremarkable. A pelvis magnetic resonance imaging (MRI) scan showed an 8-cm long enlargement of the proximal right corpus cavernosum with mass effect on the left corpus cavernosum and a normal left corpus cavernosum. There was a filling defect on T2W sequences with no enhancement after contrast. These findings were consistent with partial segmental acute thrombosis of the right corpus cavernosum.

Outcome: The patient was treated with opioid analgesia and was anticoagulated with enoxaparin followed by warfarin. He was followed over several months with gradual improvement in his pain as well as return of normal erectile function.

Key Learning Points:
- Partial thrombosis of the proximal corpora cavernosum is rare.
- Pelvic MRI has the highest diagnostic yield in this condition.
- Loss of erectile function is a significant long-term complication.

Further Reading:

Horger DC, Wingo MS, Keane TE. Partial segmental thrombosis of corpus cavernosum: case report and review of world literature. *Urology*. 2005;66(1):194.

Hulth M, Albersen M, Fode M, et al. Idiopathic partial thrombosis of the corpus cavernosum: aetiology, diagnosis and treatment. *Scand J Urol*. 2013;47(2):163-168.

Pepe P, Panella P, Candiano G, Garufi A, Priolo G, Aragona F. Partial priapism secondary to idiophatic segmental thrombosis of corpora cavernosa. *Arch Ital Urol Androl*. 2012;84(2):101-103.

Case 14-14

Superglued (cyanoacrylate adhesive) vagina

Patient Presentation: A young woman presented complaining of abdominal pain and inability to urinate. Further history revealed that super glue had been applied to her vaginal labia.

Clinical Features: The patient was alert and in mild pain. She had suprapubic tenderness to palpation. The labia were tightly adhered with dried superglue noted on the edges.

Figure 14-17. Vagina with labia majora closed with superglue (cyanoacrylate adhesive)

Differential Dx:
- Urinary retention
- Labial injury

Emergency Care: The urethral meatus was not accessible, and a suprapubic catheter was inserted to relieve the urinary retention. Multiple applications of warm viscous lidocaine to the labia were performed to soften the superglue and deliver local analgesia. After several hours, the labia separated. The suprapubic catheter was removed.

Outcome: The patient was lost to follow-up.

Key Learning Points:
- Common accidental exposures to superglue include instillation into the eye and ear.
- Deliberate instillation of superglue has been reported in the male urethra.
- Many different approaches are utilized for superglue removal, including acetone, hydrogen peroxide, mineral oil, antibiotic ointment, warm water, and soapy warm water.
- The anatomic location of superglue must be taken into consideration when determining which method is safest to utilize.
- Medical cyanoacrylate is often used in closure of simple lacerations.

Further Reading:

Abadir WF, Nakhla V, Chong P. Removal of superglue from the external ear using acetone: case report and literature review. *J Laryngol Otol*. 1995;9(12):1219-1221.

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Spencer TJ, Clark B. Self-inflicted superglue injuries. *Med J Austral*. 2004;181(6):341.
Tikka T, Al Abduwani J, Costello D. Deliberate self-harming application of superglue in the nose: case report and literature review. *J Laryngol Otol*. 2015;129(1):98-100.
Young MJ, Noblet T, Symons SJ. Surgical technique for the delayed removal of superglue from the male urethra. *Cent European J Urol*. 2016;69(3):290-292.

Case 14-15

Crack pipe hidden in the vagina

Patient Presentation: A young woman presented with an altered mental status. The patient had been riding her bike erratically, and 911 was called. During her evaluation in the ED, the patient stated she had stored a crack pipe in her vagina. The patient stated she was not hiding the pipe, but rather "storing" it for later use.

Clinical Features: Mildly altered mental status from alcohol intoxication. The patient was in no painful distress and had a benign abdominal examination.

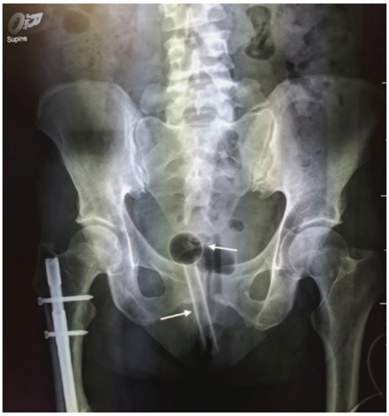

Figure 14-18. Pelvis x-ray. WA = crack pipe located in the vagina

Differential Dx:

- Foreign body in vagina

Emergency Care: A pelvis radiograph revealed the intact crack pipe in the vagina. The crack pipe was removed without difficulty.

Key Learning Points:

- Retained vaginal foreign bodies can lead to vesicovaginal fistulas.
- The most common retained vaginal foreign bodies are condoms and tampons.
- "Prince Albert" penile piercing, in which a metallic bead is anchored to the male urethral opening, has been reported as a vaginal foreign body not visualized on pelvic examination but discovered on pelvic radiograph.

Further Reading:

Das G, Rawal N, Bolton LM. The case of the missing "Prince Albert." *Obstet Gynecol*. 2005;105(5 pt 2):1273-1275.

D'ella C, Curti P, Cerruto MA, Monaco C, Artibani W. Large urethro-vesico-vaginal fistula due to a vaginal foreign body in a 22-year-old woman: case report and literature review. *Urol Int*. 2015;95(1):120-124.

Emge KR. Vaginal foreign body extraction by forceps: a case report. *Am J Obstet Gynecol*. 1992;167(2):514-515.

Evans JM, South MM, Karram MM. Vesicovaginal fistula due to remote history of vaginal foreign body. *Female Pelvic Med Reconstr Surg*. 2012;18(6):374-375.

Islam A, Arif S. Colouterine fistula with a foreign body. *J Ayub Med Coll Abbottabad*. 2010;22(2):205-207.

CHAPTER

15 Self-Imposed

Case 15-1

Strychnine poisoning

Patient Presentation: A 53-year-old man presented with an altered mental status. The initial report was that he had ingested mushrooms in a suicide gesture.

Clinical Appearance: The patient had a decreased level of consciousness and was tachycardic. His pupils were both 4 mm, reactive to light, and deviated to the right. He had intense muscular rigidity of his entire body with spastic extremity movements when physically stimulated.

Figure 15-1. RA = strychnine seeds soaking in an elixir

Differential Dx:

- Toxicologic exposure from unknown agent

Emergency Care: The patient received lorazepam IV that greatly improved his muscular rigidity and spasticity. The bottle containing the ingested substance was sent to the poison center and identified as strychnine seeds soaking in an elixir. The patient was admitted to the intensive care unit.

Outcome: The patient continued to have intermittent severe and painful muscle spasms for 24 hours and was treated with additional doses of benzodiazepine. His creatinine kinase peaked at 3500 IU/L, and he fully recovered. He was transferred to the psychiatric service.

Key Learning Points:

- The classic presentation of strychnine poisoning is the appearance of tonic-clonic seizure like activity in the setting of a normal mental status. Opisthotonos as well as risus sardonicus are seen. These muscular signs fluctuate with periods of relaxation.
- Tachycardia, rhabdomyolysis with renal failure, hyperthermia, and compartment syndrome can develop.
- Treatment is primarily supportive, including benzodiazepines, which can mitigate muscle spasms.

Further Reading:

Parker AJ, Lee JB, Redman J, Jolliffe L. Strychnine poisoning: gone but not forgotten. *Emerg Med J.* 2011;28(1):84.

Prat S, Hoizey G, Lefrancq T, Saint-Martin P. An unusual case of strychnine poisoning. *J Forensic Sci.* 2015;60(3):816-817.

Ryan CJ, Anderson J. Case 12-2001: strychnine poisoning. *N Engl J Med.* 2001;345(21):1577.

Shadnia S, Moiensadat M, Abdollahi M. A case of acute strychnine poisoning. *Vet Hum Toxicol*. 2004;46(2):76-79.

Singhapricha T, Pomerleau AC. A case of strychnine poisoning from a Southeast Asian herbal remedy. *J Emerg Med*. 2017;52(4):493-495.

Case 15-2

Fatal ingestion of 2,4-Dinitrophenol

Patient Presentation: A 26-year-old presented complaining of severe shortness of breath and chest pain after ingesting approximately 3 g of 2,4-Dinitrophenol (DNP).

Clinical Features: The patient was alert, oriented, and in severe respiratory distress. He had a normal blood pressure with a heart rate of 180 beats/min and was febrile to 40°C (104°F).

Differential Dx:

- Poisoning

Emergency Care: A bedside cardiac ultrasound demonstrated hyperdynamic cardiac activity. An electrocardiogram revealed tachycardia with peaked T waves. Metabolic shifting of suspected hyperkalemia was performed with calcium gluconate, insulin, sodium bicarbonate, and D50. The patient underwent rapid sequence intubation with etomidate and rocuronium. The ventilator settings were set to meet his increased respiratory demands. Shortly after intubation, his temperature dramatically increased to 42°C (108°F). External cooling measures were instituted. The patient suffered a cardiac arrest, during which time he became extremely rigid. Masseter spasm caused him to bite down on his endotracheal tube. He was given atracurium, calcium gluconate, and 5 g of hydroxycobalamin without effect. Chest wall compressions became ineffective due to chest wall rigidity.

Outcome: The patient died in the emergency department 91 minutes after arrival.

Key Learning Points:

- DNP uncouples oxidative phosphorylation and increases metabolic requirements and energy consumption.

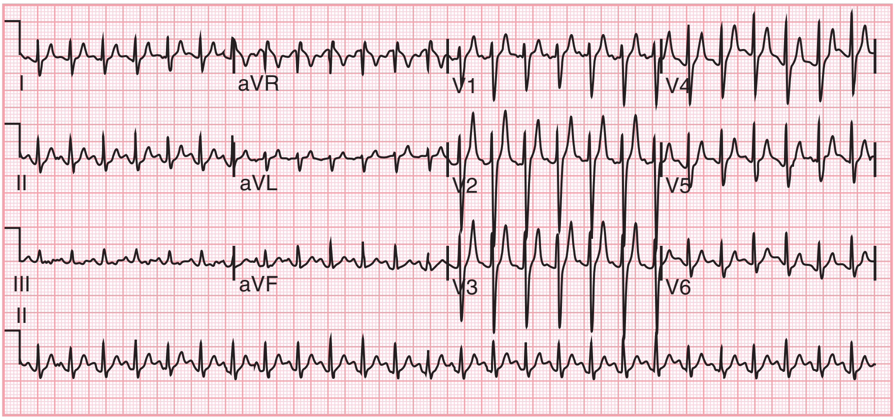

Figure 15-2. Electrocardiogram revealing sinus tachycardia with peaked T waves

- Clinical features of DNP overdose are fever (47%), tachycardia (43%), sweating (37%), nausea or vomiting (27%), skin discoloration or rash (23%), respiratory distress (23%), abdominal pain (23%), agitation (13%), and headache (13%).
- DNP is easily acquired via the internet.

