PEDIATRIC
Radiology Review

Edited by

Michael D. Pappas, MD

Loren G. Yamamoto, MD, MPH, MBA

Okechukwu Anene, MD

HUMANA PRESS

Pediatric Radiology Review

Pediatric Radiology Review

Edited by

Michael D. Pappas, MD

Children's Intensive Caring
and Department of Pediatrics
Medical University of Ohio
Toledo, OH

Loren G. Yamamoto, MD, MPH, MBA

Department of Pediatrics
John A. Burns School of Medicine
University of Hawaii
Honolulu, HI

and

Okechukwu Anene, MD

New Jersey Neuroscience Institute
Seton Hall University
Edison, NJ

Humana Press
Totowa, New Jersey

999 Riverview Drive, Suite 208
Totowa, New Jersey 07512

www.humanapress.com

For additional copies, pricing for bulk purchases, and/or information about other Humana titles, contact Humana at the above address or at any of the following numbers: Tel.: 973-256-1699; Fax: 973-256-8341, E-mail: orders@humanapr.com; or visit our Website: http://humanapress.com

Cover Illustration: Fig. 3, Chapter 3, "Abdominal Radiographs."

Cover design by Patricia F. Cleary

Production Editor: Amy Thau

This publication is printed on acid-free paper. ∞
ANSI Z39.48-1984 (American National Standards Institute) Permanence of Paper for Printed Library Materials.

Printed in the United States of America. 10 9 8 7 6 5 4 3 2 1
eISBN: 1-59745-146-0

Library of Congress Cataloging-in-Publication Data
Pediatric radiology review / edited by Michael D. Pappas, Loren G. Yamamoto, and Okechukwu Anene.
p. ; cm.
Includes bibliographical references.
ISBN-13: 978-1-58829-851-5
ISBN-10: 1-58829-851-5 (alk. paper)
1. Pediatric radiology--Examinations, questions, etc. I. Pappas, Michael D. II. Yamamoto, Loren. III. Anene, Okechukwu.
[DNLM: 1. Radiography--Examination Questions. 2. Child. 3. Infant. WN 18.2 P371 2007]
RJ51.R3P43 2007
618.92'00757076--dc22
2006017768

PREFACE

To many outside the medical field, an X-ray or radiograph is a simple picture of the interior aspect of the body, but to many health professionals the simple picture is a complicated puzzle. However, a radiographic film can provide an enormous amount of information that, when analyzed correctly, provides an accurate diagnosis and confirms a suspicion. The relative ease with which a radiographic film can be generated and analyzed ensures a quick and reliable diagnostic tool. The saying, "A picture is worth a thousand words" holds true with regards to radiographic films.

Pediatric radiography has evolved into a sophisticated yet affordable diagnostic aid with various applications throughout the human body. With the advent of a high-resolution imaging technique, anatomic details of various body parts have become routine. Many structural densities are well visualized with the appropriate utilization of detailed "window" adjustments. Indeed, it is a cost-effective diagnostic apparatus when appropriately utilized.

Pediatric Radiology Review is not just a review of radiographs in children; it is a vast font of information on embryology, anatomy, surgery, etc. The importance of these disciplines to the understanding of radiological correlates cannot be over-emphasized. References are abundant and thus provide pertinent information for the readers with a voracious appetite for more knowledge.

It is our hope that this edition will permit medical students, residents, and clinicians who are not radiologists to recognize the anatomic details of radiological images. In our opinion, *Pediatric Radiology Review* includes the most common radiological problems with which students, residents, and clinicians may be confronted on a daily basis. This text is a gift for all those who provide care for children. We do humbly welcome your comments and criticisms of this edition.

Michael D. Pappas, *MD*
Loren G. Yamamoto, *MD, MPH, MBA*
Okechukwu Anene, *MD*

Acknowledgment

We would like to give recognition to Ms. Julie Hall, who, once again, has been instrumental in the development and completion of this text. Julie has been involved with our projects from the very beginning and has worn many hats. She serves an integral role to each project being published. Thank you, Julie, for your ongoing involvement, dedication, and commitment.

We wish also to thank Humana Press for making our vision a reality,with special thanks to Mr. Harvey Kane, Ms. Ellie Shaw, Ms. Patricia Cleary, and Ms. Amy Thau.

Contents

Contributors

Okechukwu Anene, md • *New Jersey Neuroscience Institute, Seton Hall University, Edison, NJ*
Brian Barnes, md • *Reno Emergency Physicians, St. Mary's Regional Medical Center, Reno, NV*
Mohammed Cheema, md • *Children's Intensive Caring, Toledo, OH*
Jeffrey Ford, md • *Emergency Medicine Residency Department, St. Vincent Mercy Medical Center, Toledo, OH*
Brent Jacobsen, do • *California Emergency Physicians, Emeryville, CA*
Robert Kittyle, md • *Department of Radiology, Medical University of Ohio, Toledo, OH*
Valerie Lint, do • *St. Charles Mercy Hospital, Oregon, OH*
Robert Lowe, md • *Doctor's Hospital, Columbus, OH*
Michael D. Pappas, md • *Children's Intensive Caring and Department of Pediatrics, Medical University of Ohio, Toledo, OH*
Loren G. Yamamoto, md, mph, mba • *Department of Pediatrics, John A. Burns School of Medicine, University of Hawaii, Honolulu, HI*