Further Reading:

Grundlingh J, Dargan PI, El-Zanfaly M, Wood DM. 2,4-dinitrophenol (DNP): a weight loss agent with significant acute toxicity and risk of death. *J Med Toxicol*. 2011;7(3):205-212.

Holborow A, Purnell RM, Wong JF. Beware the yellow slimming pill: fatal 2,4-dinitrophenol overdose. *BMJ Case Rep*. 2016;2016.

Hsiao AL, Santucci KA, Seo-Mayer P, et al. Pediatric fatality following ingestion of dinitrophenol: postmortem identification of a "dietary supplement." *Clin Toxicol (Phila)*. 2005;43(4):281-285.

Kamour A, George N, Gwynnette D, et al. Increasing frequency of severe clinical toxicity after use of 2,4-dinitrophenol in the UK: a report from the National Poisons Information Service. *Emerg Med J*. 2015;32(5):383-386.

Case 15-3

Mercuric oxide poisoning

Patient Presentation: This is a young adult who ingested mercuric oxide. He presented with nausea, vomiting, and abdominal pain.

Clinical Features: This patient was acutely ill appearing. He was found to have acute renal failure.

Differential Dx:
- Toxic exposure to mercuric oxide
- Exposure to additional medications or substances

Emergency Care: An abdominal radiograph demonstrated radio-opaque mercuric oxide within the bowel lumen. Laboratory workup demonstrated acute renal failure.

Outcome: The patient was admitted to the hospital for emergency hemodialysis. No further follow-up was available.

Figure 15-3. Abdominal x-ray. WA = mercuric oxide

Key Learning Points:
- Mercuric oxide is used in batteries and certain pigments.
- Patients present with nausea, vomiting, abdominal pain, and bloody diarrhea. Circulatory collapse with tachycardia and hypotension occur early, with renal failure developing within 24 hours.
- Treatment is aggressive intensive care support. Activated charcoal and whole bowel irrigation are performed until abdominal radiographs show no retained mercuric oxide in the bowel. Hemodialysis may be needed for acute renal failure. Chelation therapy is complex and includes succimer and dimercaprol.

Further Reading:

Dias D, Bessa J, Guimarães S, Soares ME, Bastos Mde L, Teixeira HM. Inorganic mercury intoxication: a case report. *Forensic Sci Int*. 2016;259:e20-e24.

Ly BT, Williams SR, Clark RF. Mercuric oxide poisoning treated with whole-bowel irrigation and chelation therapy. *Ann Emerg Med*. 2002;39(3):312-315.

Case 15-4

Iron poisoning

Patient Presentation: A young patient presented with iron ingestion.

Clinical Features: Data not available.

Differential Dx:
- Iron toxicity
- Coingestion
- Other complication related to poisoning

Emergency Care: An abdominal radiograph demonstrated an iron bezoar in the stomach.

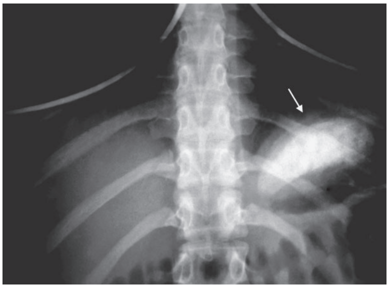

Figure 15-4. Abdominal x-ray (coned down). WA = iron bezoar in the stomach

Outcome: Data not available.

Key Learning Points:
- Initial signs and symptoms of severe iron toxicity include nausea, vomiting, bloody diarrhea, and abdominal pain. This is followed by a latent period in which the patient appears to be recovering. The next phase includes acidosis and clinical shock secondary to hypovolemia, vasodilation, and direct myocardial depression. This can be followed by hepatic failure.
- Treatment includes aggressive supportive care, bowel decontamination with whole bowel irrigation if there is a large amount of iron visualized on abdominal radiograph, and deferoxamine.
- Published case reports describe stomach iron bezoars removed via gastrotomy.

Further Reading:

Haider F, De Carli C, Dhanani S, Sweeney B. Emergency laparoscopic-assisted gastrotomy for the treatment of an iron bezoar. *J Laparoendosc Adv Surg Tech A*. 2009;19(suppl 1):S141-S143.

Kaczorowski JM, Wax PM. Five days of whole-bowel irrigation in a case of pediatric iron ingestion. *Ann Emerg Med*. 1996;27(2):258-263.

Klein-Schwartz W, Oderda GM, Gorman RL, Favin F, Rose SR. Assessment of management guidelines. Acute iron ingestion. *Clin Pediatr (Phila)*. 1990;29(6):316-321.

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Madiwale T, Liebelt E. Iron: not a benign therapeutic drug. *Curr Opin Pediatr*. 2006;18(2):174-179.

Sipahi T, Karakurt C, Bakirtas A, Tavil B. Acute iron ingestion. *Indian J Pediatr*. 2002;69(11):947-949.

Velez LI, Gracia R, Mills LD, Shepherd G, Feng SY. Iron bezoar retained in colon despite 3 days of whole bowel irrigation. *J Toxicol Clin Toxicol*. 2004;42(5):653-656.

Case 15-5

Thermometer mercury injections

Patient Presentation: A young patient presented after intentional injection of mercury from home thermometers into his fingertips.

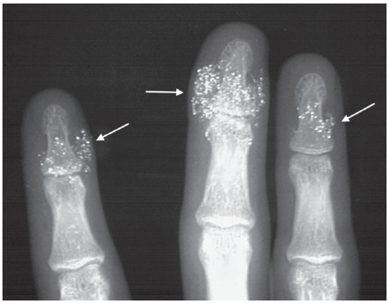

Figure 15-5. Finger x-ray. WA = finger tips injected with mercury

Clinical Features: Data not available.

Differential Dx:

- Additional coingestants

Emergency care: A hand radiograph demonstrated mercury in the fingertips of the index, long, and ring fingers.

Outcome: Data not available.

Key Learning Points:

- Given the advent of multiple new devices available for rapid and convenient temperature measurement, exposure to thermometer mercury is now infrequent.
- Acute interstitial pneumonitis can be caused by inhaled mercury and may be fatal.
- Chronic exposure can result in changes in personality such as anxiety, irritability, excitability, insomnia, memory loss, depression, fatigue, weakness, and drowsiness. Other symptoms may include diaphoresis, a desquamating rash, and hair loss.

Further Reading:

Aprahamian N, Lee L, Shannon M, Hummel D, Johnston P, Kimia A. Glass thermometer injuries: it is not just about the mercury. *Pediatr Emerg* Care. 2009;25(10):645-647.

Ochs H, Boldt I, Messerschmidt W, Boldt U. Intravenous injection of thermometer mercury (author's transl) [in German]. *MMW Munch Med Wochenschr*. 1975;27;117(26):1117-1120.

Shen Z, Zheng S, Dong K, Xiao X, Shi W. Subperitoneal pelvic exposure of elemental mercury from a broken thermometer. *Clin Toxicol (Phila)*. 2012;50(2):145-148.

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Tanaka T, Miyake M, Tono S, Asatani T, Usui M. Surgical extraction of traumatic orbital mercury. *Ophthalmologica*. 1997;211(6):402-404.

Zupanc O, Zupanc T, Brvar M, Bunc M. Arthroscopic treatment of knee joint injury for intraarticular mercury from a broken thermometer. *Arch Orthopaed Trauma Surg*. 2008;128(9):979-983.

Case 15-6

Accidental IV air injection

Patient Presentation: A 54-year-old presented with shortness of breath, weakness, and transient hypotension. The patient had a history of IV drug abuse.

Clinical Features: The patient was hemodynamically stable and well appearing.

Differential Dx:

- Metabolic or endocrine abnormality
- Cardiovascular or pulmonary disease
- Central nervous system pathology
- Gastrointestinal disorder
- Infection or sepsis

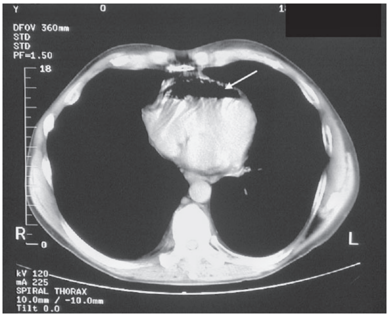

Figure 15-6. Contrast-enhanced chest CT scan. WA = air in the right ventricle

Emergency Care: The patient underwent a contrast-enhanced chest computed tomography (CT) scan that demonstrated free air in the right ventricle and pulmonary artery. The patient remained stable and underwent hyperbaric oxygen therapy.

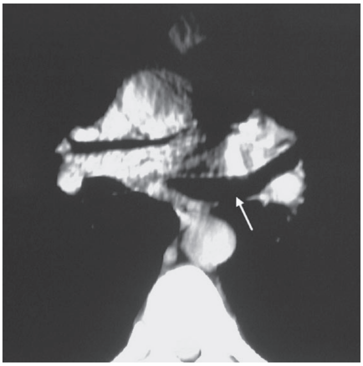

Figure 15-7. Contrast-enhanced chest CT scan. WA = air in pulmonary artery

Outcome: This patient was lost to follow-up.

Key Learning Points:

- Diagnostic imaging frequently confirms the presence of IV air associated with peripheral and central venous catheter placement in patients.
- The development of symptoms and signs of venous air embolism from peripheral and central line placement or removal depends on several factors. These include the route and location of air entry, the volume of air injected, the rate of air entry, and the presence of a patent foramen ovale.
- It is likely that many patients have subclinical venous air entry during vascular procedures.
- The minimum volume of air to result in fatality is unknown, but cases of 200 cc of injected air leading to death have been reported.

Further Reading:

Agarwal SS, Kumar L, Chavali KH, Mestri SC. Fatal venous air embolism following intravenous infusion. *J Forensic Sci*. 2009;54(3):682-684.

Geissler HJ, Allen SJ, Mehlhorn U, Davis KL, Morris WP, Butler BD. Effect of body repositioning after venous air embolism. An echocardiographic study. *Anesthesiology*. 1997;86(3):710-717.

Groell R, Schaffler GJ, Rienmueller R. The peripheral intravenous cannula: a cause of venous air embolism. *Am J Med Sci*. 1997;314(5):300-302.

Thomas JK, Rossberg MI, Hutchins GM. Volume of air in a lethal venous air embolism. Anesthesiology. 2001;94(2):360-361.

Sakai O, Nakashima N, Shinozaki T, Furuse M. Air bubbles in the subclavian or internal jugular veins: a common finding on contrast-enhanced CT. *Neuroradiology*. 1998;40(4):258-260.

Varga C, Luria I, Gravenstein N. Intravenous air: the partially invisible phenomenon. *Anesthes Analg*. 2016;123(5):1149-1155.

Case 15-7

Anterior chest wall lacerations

Patient Presentation: A young woman presented to the emergency department (ED) with significant lacerations to her anterior chest wall.

Clinical Features: The patient was in moderate pain and hemodynamically stable. Examination revealed significant wounds to her anterior chest wall and breasts.

Differential Dx:
- Intrathoracic pulmonary or cardiac injury
- Intraperitoneal injury
- Extensive soft tissue injury

Figure 15-8. Significant anterior chest and breast wounds

Emergency Care: The patient was provided analgesia.

Outcome: The patient was taken to the operating room for primary closure of her wounds. Her wounds healed.

Key Learning Points:
- Self-harm can be defined as purposeful injury of bodily tissue without suicidal intention that is not socially endorsed.
- From 2006 to 2013, there was a total of 3,567,084 visits to U.S. emergency departments for suicide attempts and self-inflicted injury.
- Patients that present with self-cutting to areas other than the arm or wrist are at increased risk of suicide compared to those presenting with cutting limited to the arm or wrist.
- Patients with self-cutting wounds that require hospitalization are at increased risk for future suicide.
- Nonsuicidal self-harm is associated with significant psychiatric disease including bipolar disease and severe depression.
- The ability to regulate emotion has been linked to the cessation of self-injurious behavior.

Further Reading:

Beckman K, Mittendorfer-Rutz E, Waern M, et al. Method of self-harm in adolescents and young adults and risk of subsequent suicide. *Journal of Child Psychology and Psychiatry* 2018;March 05.

Canner JK, Giuliano K, Selvarajah S, et al. Emergency department visits for attempted suicide and self harm in the USA:2006-2013. *Epidemiology and Psychiatric Sciences* 2018;27(1):94-102.

Carroll R, Thomas KH, Bramley K, et al. Self-cutting and risk of subsequent suicide. *Journal of Affective Disorders* 2016;192;8-10.

Kiekens G, Hasking P, Bruffaerts R, et al. What predicts ongoing non-suicidal self-injury? A comparison between persistent and ceased self-injury in emerging adults. *J Nerv Ment Dis.* 2017;205(10):762-770.

Sampson D. An unusual self-inflicted injury of the breast. *Postgrad Med J.* 1975;51(592):116-118.

Weintraub MJ, Van de Loo MM, Gitlin MJ, Miklowitz DJ. Self-harm, affective traits, and psychosocial functioning in adults with depressive and bipolar disorders. *J Nerv Ment Dis.* 2017;205(11):896-899.

Case 15-8

Patient self-written "do not resuscitate" order

Patient Presentation: A middle-aged patient presented to the ED in critical condition.

Clinical Features: The patient was critically ill with a profound alteration in consciousness.

Differential Dx:

- Central nervous system, metabolic, endocrine, toxicologic, psychiatric etiology

Emergency Care: The patient was quickly undressed, and "Do Not Rezuzitate Intudate" had been written in ink on her anterior abdominal wall. The "Not" was much lighter for reasons unclear to the physicians. This handwritten note could not be (and ultimately was not) relied upon to direct resuscitative efforts.

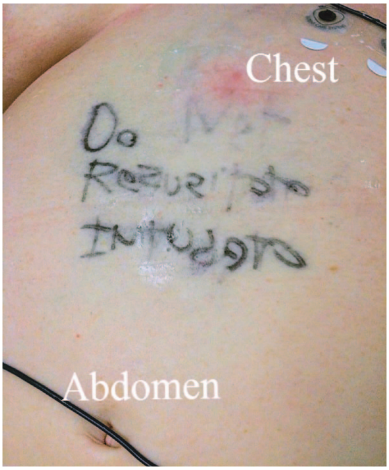

Figure 15-9. Patient self-written "do not resuscitate" order on the patient's skin

Outcome: The patient was in acute renal failure and had suffered a severe anoxic event with subsequent brain death.

Key Learning Points:

- It would be unwise for health care providers to make medical care decisions based on self-written or typed letters that accompany patients with suicidal gestures because their authenticity and veracity cannot be verified.
- Physician Orders for Life-Threatening Treatment (POLST) forms have improved communication and patient autonomy in critical situations.

Further Reading:

Hickman SE, Keevern E, Hammes BJ. Use of the physician orders for life-sustaining treatment program in the clinical setting: a systematic review of the literature. *J Am Geriatr Soc*. 2015;63(2):341-350.

Information and supportive materials regarding the POLST program can be found at www.POLST.org. This program has been adopted in most of the United States.

Case 15-9

Self-inflicted lacerations

Patient Presentation: A young man presented with extensive self-inflicted lacerations.

Clinical Features: The patient was in mild painful distress with a depressed affect. He had extensive lacerations involving all four extremities, his anterior chest, and his abdomen.

Differential Dx:
- Depression with self-inflicted lacerations
- Cutting behavior
- Possibility of ingestants

Emergency Care: Wound care and primary laceration repair was accomplished with propofol sedation. Local anesthetic could not be used as the amount needed would have resulted in toxicity. A total of 900 cm of lacerations were repaired using 910 staples.

Outcome: The patient was admitted to inpatient psychiatry for treatment of depression.

Key Learning Points:
- Systemic central nervous system toxicity caused by local anesthetics like lidocaine is manifested by metallic taste, tinnitus, agitation, and seizures.
- Cardiovascular affects include bradycardia, decreased myocardial function, vasodilation, ventricular arrhythmias, and atrioventricular block.
- Conservative maximum doses of lidocaine for infiltrative local anesthesia is 300 mg without epinephrine and 500 mg with epinephrine. For pediatric patients, it is 4.5 mg/kg without epinephrine and 7 mg/kg with epinephrine.

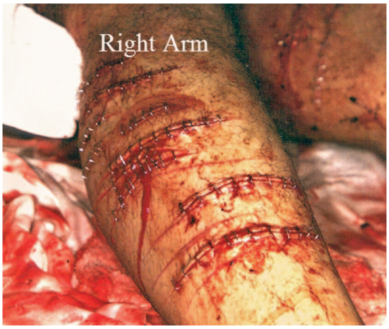

Figure 15-10. Right forearm repaired lacerations

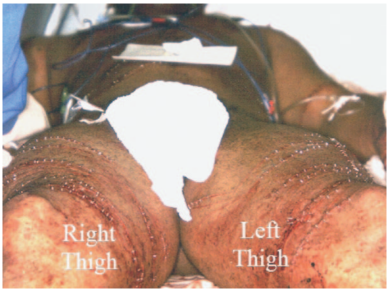

Figure 15-11. Bilateral repaired thigh lacerations

Figure 15-12. Repaired neck and chest wall lacerations

Further Reading:

McGee DL. Local and topical anesthesia. In: Custalow CB, Thompson CW, Hedges JR, eds. *Roberts and Hedges' Clinical Procedures in Emergency Medicine*, 6th ed. Philadelphia, PA: Elsevier; 2014.

Rosenberg PH, Veering BT, Urmey WF. Maximum recommended doses of local anesthetics: a multifactorial concept. *Reg Anesth Pain Med*. 2004;29(6):564-575.

Yerzingatsian KL. The dosage of dilute lignocaine for the infiltration technique of local analgesia. *Ann R Coll Surg Engl*. 1991;73(4):201-203.

Case 15-10

Munchausen syndrome

Patient Presentation: A 28-year-old presented with chest pain, shortness of breath, and hemoptysis. The patient reported significant prior thromboembolic disease that was treated with anticoagulation and inferior vena cava filter placement.

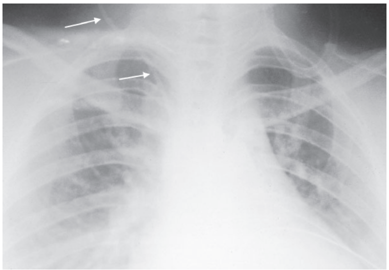

Figure 15-13. Chest x-ray. WA = central venous line

Clinical Features: The patient was in no painful distress and was hemodynamically stable. There were no significant physical findings on examination.

Differential Dx:
- Pulmonary embolism
- Pneumonia
- Tumor
- Tuberculosis
- Cardiac disease
- Foreign body
- Bronchitis

Emergency Care: The patient had limited peripheral vascular access, and a central venous catheter was placed. Chart review did not reveal corroborating evidence for the patient's presenting history of previous thromboembolic disease. Workup in the ED was unremarkable, and the patient was admitted for further diagnostic evaluation.

Outcome: The patient was noted by a nurse to have disconnected her central line tubing, and she was surreptitiously sucking blood into her mouth with the intent of feigning hemoptysis. No cardiopulmonary disease was discovered, and the patient was further evaluated by the psychiatry service.

Key Learning Points:
- Factitious disorder imposed on self, also known as Munchausen syndrome, can be a difficult diagnostic and therapeutic challenge for the treating physician.
- Deliberate deception is a key component in this disease.
- Physicians treating this disorder must balance the need to rule out potentially life-threatening illness on one hand, with the risk of performing unneeded and invasive procedures that have inherent risks, on the other hand.