Companion CD

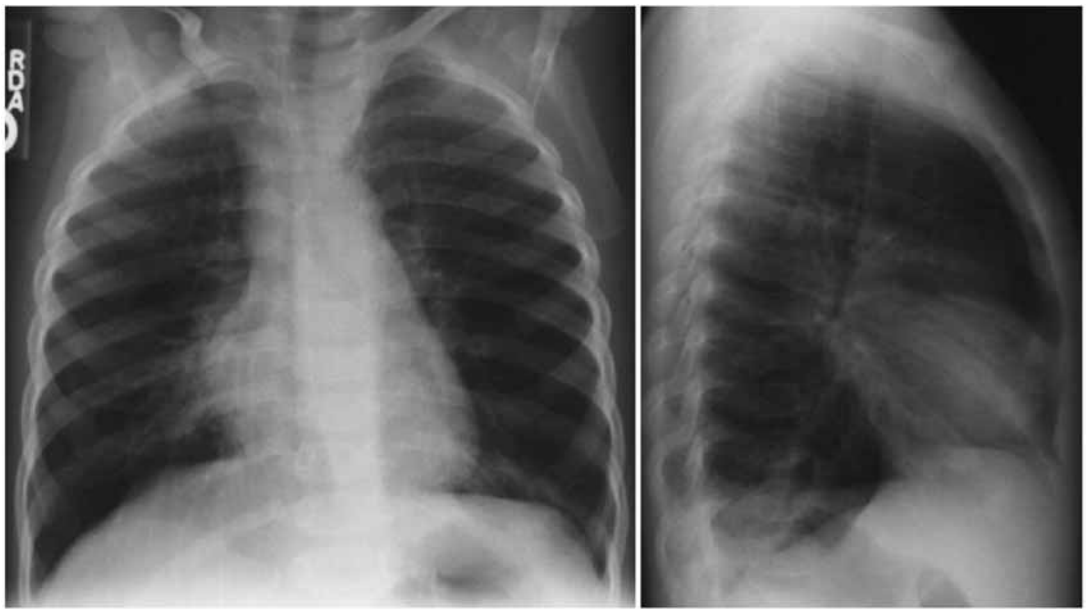
The Companion CD contains an interactive version of the test questions found in this volume. The Companion CD is compatible with both Mac and PC operating systems that run any web browser over 4.0.

1 Chest Radiographs

The following chapter will focus on radiographs of the chest. Pertinent questions, answers, and rationale will be reviewed.

Key Words: Heart; lungs; pneumonia; lobar; effusion; pneumothorax; cardiomegaly.

QUESTIONS 1–3: A 16-month-old male presents with a 3-day history of coughing. Vital signs: pulse 120, respiratory rate 38, temperature 101.3°F, pulse oximetry 97%. The following X-ray is obtained.



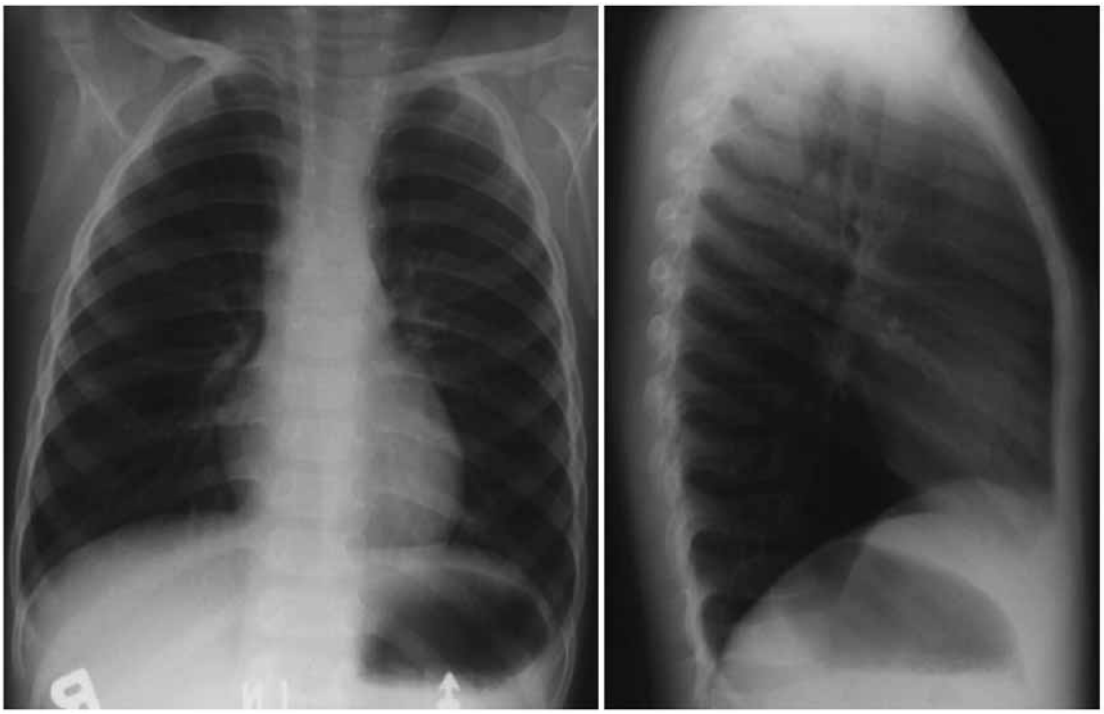
1. The correct interpretation of this X-ray is:
   a. Right middle lobe infiltrate.
   b. Left lower lobe infiltrate.
   c. Left upper lobe infiltrate.
   d. Both a and b.
   e. Both b and c.