Further Reading:

Kenedi CA, Shirey KG, Hoffa M, et al. Laboratory diagnosis of factitious disorder: a systematic review of tools useful in the diagnosis of Munchausen's syndrome. *N Z Med J*. 2011;124(1342):66-81.

Klaassen FJ, Schober P, Schwarte LA, Boer C, Loer SA. Acute respiratory failure leading to emergency intubation: an unusual manifestation of Munchausen's syndrome. *Resuscitation*. 2007;75(3):534-539.

Payne JE, Newlands JS. Münchausen syndrome masquerading as pulmonary embolism. *Med J Austral*. 1971;1(12):661.

Pulman A, Taylor J. Munchausen by internet: current research and future directions. *J Med Int Res*. 2012;14(4):e115.

Roethe RA, Fuller PB, Byrd RB, Stanford W, Fisk DE. Munchausen syndrome with pulmonary manifestations. *Chest*. 1981;79(4):487-488.

Yates GP, Feldman MD. Factitious disorder: a systematic review of 455 cases in the professional literature. *Gen Hosp Psych*. 2016;41:20-28.

Case 15-11

Myocardial necrosis from a self-inflicted gunshot wound

Patient Presentation: A 32-year-old was admitted with a self-inflicted gunshot wound to the left chest using a rifle. At an outside hospital, he underwent rapid sequence intubation, sedation, and placement of a thoracostomy tube. He was given 2 units of packed red blood cells.

Figure 15-14. Chest x-ray. BA = thoracostomy tube, WA = bullet fragments, WDA = endotracheal tube

Clinical Features: The patient was hypoxic, hypotensive, and tachycardic. Blood was in his endotracheal tube.

Differential Dx:

- Cardiac, large blood vessel, or lung injury

Emergency Care: The endotracheal tube was suctioned with improvement in his oxygen saturation. The patient received packed red blood cell transfusion and tranexamic acid. A chest radiograph demonstrated multiple bullet fragments, a correctly placed endotracheal tube, and a thoracostomy tube. A contrast-enhanced CT scan revealed multiple bullet fragments, including one near the pericardium. Pulmonary injury and contusions were evident. An ED bedside ultrasound revealed no intraperitoneal hemorrhage and a small (hypovolemic) and hyperdynamic heart with minimal pericardial fluid. An electrocardiogram revealed ST-T wave abnormalities indicative of lateral ischemia. Initial troponin returned at 8 mcg/L.

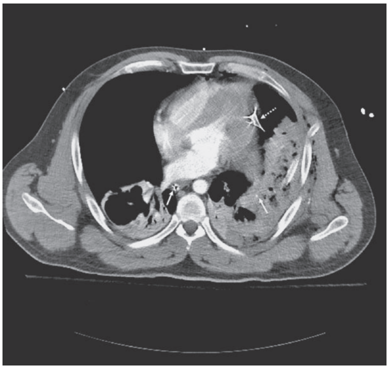

Figure 15-15. Contrast-enhanced chest CT scan. WA = multiple bullet fragments, WDA = bullet fragment near pericardium

Outcome: The patient was diagnosed with myocardial necrosis. A transesophageal cardiac ultrasound demonstrated no cardiac thrombus and a minimal pericardial effusion. Seven days after admission, he developed dysarthria, and a noncontrast head CT scan demonstrated multiple cortical and subcortical acute infarcts. A search for thrombus, including repeat transesophageal ultrasound, was negative, and the patient was started on aspirin therapy. Ten days after admission, the patient developed acute shortness of breath with a cardiac ultrasound demonstrating increased pericardial fluid and tamponade physiology. A pericardial window was emergently

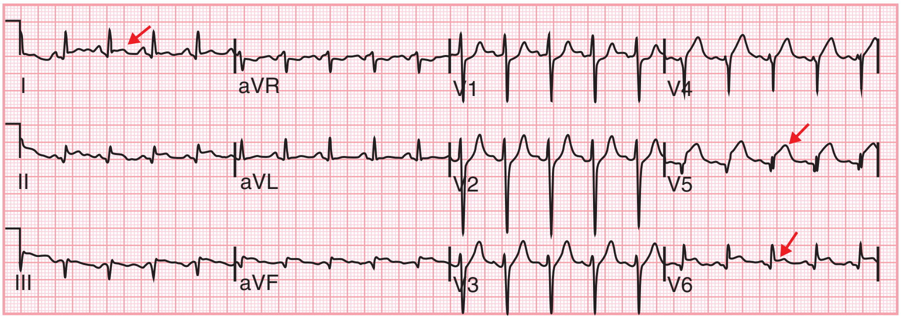

Figure 15-16. Electrocardiogram. RA = ST segment and T wave changes

performed. The patient slowly recovered and was transferred to an acute care rehabilitation facility for ongoing medical and psychiatric care.

Key Learning Points:

- Differentiating self-inflicted from non–self-inflicted gunshot wounds using forensic analysis is complex.
- The bullet entrance location, trajectory of the bullet, presence or absence of gun muzzle contact evidence, and the number of bullets fired are all factors to consider.
- The most common anatomic locations for self-inflicted gunshot wounds are the temple, forehead, mouth, and left chest.
- Multiple self-inflicted gunshot wounds (in the same patient) with different entry points, and unusual anatomic entry locations such as the back of the head have been reported.
- The myth that patients with self-inflicted gunshot wounds shoot on bare skin and not through their clothing has been debunked.

Further Reading:

Betz P, Peschel O, Eisenmenger W. Suicidal gunshot wounds—site and characteristics. *Arch Kriminol*. 1994;193(3-4):65-71.

Boxho P. Fourteen shots for a suicide. *Forensic Sci Int*. 1999;101(1):71-77.

Hejna P, Safr M. Shooting through clothing in firearm suicides. *J Forensic Sci*. 2010;55(3):652-654.

Karger B, Billeb E, Koops E, Brinkmann B. Autopsy features relevant for discrimination between suicidal and homicidal gunshot injuries. *Int J Legal Med*. 2002;116(5):273-278.

Karger B, Duchesne A. Who fired the gun? A casuistic contribution to the differentiation between self-inflicted and non-self-inflicted gunshot wounds. *Int J Legal Med*. 1997;110(1):33-35.

Karger B, Kersting C, Brinkmann B. Prior exposure of the entrance wound region from clothing is uncommon in firearm suicides. *Int J Legal Med*. 1997;110(2):79-81.

CHAPTER 16 Lifesaving

Case 16-1

Recovery from a severe cervical spine injury

Patient Presentation: A 19-year-old dove into a shallow lake.

Clinical Features: The patient was in mild painful distress. He was awake, alert and oriented with significant motor and sensory deficits. The patient had no sensation below the C4 level. He had no rectal tone and had priapism. His only motor function was an inconsistent flicker of movement in one of his feet.

Differential Dx:

- Cervical spinal cord injury, including fracture, dislocation, or vascular injury

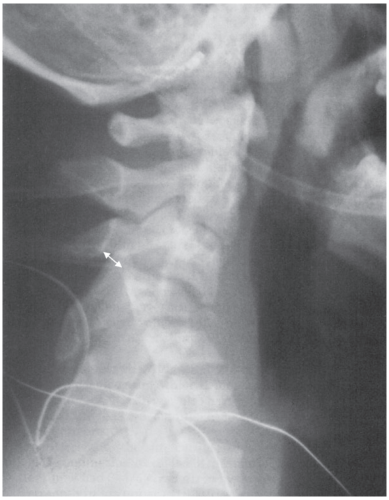

Figure 16-1. Cervical spine x-ray before reduction. WA = severe compromise of the spinal canal diameter from a fracture/dislocation of the C3-C4 vertebra

Reproduced with permission from Brunette DD, Rockswold GL. Neurologic recovery following rapid spinal realignment for complete cervical spinal cord injury, *J Trauma* 1987 Apr;27(4):445-447.

Emergency Care: An initial lateral cervical spine radiograph demonstrated a fracture/dislocation at the C3-C4 level. Marked narrowing of the width of his spinal canal was evident. The patient was lightly sedated, Gardner-Wells cervical tongs were placed, and a series of increasing weights were applied as traction. Within 90 minutes from injury, reduction of the fracture/dislocation was obtained with a markedly increased spinal canal diameter.

Outcome: Shortly after reduction, the patient began to regain sensory and motor function in a symmetrical pattern, starting with his lower extremities. He had a complete recovery of neurologic function.

Key Learning Points:

- The published case report for this patient gives additional details (see the first reference under Further Reading).
- Early decompression of the cervical spinal cord appears to improve neurologic outcome.

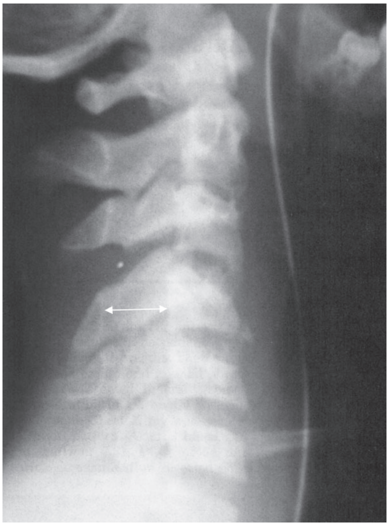

Figure 16-2. Cervical spine x-ray post-reduction. WA = normal spinal canal diameter as a result of the reduction

Reproduced with permission from Brunette DD, Rockswold GL. Neurologic recovery following rapid spinal realignment for complete cervical spinal cord injury, *J Trauma* 1987 Apr;27(4):445-447.

Further Reading:

Battistuzzo CR, Armstrong A, Clark J, et al. Early decompression following cervical spinal cord injury: examining the process of care from accident scene to surgery. *J Neurotrauma*. 2016;33(12):1161-1169.

Brunette DD, Rockswold GL. Neurologic recovery following rapid spinal realignment for complete cervical spinal cord injury. *J Trauma*. 1987;27(4):445-447.

Evaniew N, Noonan VK, Fallah N, et al. Methylprednisolone for the treatment of patients with acute spinal cord injuries: a propensity score-matched cohort study from a canadian multi-center spinal cord injury registry. *J Neurotrauma*. 2015;32(21):1674-1683.