2. Common causes of pneumonia for this age and presentation include all the following except:
   a. Respiratory syncytial virus and other respiratory viruses.
   b. *Streptococcus pneumoniae*.
   c. *Escherichia coli*.
   d. *Haemophilus influenzae*.

3. Admission criteria would include:
   a. Persistent hypoxia.
   b. History of cyanosis or apneic episodes.
   c. Age less than 3 months.
   d. Impaired immune function.
   e. All of the above.

From: *Pediatric Radiology Review*
Edited by: M. D. Pappas, L. G. Yamamoto, and A. Okechukwu © Humana Press Inc., Totowa, NJ

QUESTIONS 4–6: A 3-year-old male presents to the emergency department, accompanied by his babysitter and 5-year-old brother. Chief complaint is coughing with difficulty breathing. On exam the child is afebrile, pulse oximetry is 99%, and there is bilateral stridor with a brochospastic cough.



4. This X-ray would be best described as:

a. Normal.
b. Hyperexpansion.
c. Right middle infiltrate.
d. Right-side rib fractures.

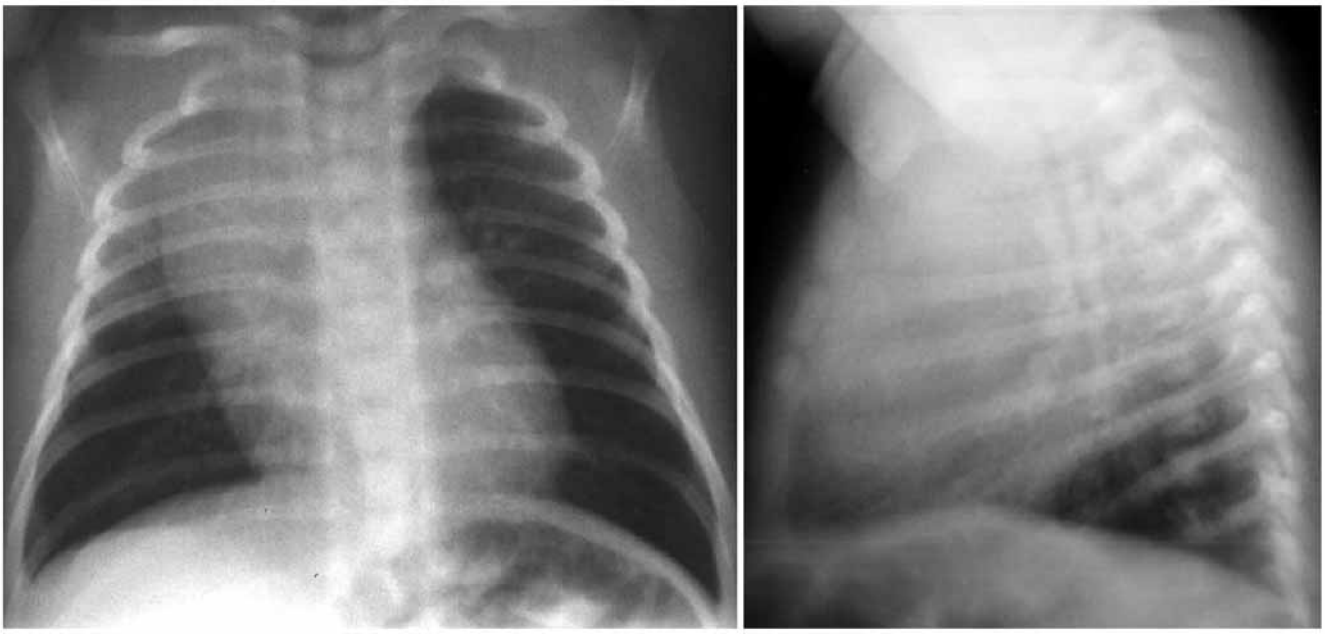
5. Further information from the 5-year-old brother reveals that the children were eating peanut candies and jumping on the bed prior to the coughing episode. This leads you to suspect:

a. Asthma.
b. Foreign-body aspiration.
c. Rupture of bronchus.
d. Aspiration pneumonia.

6. After stabilization of the airway, breathing, and circulation, management of this case includes:

a. Antibiotic coverage.
b. Nebulized albuterol treatments.
c. Foreign-body removal.

QUESTIONS 7–8: A 10-week-old male presents with a history of cough for 2 days, fever, and congestion. The child continues to nurse well, and the parents report no decrease in the number of wet diapers. Vital signs reveal a pulse of 142, respiratory rate of 36, temperature of 102.1°F rectally, and pulse oximetry 97%.



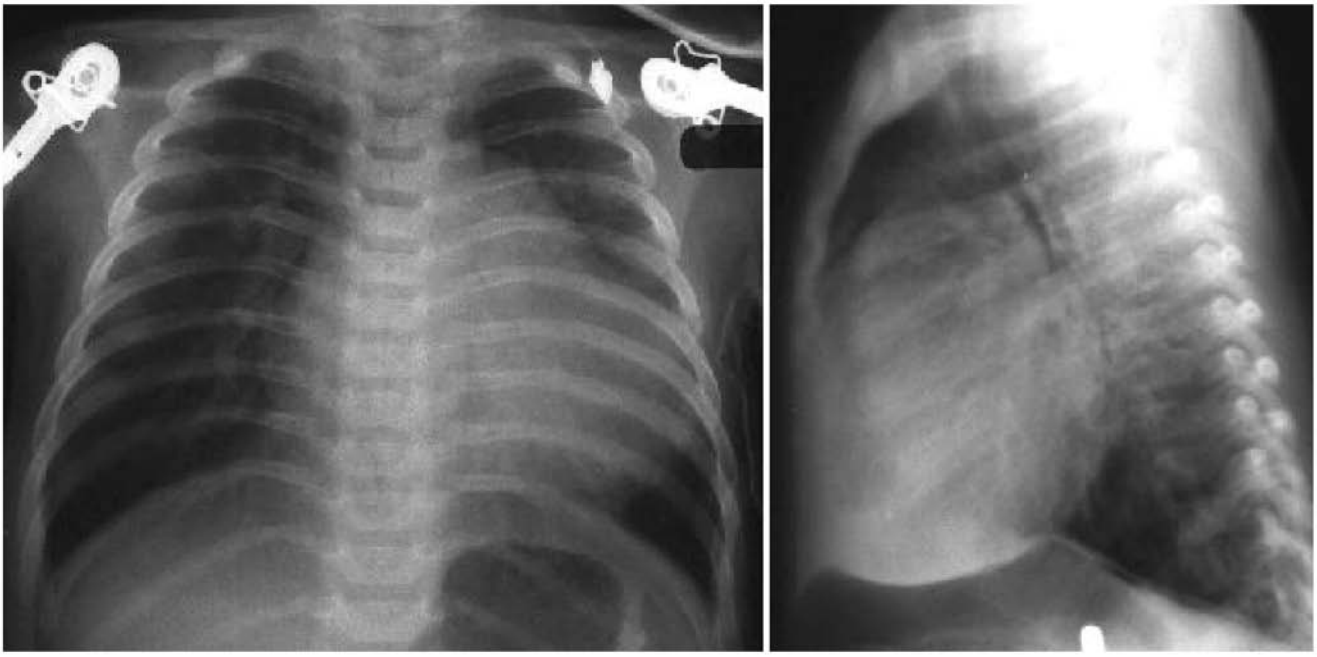
7. The correct interpretation of this X-ray is:

a. Normal.
b. Cardiomegaly.
c. Retrocardiac infiltrate.
d. Right upper lobe infiltrate.

8. Proper management may include all of the following except:

a. Supplemental oxygen.
b. Admission to the hospital.
c. Intravenous diuretics.
d. Oral antibiotics.

QUESTIONS 9–10: A 7-week-old male arrives via EMS. His parents report a shaking episode involving all extremities lasting 1–2 minutes. He has a previous history of a ventricular septal defect. Physical exam reveals an alert child in no distress, a systolic murmur, lungs clear to auscultation, and no appreciated neurological abnormalities. The following X-ray is obtained.



9. Your interpretation of this X-ray is which of the following?

a. Mediastinal shifting.
b. Situs inversus.
c. Right lower lobe infiltrate.
d. Presence of a thymic shadow.

10. While the child is in the emergency department, you witness a second seizure lasting approximately 50 seconds, consisting of generalized extremity movement. The child does not appear drowsy after the seizure subsides. In which of the following serum electrolytes would you expect to see an abnormality?

a. Sodium.
b. Chloride.
c. Calcium.
d. Potassium.

QUESTIONS 11–13: A 15-year-old male with a history of asthma presents with a 2-day history of worsening difficulty in breathing. Vital signs reveal an afebrile patient with pulse of 90, respiratory rate 26, pulse oximetry 93%. Physical exam reveals diffuse wheezing with poor air movement. After two nebulized treatments of albuterol and atrovent, the patient feels symptomatically better. Pulse oximetry is 95% with continued poor air movement. The following X-ray is obtained.

11. Your interpretation of this X-ray is best described as:

a. Hyperinflation.
b. Possible bilateral infiltrates.
c. Pneumomediastinum.
d. Atelectasis.
e. All of the above.