Li Y, Walker CL, Zhang YP, Shields CB, Xu XM. Surgical decompression in acute spinal cord injury: a review of clinical evidence, animal model studies, and potential future directions of investigation. *Front Biol (Beijing)*. 2014;9(2):127-136.

Shields CB, Zhang YP, Shields LB, Han Y, Burke DA, Mayer NW. The therapeutic window for spinal cord decompression in a rat spinal cord injury model. *J Neurosurg Spine*. 2005;3(4):302-307.

Stevenson CM, Dargan DP, Warnock J, et al. Traumatic central cord syndrome: neurological and functional outcome at 3 years. *Spinal Cord*. 2016;54(11):1010-1015.

Zariffa J, Curt A, Verrier MC, Fehlings MG, Kalsi-Ryan S, et al; GRASSP Cross-Sectional Study Team and Ontario GRASSP Longitudinal Study Team. Predicting task performance from upper extremity impairment measures after cervical spinal cord injury. *Spinal Cord*. 2016;54(12):1145-1151.

Zhu H, Feng YP, Young W, et al. Early neurosurgical intervention of spinal cord contusion: an analysis of 30 cases. *Chin Med J (Engl)*. 2008;121(24):2473-2478.

Case 16-2

Cervical spine inury in an infant

Patient Presentation: A 1-year-old was involved in a motor vehicle crash. The infant was restrained in an appropriately-sized child car seat. The infant was initially seen in the emergency department (ED) of an outside hospital and subsequently was discharged following a normal physical examination; no diagnostic studies were performed. The mother brought the infant back to the ED the next day stating that every time she attempts to feed the infant, the infant develops inconsolable crying. The outside ED physician ordered a plain cervical spine radiograph. There was a fracture through the C2 synchondrosis, with 100% displacement of the dens anterior to the body of C2. To highlight the abnormal alignment of this infant's injured cervical spine, the two white lines in figure would normally be unbroken and represent the posterior vertebral line. The infant was transferred to our facility for neurosurgical evaluation.

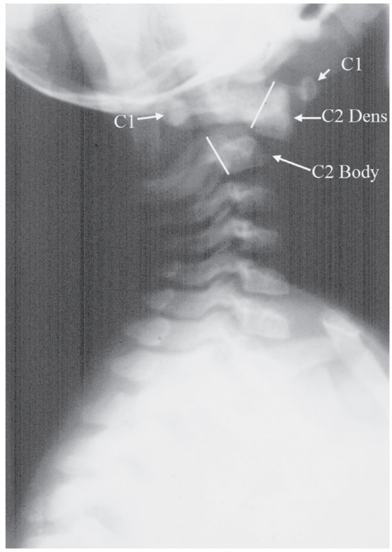

Figure 16-3. Cervical spine x-ray. Fracture through C2 synchondrosis with 100% anterior displacement of the C2 dens over the body of C2

Clinical Features: The infant had a normal neurologic and physical examination.

Differential Dx:

- Fracture through the C2 synchondrosis

Emergency Care: None. The infant was admitted to the neurosurgical service.

Outcome: The method of reduction was lost to follow-up. A specially designed cervical spine fixation device was manufactured for the infant. The patient never developed neurologic deficits.

Key Learning Points:

- Inconsolable crying in an infant should be considered a concerning history and physical examination finding in both medical and trauma-related cases.

Further Reading:

Mousny M, Saint-Martin C, Danse E, Rombouts JJ. Unusual upper cervical fracture in a 1-year-old girl. *J Pediatr Orthop.* 2001;21(5):590-593.

Mueller OM, Gasser T, Hellwig A, Dohna-Schwake C, Sure U. Instable cervical spine injury in a toddler: technical note. *Childs Nerv Syst*. 2010;26(11):1625-1631.
Parent S, Dimar J, Dekutoski M, Roy-Beaudry M. Unique features of pediatric spinal cord injury. *Spine (Phila Pa 1976)*. 2010;35(21 suppl):S202-S208.
Rusin JA, Ruess L, Daulton RS. New C2 synchondrosal fracture classification system. *Pediatr Radiol*. 2015;45(6):872-881.
Shin JI, Lee NJ, Cho SK. Pediatric cervical spine and spinal cord injury: a national database study. *Spine*. 2016;41(4):283-292.

Case 16-3

Cardiac gunshot wound and ED thoracotomy

Patient Presentation: A 28-year-old presented to the ED after he suffered a single gunshot wound to his posterior shoulder.

Clinical Features: The patient was unresponsive and markedly tachycardic with clinical signs of severe shock. The patient was hypoventilating and undergoing bag-valve-mask ventilation. Peripheral pulses could not be palpated.

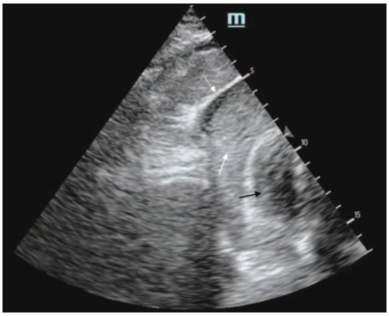

Figure 16-4. Cardiac ultrasound. BA = right ventricle, WA = pericardial effusion with hyperechoic clotted blood, WDA = pericardium

Differential Dx:

- Hemorrhage shock
- Tension hemothorax
- Tension pneumothorax
- Pericardial tamponade
- Penetrating cardiac injury

Emergency Care: A bedside cardiac ultrasound was immediately performed demonstrating a large clotted pericardial effusion that correlated with his tamponade physiology. The patient underwent rapid sequence intubation, followed by a left lateral resuscitative thoracotomy. The pericardium was incised, and the hemopericardium was evacuated, with resulting marked improvement in cardiac performance. Significant hemorrhage was noted to be coming from a right ventricular wound that was plugged with a physician's finger. The patient regained hemodynamic stability.

Outcome: The patient was taken to the operating room where his right ventricular wound was repaired. The patient was discharged from the hospital 10 days later neurologically intact with normal cardiac function.

Key Learning Points:

- This case is a great example of the utility of bedside ultrasound in the setting of penetrating thoracoabdominal trauma.
- Within the first 30 seconds of this case, the emergency physician ruled out tension hemothorax, tension pneumothorax, and intraperitoneal hemorrhage, while definitely diagnosing cardiac tamponade, which led to the resuscitative ED thoracotomy.
- Neurologically intact survival following a gunshot wound to the heart is distinctly uncommon.

Further Reading:

Asensio JA, Berne JD, Demetriades D, et al. One hundred five penetrating cardiac injuries: a 2-year prospective evaluation. *J Trauma.* 1998;44(6):1073-1082.

Kaljusto M, Skaga NO, Pillgram-Larsen J, Tønnessen T. Survival predictor for penetrating cardiac injury; a 10-year consecutive cohort from a Scandinavian trauma center. *Scand J Trauma Resusc Emerg Med.* 2015;23:41.

Mandal AK, Sanusi M. Penetrating chest wounds: 24 years experience. *World J Surg.* 2001;25(9):1145-1149.

Morse BC, Mina MJ, Carr JS, et al. Penetrating cardiac injuries: a 36-year perspective at an urban, Level I trauma center. *J Trauma Acute Care Surg*. 2016;81(4):623-631.

Seamon MJ, Shiroff AM, Franco M, et al. Emergency department thoracotomy for penetrating injuries of the heart and great vessels: an appraisal of 283 consecutive cases from two urban trauma centers. *J Trauma*. 2009;67(6):1250-1257.

Tayal VS, Beatty MA, Marx JA, Tomaszewski CA, Thomason MH. FAST (focused assessment with sonography in trauma) accurate for cardiac and intraperitoneal injury in penetrating anterior chest trauma. *J Ultrasound Med*. 2004;23(4):467-472.

Tyburski JG, Astra L, Wilson RF, Dente C, Steffes C. Factors affecting prognosis with penetrating wounds of the heart. *J Trauma*. 2000;48(4):587-590.

Case 16-4

Blunt traumatic transection of the trachea

Patient Presentation: A 12-year-old fell off of his bicycle and struck his neck against the handlebars. He was found by paramedics to be awake and alert, cyanotic, with a markedly swollen face and neck, unable to talk, and in severe respiratory distress. Immediately before reaching the ED, the patient appeared to develop complete airway obstruction.

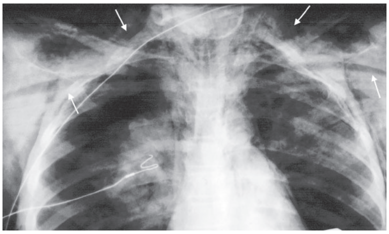

Figure 16-5. Chest x-ray. WA = extensive subcutaneous emphysema

Clinical Features: The patient was in severe respiratory distress, and auscultation revealed no air movement. There was significant subcutaneous emphysema and swelling of his face and neck that extended down his anterior thorax and abdomen.

Differential Dx:

- Injury to trachea, cricoid, or larynx

Emergency Care: Orotracheal intubation was attempted simultaneously with preparation for a surgical airway. On the initial attempt, the endotracheal tube could not be passed beyond the vocal cords. A surgical airway was performed. Exposure of the airway was extremely difficult secondary to the altered anatomy. The patient had a cardiac arrest, and 4 minutes of CPR was performed. During this time, the proximal end of the transected trachea was exposed, a feeding tube placed into it, and Seldinger technique was utilized to place a tracheostomy tube over the feeding tube. Spontaneous circulation returned. A chest radiograph revealed the massive subcutaneous emphysema in the axilla, chest wall, and neck. The patient was transferred to the operating room.

Outcome: The patient's cricoid cartilage had been completely crushed and was collapsed. There was a 100% transection of the trachea 2 cm below the cricoid cartilage. The patient underwent two operative procedures on his airway injuries. He was discharged from the hospital neurologically intact.

Key Learning Points:

- Adult and pediatric patients presenting with upper airway injury from blunt trauma are difficult clinical situations.
- The presence of severe subcutaneous emphysema made the diagnosis of an airway injury readily apparent.
- In a patient such as this, one gentle pass at orotracheal intubation is warranted ideally using a bougie or fiberoptic bronchoscope. If any obstruction is encountered, the orotracheal intubation should be abandoned, and a surgical airway should be

performed. Many times, however, the bougie is able to traverse the area of injury, and the endotracheal tube can be advanced over the bougie.

- The operative findings in this patient indicated that utilizing a bougie device would not have been successful.

Further Reading:

Chatterjee D, Agarwal R, Bajaj L, Teng SN, Prager JD. Airway management in laryngotracheal injuries from blunt neck trauma in children. *Paediatr Anaesth*. 2016;26(2):132-138.

Ford HR, Gardner MJ, Lynch JM. Laryngotracheal disruption from blunt pediatric neck injuries: impact of early recognition and intervention on outcome. *J Pediatr Surg*. 1995;30(2):331-334.

Hirose T, Ogura H, Kiguchi T, et al. The risk of pediatric bicycle handlebar injury compared with non-handlebar injury: a retrospective multicenter study in Osaka, Japan. *Scand J Trauma Resusc Emerg Med*. 2015;23:66.

Holmes JE, Hanson CA. Complete tracheal transection following blunt trauma in a pediatric patient. *J Trauma Nurs*. 2015;22(1):41-43.

Shires CB, Preston T, Thompson J. Pediatric laryngeal trauma: a case series at a tertiary children's hospital. *Int J Pediatr Otorhinolaryngol*. 2011;75(3):401-408.

Case 16-5

ED skull trephination for epidural hematoma

Patient Presentation: A young adult suffered a closed head trauma. There had been a brief loss of consciousness.

Clinical Features: The patient presented awake and answering questions appropriately and was complaining of a bad headache.

Differential Dx:

- Closed head trauma with concussion
- Intracranial hematoma
- Intracerebral hemorrhage
- Subarachnoid hemorrhage

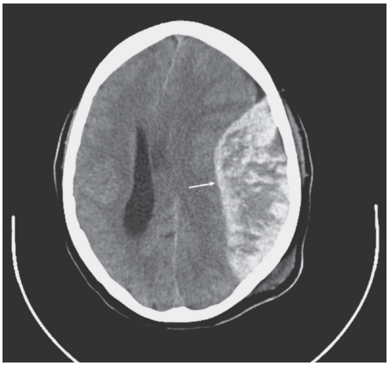

Figure 16-6. Noncontrast head CT scan. WA = large epidural hematoma with midline shift

Emergency Care: An immediate noncontrast head computed tomography (CT) scan demonstrated a large epidural hematoma with midline shift. Shortly after the CT scan, the patient had a precipitous decline in mental status. A bedside skull trephination was performed with release of the epidural hematoma.

Outcome: The patient went to the operating room for a formal craniotomy and drainage of her epidural hematoma. The patient made an uneventful recovery.

Key Learning Points:

- In patients with closed head trauma with classic epidural hematoma presentation, ie, loss of consciousness at the time of injury followed by a lucid interval followed by marked mental status deterioration, bedside ED skull trephination can be lifesaving.
- These patients have appropriately been labelled as patients that "talk and deteriorate."

Further Reading:

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Case 16-6

Nail gun injuries to the sternum (two patients)

Patient Presentation: These two patients suffered accidental nail gun injuries to the anterior chest in unrelated incidents.

Clinical Features: Both patients were awake, in moderate painful distress, and hemodynamically stable. The nail in both patients was deeply embedded through the mid-sternum.

Differential Dx:

- Penetrating chest trauma with multiple possible injuries

Emergency Care: Both patients received analgesia and transfer to the operating room.

Outcome: Both patients had a median sternotomy. The first patient had a pulmonary artery injury that was repaired, and the second patient had a right ventricular injury that was also repaired. Both patients had uneventful recoveries.

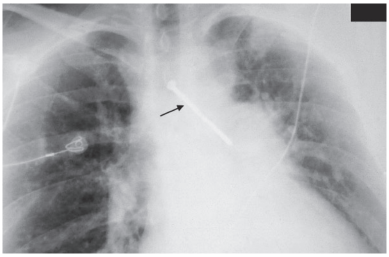

Figure 16-7. First patient. Chest x-ray. BA = nail gun embedded into the sternum

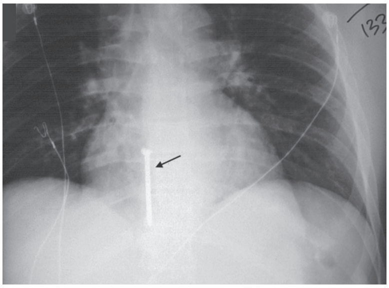

Figure 16-8. Second patient. Chest x-ray. BA = nail gun embedded into the sternum

Key Learning Points:

- Patients with penetrating nail gun injuries through the sternum who are hemodynamically stable should be sent directly to the operating room for exploration.
- The nail should never be removed in the ED, especially in stable patients.
- Hemodynamically unstable patients with nail gun injuries through the sternum should be aggressively managed in the ED. Transthoracic ultrasound can quickly diagnose a tension pneumothorax, hemothorax, or pericardial tamponade. Pericardiocentesis has been reported to be lifesaving in at least one case. ED thoracotomy in this situation should be reserved for patients with peri- or full cardiac arrest.

Further Reading:

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Case 16-7

Electrical cardiac storm

Patient Presentation: A 56-year-old suffered an out-of-hospital cardiac arrest. The patient had a history of three-vessel coronary artery disease.

Clinical Features: The patient arrived in full cardiopulmonary arrest with an initial rhythm of ventricular fibrillation.

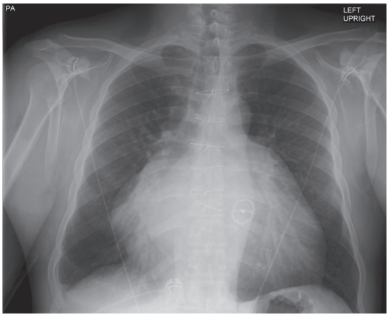

Figure 16-9. Chest x-ray

Differential Dx:
- Primary cardiac arrhythmia
- Acute myocardial infarction
- Electrolyte imbalance
- Endocrine or other metabolic condition

Emergency Care: The patient was in refractory ventricular fibrillation. The patient was treated with epinephrine, lidocaine, and amiodarone and received a total of 24 defibrillations without success. Esmolol was then administered, and the 25th defibrillation resulted in normal sinus rhythm. A chest radiograph was taken before transport to the cardiac catheterization lab.

Outcome: The patient had patent coronary artery grafts without acute disease. The patient made an uneventful recovery and was neurologically intact at the time of hospital discharge. He received an automated implantable cardiac defibrillator.

Key Learning Points:
- Electrical storm is defined as two or more episodes of ventricular fibrillation or tachycardia requiring defibrillation within a 24-hour period.
- Survival at 30 days among these patients is inversely related to the number of defibrillation attempts.
- In one study of electrical storm, 7.5% of patients required more than 10 shocks for management of ventricular fibrillation or tachycardia.
- The use of a ß-blocker, as in this case, should be considered in the setting of electrical storm resuscitation.

Further Reading:
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Case 16-8

Hypothermic cardiac arrest

Patient Presentation: A 48-year-old was found unresponsive outside on a bench and was covered with a recent snowfall.

Clinical Features: The patient was very cold to the touch. Initial temperature was 25.5°C (78°F). Almost immediately after ED arrival, the patient suffered a cardiac arrest.

Differential Dx:
- Severe hypothermia with cardiac arrest

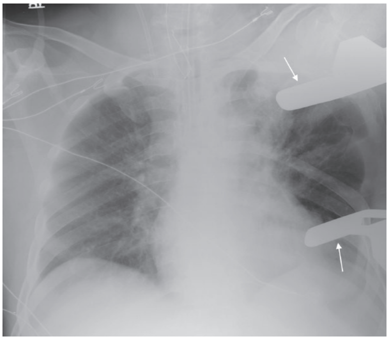

Figure 16-10. Chest x-ray. WA = ribs spreaders for ED thoracotomy

Emergency Care: The patient underwent orotracheal intubation, and active rewarming efforts were initiated. A left lateral thoracotomy was performed. Rib spreaders were placed, and internal cardiac massage and warm mediastinal saline irrigation was performed for approximately 1.5 hours until he was transferred to the operating room for cardiac bypass.

Outcome: The patient underwent successful extracorporeal rewarming with return of spontaneous circulation. He had an uneventful recovery and was neurologically intact at the time of discharge.

Key Learning Points:
- Thoracotomy with internal cardiac massage and mediastinal irrigation is a well-described and successful management option for hypothermic cardiac arrest, either as a bridge to extracorporeal rewarming or as an independent therapy.
- Prolonged CPR using mechanical compression devices generally provides outstanding perfusion and has facilitated favorable outcomes in hypothermic cardiac arrest patients who succumb to exposure before anoxia. In hypothermic patients whose chest wall is frozen and noncompliant, CPR is of limited utility.

Further Reading:

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Case 16-9

Blunt traumatic rupture of tricuspid valve

Patient Presentation: A 38-year-old was kicked in the chest by a horse. At an outside institution, she became hemodynamically unstable and was orotracheally intubated. She had a right thoracostomy tube placed for a likely tension pneumothorax and was transferred to our institution.

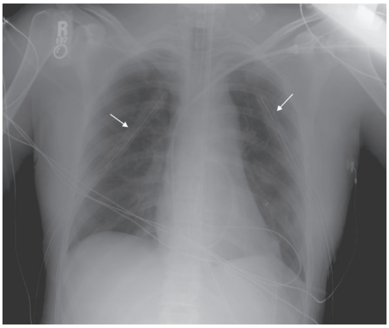

Figure 16-11. Chest x-ray. WA = thoracostomy tubes

Clinical Features: The patient was intubated and sedated and was hemodynamically stable.

Differential Dx:

- Multiple traumatic thoracoabdominal injuries are possible.

Emergency Care: A CT scan demonstrated a sternal fracture, mediastinal hematoma, and free intraperitoneal fluid. Laboratory tests including a troponin were drawn.