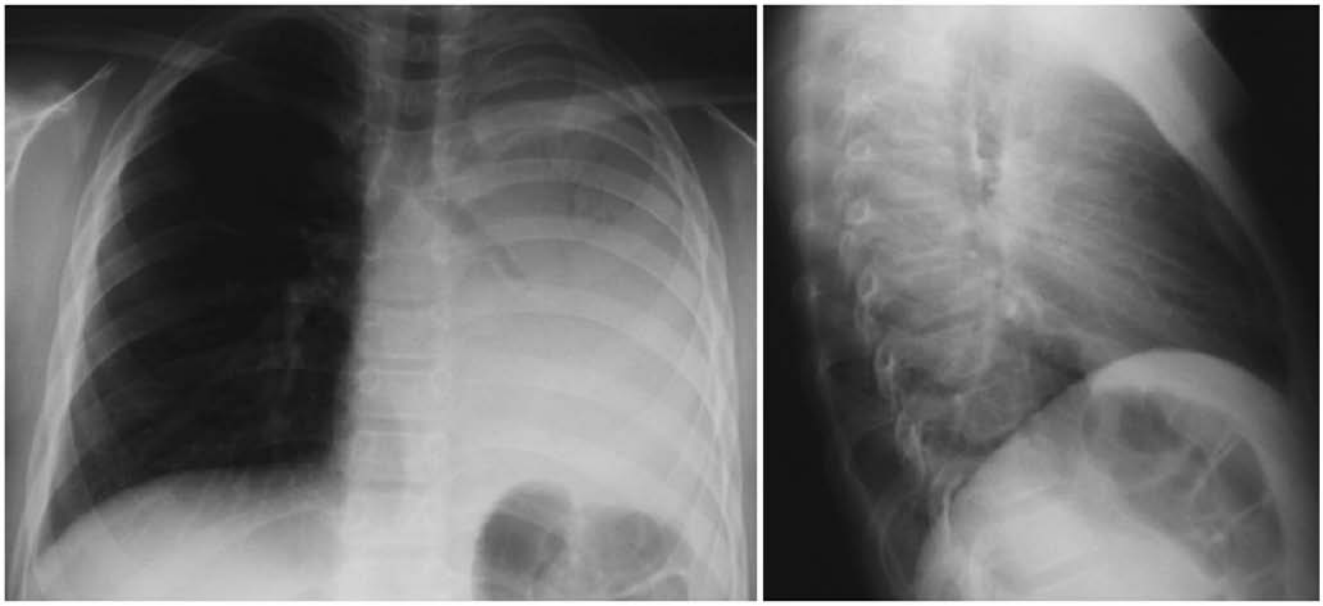
12. Possible complications of asthma include which of the following?

a. Muscle fatigue.
b. Respiratory failure.
c. Pneumomediastinum.
d. Pneumonia.
e. All of the above.

13. All the following represent asthma admission criteria except:

a. Persistent oxygen requirement.
b. Steroid therapy in emergency department or office.
c. Underlying cardiopulmonary disease.
d. Large pneumomediastinum.

QUESTIONS 14–16: An 11-year-old child presents with a history of cough and fever for 2–3 days. Vital signs: pulse 86, respiratory rate 20, pulse oximetry 97%, and temperature of 100.2°F orally. Physical examination notes poor breath sounds throughout the left lung.



14. Your interpretation of this X-ray is best described as:

a. Normal.
b. Tension pneumothorax on right.
c. Pneumomediastinum.
d. Atelectasis.
e. Hemothorax.

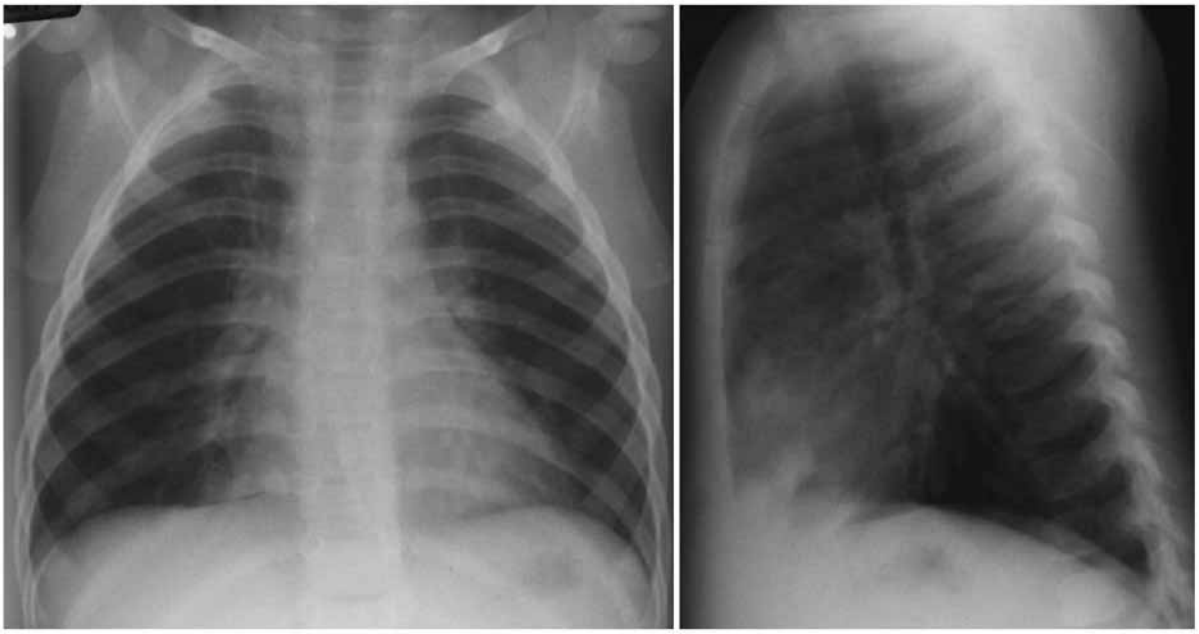
15. Further history from the child now reveals that 4 days ago he swallowed a "plastic bullet." The best explanation for the X-ray findings is:

a. Complete obstruction of left main stem bronchus.
b. Overinflation of the right lung, resulting in barotrauma.
c. Consolidation from pneumonia.
d. Blunt trauma.