Outcome: The patient was taken to the operating room for an exploratory laparotomy, which was unremarkable except for serous intraperitoneal fluid. A left thoracostomy tube was placed. The patient's troponin returned abnormally elevated, and a

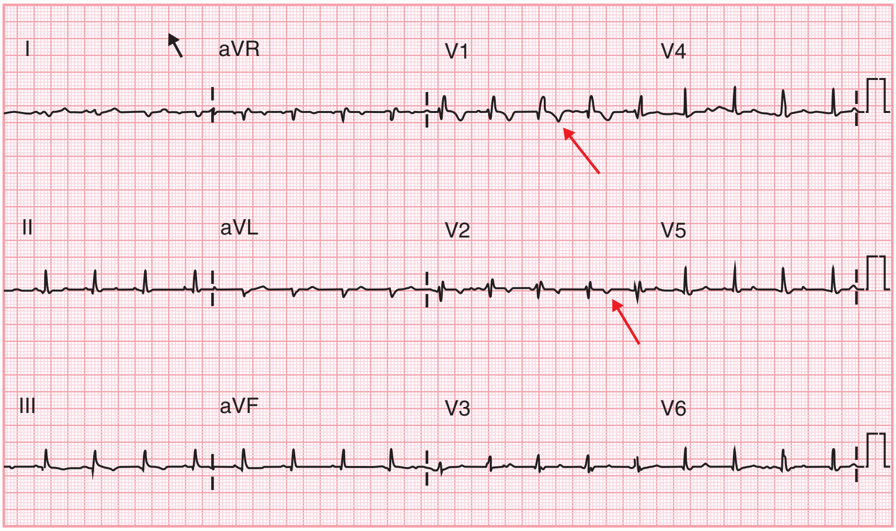

Figure 16-12. Electrocardiogram. RA = inverted T waves in V1 and V2 indicating right ventricular strain

subsequent electrocardiogram showed right heart strain with inverted T waves in V1 and V2. A cardiac ultrasound revealed a rupture of the papillary muscle in the right ventricle, decreased right ventricular function, and tricuspid insufficiency with low cardiac output. The patient was taken to the operating room for an emergent tricuspid valve replacement. Postoperatively, the patient developed complete heart block and had an internal pacemaker placed. The patient went on to make a full recovery.

Key Learning Points:

- Acute tricuspid valve rupture can present with signs and symptoms of tricuspid regurgitation and complete heart block or right ventricular strain on electrocardiogram. Cardiac ultrasound with color flow imaging is an excellent point-of-care diagnostic test in this setting.

Further Reading:

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Case 16-10

Isoniazid overdose

Patient Presentation: A 22-year-old was found seizing next to an empty pill bottle of isoniazid.

Clinical Features: The patient was unresponsive with ongoing tonic-clonic seizure activity. He received bag-valve-mask ventilation with an unprotected airway.

Differential Dx:

- Primary seizure disorder
- Secondary seizure from isoniazid (INH) toxicity
- Occult trauma
- Metabolic or endocrine disorder

Figure 16-13. RA = 90 vials (total of 9 g) of pyridoxine (B6) utilized for treatment of isoniazid overdose in a single patient

Emergency Care: A finger-stick glucose was normal. The patient underwent rapid sequence intubation with edomidate and succinylcholine. Despite several doses of a benzodiazepine and propofol, the patient continued to seize. Arterial blood gases revealed a pH of 6.5. The patient received a total of 10 amps of sodium bicarbonate. Given the intractable seizure activity and severe metabolic acidosis, vecuronium was administered to decrease lactate production and mitigate hyperthermia. A total of 9 g of pyridoxine was administered. This represented the entire hospital supply. Pyridoxine came in vials containing 100 mg each. A nurse needed to draw up pyridoxine from 90 vials. A dialysis catheter was placed in the ED.

Outcome: The patient underwent emergent hemodialysis. He had a complicated hospital course but eventually recovered fully from his intentional overdose of isoniazid and received extensive psychiatric care.

Key Learning Points:

- Isoniazid doses of 20 mg/kg or greater result in seizure activity.
- Severe acidosis can occur from status seizure activity and must be aggressively treated.
- INH depletes gamma amino butyric acid (GABA). Pyridoxine binds to isoniazid and replenishes stores of GABA.
- The dose of pyridoxine is 1 g IV for every gram of INH ingested. An initial dose of 5 g can be given to an adult when the quantity of INH ingested is unknown. The pediatric dose is 70 mg/kg to a maximum of 5 g.
- Aggressive seizure management includes benzodiapepines and propofol. Rarely, a life-threatening metabolic acidosis may develop if status epilepticus is refractory. In this instance, neuromuscular blockade and electroencephalogram (EEG) monitoring are necessary.

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Case 16-11

Blunt traumatic rupture of atrial appendage

Patient Presentation: A 55-year-old was involved in a motor vehicle crash.

Clinical Features: The patient was initially seen at an outside hospital. She was reportedly alert and oriented but hemodynamically unstable. A chest radiograph demonstrated a wide mediastinum. During transport to our facility, her level of consciousness markedly decreased.

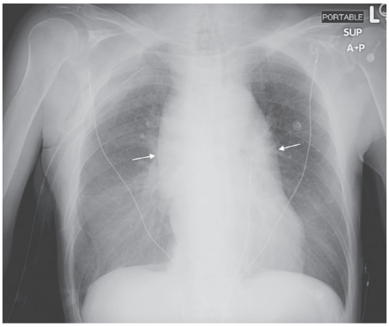

Figure 16-14. Chest x-ray. WA = widened mediastinum caused by atrial appendage rupture

Differential Dx:

- Multiple traumatic injuries

Emergency Care: The patient underwent rapid sequence intubation and received IV saline and blood. A right thoracostomy tube was placed in the presence of a hemothorax and immediately drained 2 L of blood. She remained hemodynamically unstable and was taken directly to the operating room for an emergent thoracotomy.

Outcome: The patient had a torn right atrial appendage that was repaired. A post-thoracotomy abdominal and pelvis CT scan showed liver and spleen lacerations with intraperitoneal hemorrhage; these were found to be contained on exploratory laparotomy, and no surgical intervention was required. After a complicated hospital course, the patient was discharged neurologically intact.

Key Learning Points:

- Ruptured atrial appendages can present with pericardial tamponade. If there is an injury to the pericardium, hemorrhage may leak outside of the pericardial sac into the mediastinum or into the pleural cavity. The hemothorax in this patient may have been due to venting of the mediastinal hematoma into the pleural space or the result of direct trauma to the right lung.

Further Reading:

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Case 16-12

Transfontanelle aspiration of pediatric subdural hematoma

Patient Presentation: A 3-month-old infant presented with respiratory distress. No additional history was available.

Clinical Features: The infant was unresponsive with agonal respirations. The patient was relatively bradycardic with a heart rate of 90 beats/min. The right pupil was 4 mm and nonreactive, and the left was 2 mm and minimally reactive. The anterior fontanelle was bulging. The patient was afebrile.

Differential Dx:

- Critically ill infant with minimal history available
- Multiple possibilities for altered mental status

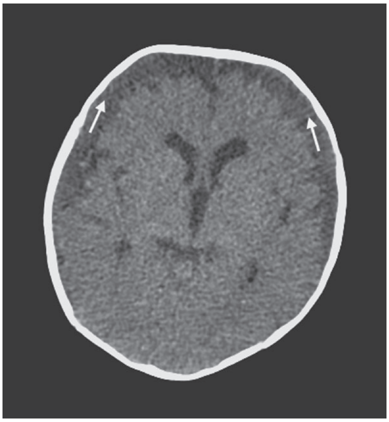

Figure 16-15. Noncontrast head CT scan. WA = bilateral subdural hematomas

Emergency Care: The patient underwent rapid sequence intubation. Vascular access was obtained, and a noncontrast head CT scan demonstrated bilateral subdural hematomas. A bedside aspiration of subdural blood through the anterior fontanelle resulted in 20 cc of old-appearing dark blood. The right pupil decreased in size and became reactive. The patient was admitted for further diagnostic and therapeutic intervention.

Outcome: The patient did not require any additional neurosurgical interventions as the subdural hematomas remained stable in size. The infant was extubated. An EEG was grossly abnormal, concerning for brain damage or encephalopathy. Over time, this infant has demonstrated mild developmental and cognitive delays.

Key Learning Points:

- Percutaneous subdural aspiration through the anterior fontanelle can be lifesaving in the setting of a clinical herniation syndrome.
- Subdural hematomas aspirated percutaneously need close observation for recurrence and the potential need for additional neurosurgical intervention.
- The possibility of nonaccidental trauma needs to be considered in patient presentations such as this one.

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Case 16-13

Prolonged extra-corporeal membrane oxygenation (ECMO)

Patient Presentation: A 15-year-old presented after <10-minute submersion in warm water. She received CPR at the scene but had a pulse on paramedic arrival.

Clinical Features: The patient was unresponsive with secretions, water, and sand in her airway and was undergoing bag-valve-mask ventilation.

Differential Dx:

- Significant water submersion with pulmonary, cardiac, and central nervous system pathology

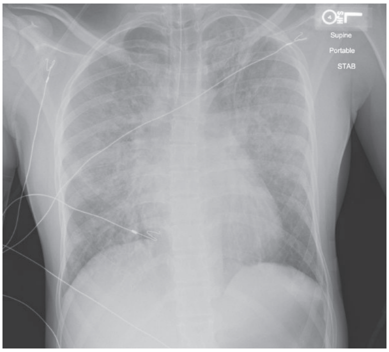

Figure 16-16. Chest x-ray. Initial chest radiograph of severe lung injury from submersion

Emergency Care: The patient underwent rapid sequence intubation. A large amount of discolored water and sand were aspirated via the endotracheal tube. An initial chest radiograph demonstrated significant pulmonary injury. A chest CT scan revealed aspiration, and a head CT scan was concerning for early edema.