16. The next diagnostic and/or therapeutic step is:

a. Bronchoscopy.
b. Left chest tube thoracotomy.
c. Intravenous antibiotics and admission.
d. CT scan of the chest.

QUESTIONS 17–19: A 12-month-old female arrives with both parents, who relate a history of fever and coughing at home. Vital signs: pulse 130, respiratory rate 32, pulse oximetry 99%, and temperature of 100.4°F rectally. Physical exam reveals mild wheezing throughout and occasional rales.



17. Your interpretation of this X-ray is best described as:

a. Normal.
b. Bilateral central infiltrates.
c. Retrocardiac infiltrate.
d. Atelectasis.

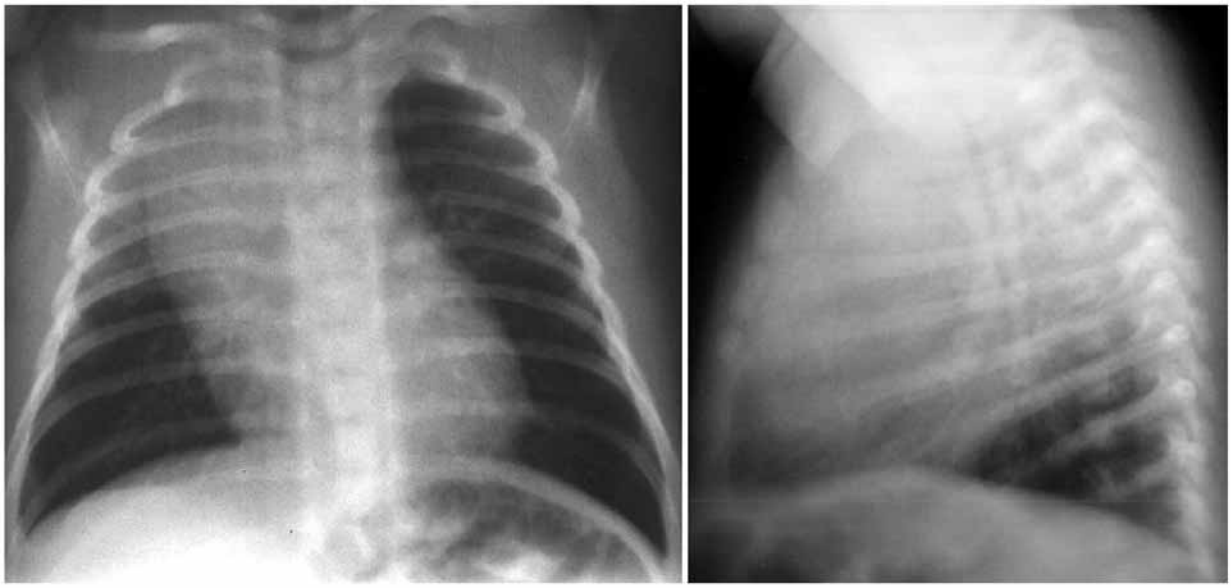
18. The X-ray findings are most consistent with a diagnosis of:

a. No acute disease.
b. Viral pneumonia.
c. Bacterial pneumonia.
d. Acute asthma exacerbation.

19. Therapy for this child would include:

a. Intravenous antibiotics.
b. Admission to the hospital.
c. Fever control and hydration.
d. Endotracheal intubation.

QUESTIONS 20–21: A 6-week-old female is brought to the emergency department with a 1-day history of coughing and congestion. Parents state that she had an episode of frequent coughing in the waiting room, but is better now. Vital signs: pulse 150, respiratory rate 40, pulse oximetry 99%, temperature of 99.8°F rectally. Physical exam reveals a normal lung and chest exam.



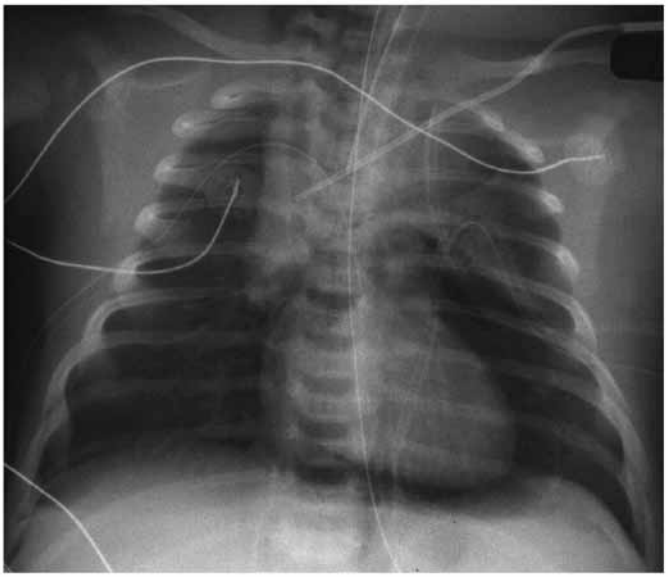
20. Your interpretation of this X-ray is best described as:

a. Normal.
b. Abnormal thymus.
c. Right upper lobe infiltrate.
d. Mediastinal shift to the right.

21. The clinical diagnosis is most consistent with:

a. Normal.
b. Pneumonic process.
c. DiGeorge's syndrome.
d. None of the above.