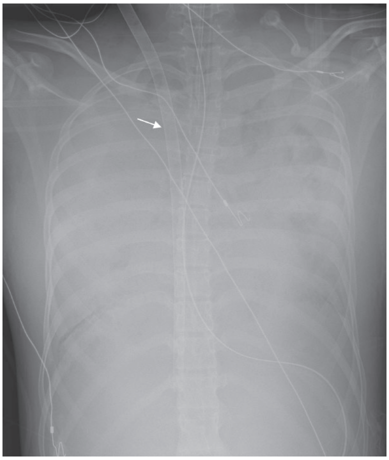

Figure 16-17. Chest x-ray. Obtained after initiation of ECMO. WA = ECMO cannula

Outcome: Approximately 24 hours after admission, a chest radiograph demonstrated complete white-out of both lungs, and a right internal jugular extracorporeal membrane oxygenation (ECMO) cannula was placed. The patient was placed on veno-venous ECMO due to refractory hyopoxemia. She suffered a brief cardiac arrest while on ECMO. The patient remained on ECMO for 9 days before a chest radiograph demonstrated significant clearing of her pulmonary injury. She eventually was extubated and discharged to an acute rehabilitation facility. At the time of discharge, she had mild fine motor deficits with intricate tasks and possibly some visual component involved. Cognitively, she has moderate to severe cognitive-linguistic deficits in the areas of auditory processing, attention, immediate, and short-term memory.

Key Learning Points:

- There are approximately 4,000 deaths per year in the United States from drowning, many of these children.
- ECMO can serve as a bridge to recovery of pulmonary function.

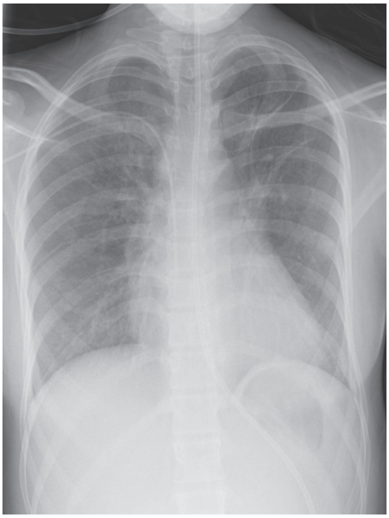

Figure 16-18. Chest x-ray. Final radiograph taken after endotracheal extubation

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Case 16-14

Pericardiocentesis for penetrating cardiac injury

Patient Presentation: A 46-year-old walked into the ED after sustaining multiple gunshot wounds. The chief complaint was severe shortness of breath.

Clinical Features: The patient was awake and in moderate painful distress. The patient had multiple wounds on his anterior chest wall and was in severe respiratory distress despite having bilateral breath sounds on auscultation.

Differential Dx:

- Penetrating thoracic traumatic injury including tension pneumothorax
- Cardiac wound causing pericardial tamponade
- Open pneumothorax
- Vascular injury

Emergency Care: An immediate ED bedside ultrasound demonstrated a large pericardial effusion with ultrasonographic evidence of tamponade physiology, notably a collapsing free right ventricular wall and a compressed right ventricle. These findings indicate hemodynamically significant pericardial tamponade. The patient underwent immediate rapid sequence intubation utilizing etomidate and succinylcholine. A pig tail pericardial catheter was placed under ultrasound guidance with drainage of 120 cc of dark blood. Repeat cardiac ultrasound demonstrated the correct placement of the pigtail catheter within the pericardial sac. There was a marked reduction in the size of the pericardial effusion with improved diastolic filling of the cardiac chambers.

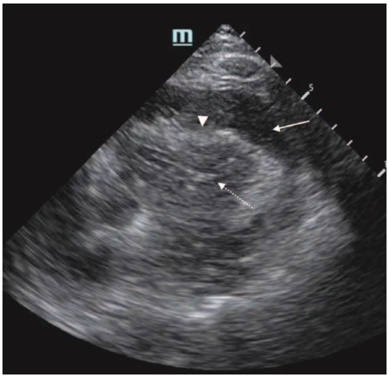

Figure 16-19. Cardiac ultrasound. WA = large pericardial effusion, WAH = collapsed free right ventricular wall, WDA = small right ventricular chamber

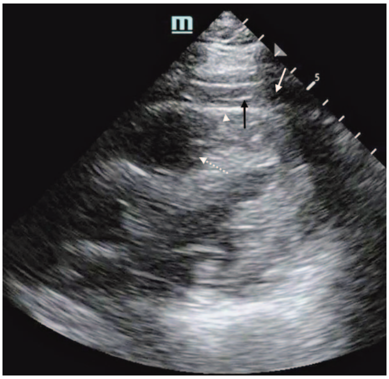

Figure 16-20. Cardiac ultrasound. BA = pericardial pigtail catheter, WA = small pericardial effusion, WAH = normal free right ventricular wall, WDA = larger right ventricular chamber

Outcome: The patient was taken to the operating room where a right ventricular wound was repaired. The patient recovered quickly and was discharged 1 week later.

Key Learning Points:

- Classic teaching states that pericardiocentesis for traumatic pericardial tamponade is ineffective because the intrapericardial blood clots quickly and is not amenable to drainage with a small catheter. However, there is a window of opportunity immediately after the injury where the pericardial blood has not yet had enough time to clot, allowing for successful pericardiocentesis.
- Point-of-care cardiac ultrasound not only diagnoses traumatic pericardial effusion and tamponade, but also can readily differentiate clot from unclotted blood, thereby providing information to the provider on the likelihood of pericardiocentesis success.
- Hemodynamically unstable traumatic pericardial tamponade with a predominance of clot in the pericardiac sac will require thoracotomy for management.

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Case 16-15

Interstate 35W (I-35W) bridge collapse

On August 1, 2007, the Interstate 35W (I-35W) bridge in downtown Minneapolis collapsed into the Mississippi River, killing 13 people and injuring 127. This was the busiest bridge in Minnesota, carrying over 140,000 vehicles per day on eight lanes of traffic. It spans 458 ft of river, at a height of 116 ft above the water.

On the day of the collapse, only four lanes were operational due to resurfacing construction. During the evening rush hour at 6:15 PM, with bumper-to-bumper traffic, the center portion dropped into the river, with the ends of the bridge buckling toward the river banks. There were 114 vehicles on the bridge and 18 construction workers.

A total of 25 patients were transported to Hennepin County Medical Center (HCMC), located 1 mile from the bridge. Interestingly, a number of those patients were transported in nonmedical vehicles commandeered at the scene, such as flatbed trucks. Of those 25 patients, 16 (60%) were admitted. Of the first seven patients transported to HCMC, four were stabilized in the ED and sent to the operating room, two were stabilized in the ED and admitted to the intensive care unit, and one patient died in the ED.

The author was present and working in the ED during this disaster response.

Figure 16-21. Interstate 35W Bridge collapse in Minneapolis, Minnesota on August 1, 2007
Used with permission from Andrew Worrall.

Figure 16-22. Thirteen people died, and 127 others were injured
Used with permission from Andrew Worrall.

Further Reading:

Hick JL, Chipman J, Loppnow G, et al. Hospital response to a major freeway bridge collapse. *Disaster Med Public Health Prep*. 2008;2(Suppl 1):S11-S16.

Hick JL, Ho JD, Heegaard WG, et al. Emergency medical services response to a major freeway bridge collapse. *Disaster Med Public Health Prep*. 2008;(2 Suppl 1):S17-S24.

Case 16-16

A physician's lifesaving hand

Patient Presentation: A 29-year-old man was driven to the ED by friends after suffering multiple gunshot wounds. The patient was in cardiopulmonary arrest and was taken directly to the ED stabilization room.

Clinical Features: The patient was apneic with no palpable pulse or other signs of life.

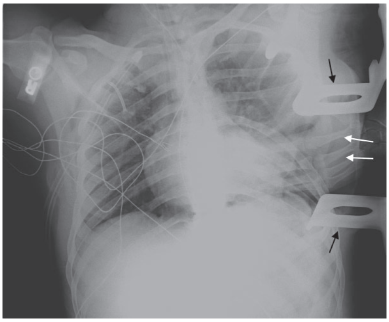

Figure 16-23. Chest x-ray. BA = thoracotomy rib spreaders, WA = fingers of a physician temporarily sealing closed two right ventricular gunshot wounds, preventing exsanguinating hemorrhage

Differential Dx:
- This patient had gunshot wounds resulting in cardiac arrest. The most likely etiology would be a significant vascular injury in his thorax, mediastinum, or intraperitoneal cavity.
- Barotrauma such as a tension pneumothorax was also a possibility, along with cardiac tamponade.

Emergency Care: The patient was immediately intubated without the need for sedation or paralysis. His clothes were quickly cut off, and a cursory external examination revealed numerous gunshot wounds to his thorax, abdomen, and extremities. A resuscitative thoracotomy was immediately performed. A massive left hemothorax was encountered with clotted and fresh blood quickly evacuated. A pericardiotomy was performed revealing a through-and-through left ventricular gunshot wound. The emergency physician placed fingers in both ventricular wounds. A chest radiograph demonstrated the rib spreaders in proper position with the hand of the physician entering the left hemithorax and the physicians's fingers plugging the left ventricular wounds. The patient was given 1 mg of intracardiac epinephrine with spontaneous return of organized cardiac activity. He was taken to the operating room for definitive repair of his cardiac wounds. His other gunshot wounds resulted in significant intraperitoneal and orthopedic injuries.

Outcome: The patient had a 6-week complicated hospital course with acute respiratory distress syndrome, recurrent cardiac arrhythmias, sepsis, pneumonia, enteric fistulas, acute renal failure, and extensive orthopedic procedures. The patient was discharged to a rehabilitation facility and eventually fully recovered from his injuries.

Key Learning Points:
- Through and through cardiac gunshot wounds have an extremely poor prognosis with minimal chance of successful resuscitation and subsequent meaningful neurologic survival if the patient arrives to the ED without signs of life. This dramatic case demonstrates that the odds, though quite low, are not zero.

Further Reading:

Molina EJ, Gaughan JP, Kulp H, McClurken JB, Goldberg AJ, Seamon MJ. Outcomes after emergency department thoracotomy for penetrating cardiac injuries: a new perspective. *Interact Cardiovasc Thorac Surg*. 2008;7(5):845.

Seamon MJ, Shiroff AM, et al. Emergency department thoracotomy for penetrating injuries of the heart and great vessels: an appraisal of 283 consecutive cases from two urban trauma centers. *J Trauma*. 67(6):1250-1257.

Tyburski JG, Astra L, Wilson RF, Dente C, Steffes C. Factors affecting prognosis with penetrating wounds of the heart. *J Trauma*. 2000;48(4):587-590.

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List of Cases

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List of Figure Legends

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Index

Note: Page numbers followed by *f* indicate figures.

I

J

K

U

Z