QUESTIONS 22–24: You are called to urgently see a 6-week-old female in the pediatric ICU who has suddenly decompensated, becoming very bradycardic, cyanotic, and severely hypotensive. The child is admitted 36 hours post-op and in severe respiratory distress. A stat portable chest X-ray has just been completed.



22. Your interpretation of this X-ray includes all the following except:

a. Endotracheal tube with distal end above the carina.
b. Gastric tube with distal end below the diaphragm.
c. Right mainstem intubation.
d. Left subclavian line with the distal tip in the superior vena cava.
e. Pneumopericardium.

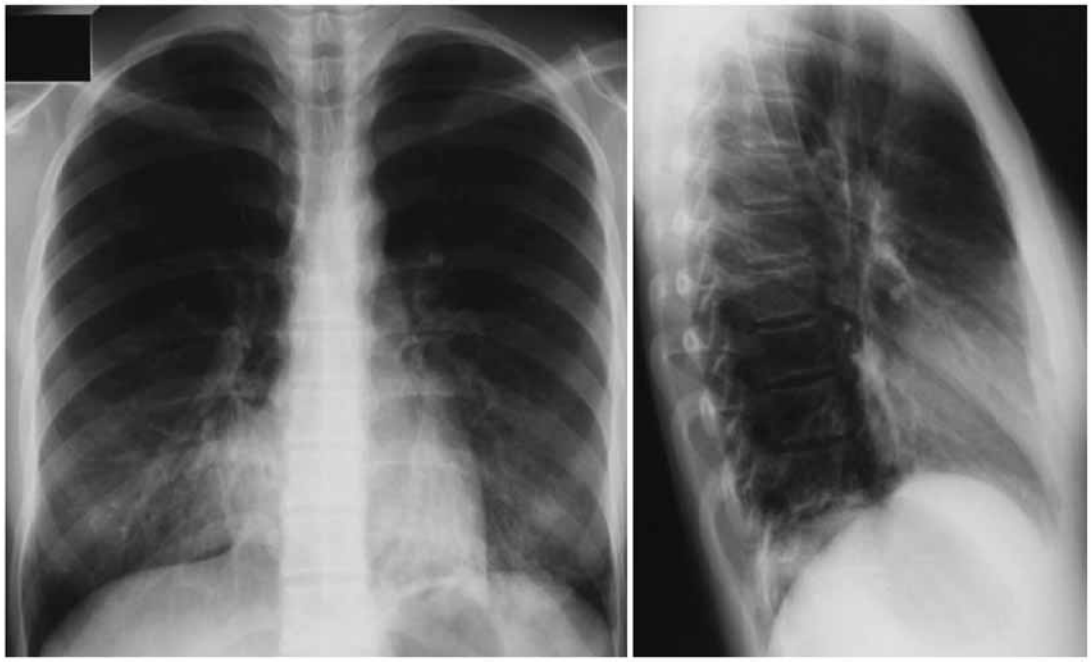
23. The X-ray data and clinical presentation lead you to conclude a diagnosis of:

a. Acute respiratory distress syndrome.
b. Tension pneumopericardium or cardiac tamponade.
c. Ventilatory circuit malfunction.
d. Congestive heart failure.

24. The following intervention is most appropriate:

a. Begin intravenous steroids.
b. Withdraw the endotracheal tube 1–2 cm and re-evaluate.
c. Disconnect the ventilatory circuit and begin aggressive bagging.
d. Perform a pericardiocentesis.

QUESTIONS 25–29: A 10-year-old male presents with a history of fever and cough over the past 4 days. Vital signs: pulse 130, respiratory rate 22, temperature of 102.1°F, pulse oximetry 99% on room air. Physical exam reveals rhonchi in the left base.



25. The correct interpretation of this X-ray is:

a. Normal.
b. Retrocardiac infiltrate.
c. Right middle lobe infiltrate and left lower lobe infiltrate.
d. None of the above.

26. Proper management may include which of the following?

a. Blood cultures.
b. Antibiotics.
c. Early follow-up by primary care physician.
d. All of the above.

27. At this age, the most likely pathogen would be:

a. Respiratory syncytial virus.
b. *Mycoplasm pneumoniae*.
c. Group B *Streptococcus*.
d. *Listeria*.

28. Which of the following is/are true?

a. Bilateral infiltrates are always "true" pneumonias.
b. Unilateral infiltrates are always "true" pneumonias.
c. Bilateral infiltrates are always "atypical" pneumonias.
d. Unilateral infiltrates are always "atypical" pneumonias.
e. None of the above.

29. All the following are true for "typical" versus "atypical" pneumonia except:

a. Typical pneumonia is abrupt in onset and has a high-grade fever.
b. Atypical pneumonia is gradual in onset and has low-grade fever.
c. Localized findings and a toxic appearance are associated with the typical pattern.
d. A productive cough is often associated with an atypical infection.

QUESTIONS 30–34: An 8-year-old child presents with recent headache, cough, fever, and nausea. Vital signs: pulse 95, respiratory rate 20, temperature of 102.1°F, pulse oximetry 98%.

30. The correct interpretation of this X-ray is:

a. Normal.
b. Left pleural effusion.
c. Right-sided circular density.
d. Left lower lobe infiltrate.

31. Clues to distinguishing a mass from an infiltrate include all the following except:

a. An infiltrate is more likely given the clinical picture of fever, cough, and illness.
b. Multiple circular densities would be more suspect for noninfectious lesions.
c. The presence of costophrenic angle blunting and a "mass" near the lung fissure suggest a pseudotumor.
d. The absence of known metastatic disease rules out a cancerous mass.

32. You suspect an infectious process, but schedule a follow-up X-ray. After the acute illness has improved, how long does it take for a pneumonic infiltrate to resolve on X-ray?

a. 1–2 days.
b. 4–6 weeks.
c. 2–4 months.
d. Up to 1 year.

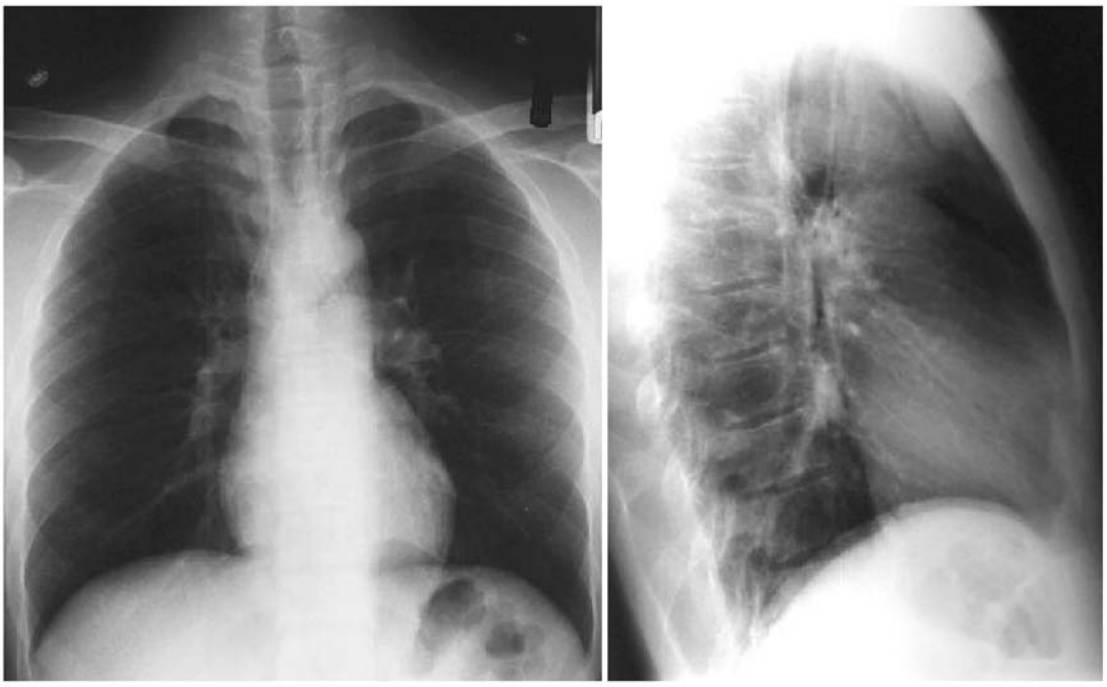
33. Populations with high incidence of tuberculosis include all the following except:

a. Immigrants from high-prevalence countries.
b. Nonimmunized children.
c. HIV-infected patients.
d. Crowded living conditions, such as shelters or prisons.
e. Alcoholics or illicit drug users.

34. Chest X-ray findings in tuberculosis include all the following except:

a. Hilar adenopathy.
b. Upper lobe cavitary lesion.
c. Atelectasis.
d. Diffuse (1–3 mm) nodules.
e. Pleural effusion.

QUESTIONS 35–36: A 19-year-old male presents with a complaint of shortness of breath. He is previously healthy with an admitted history of smoking crack cocaine as recently as the last 12 hours. Vital signs are normal and auscultation reveals an additional grating sound in synchrony with the heart rate.



35. Your interpretation of this X-ray is:

a. Pneumothorax.
b. Cardiomegaly.
c. Retrocardiac infiltrate.
d. Normal.
e. Pneumomediastinum.

36. This X-ray finding is consistent with all the following except:

a. Asthma.
b. Severe coughing event.
c. Valsalva maneuvers.
d. Cardiac disease.

QUESTIONS 37–40: A 14-month-old child is placed in a bathtub sitting with the water level to mid-abdomen. The mother steps away to answer the phone and returns in "less than 5 minutes" to find the child floating face up with no spontaneous respirations. CPR is immediately initiated; 911 is called. On emergency medical services arrival the child has spontaneous respirations, which are assisted by bag-valve mask. Arrival in the emergency department finds the child to be crying and recognizing the mother. Vital signs: pulse 115, respiratory rate 48, temperature 96.5°F. Physical exam reveals wheezing and rales but is otherwise normal. The following X-ray is obtained.

37. Your interpretation of this X-ray is:

a. Normal.
b. Increased interstitial markings.
c. Pleural effusion.
d. Pneumothorax.

38. Near-drowning is defined as:

a. Survival beyond 24 hours of submersion.
b. Survival beyond 1 month of submersion.
c. Arrival at the hospital with pulse and spontaneous respirations.
d. No documented loss of pulse or respiratory effort with submersion.

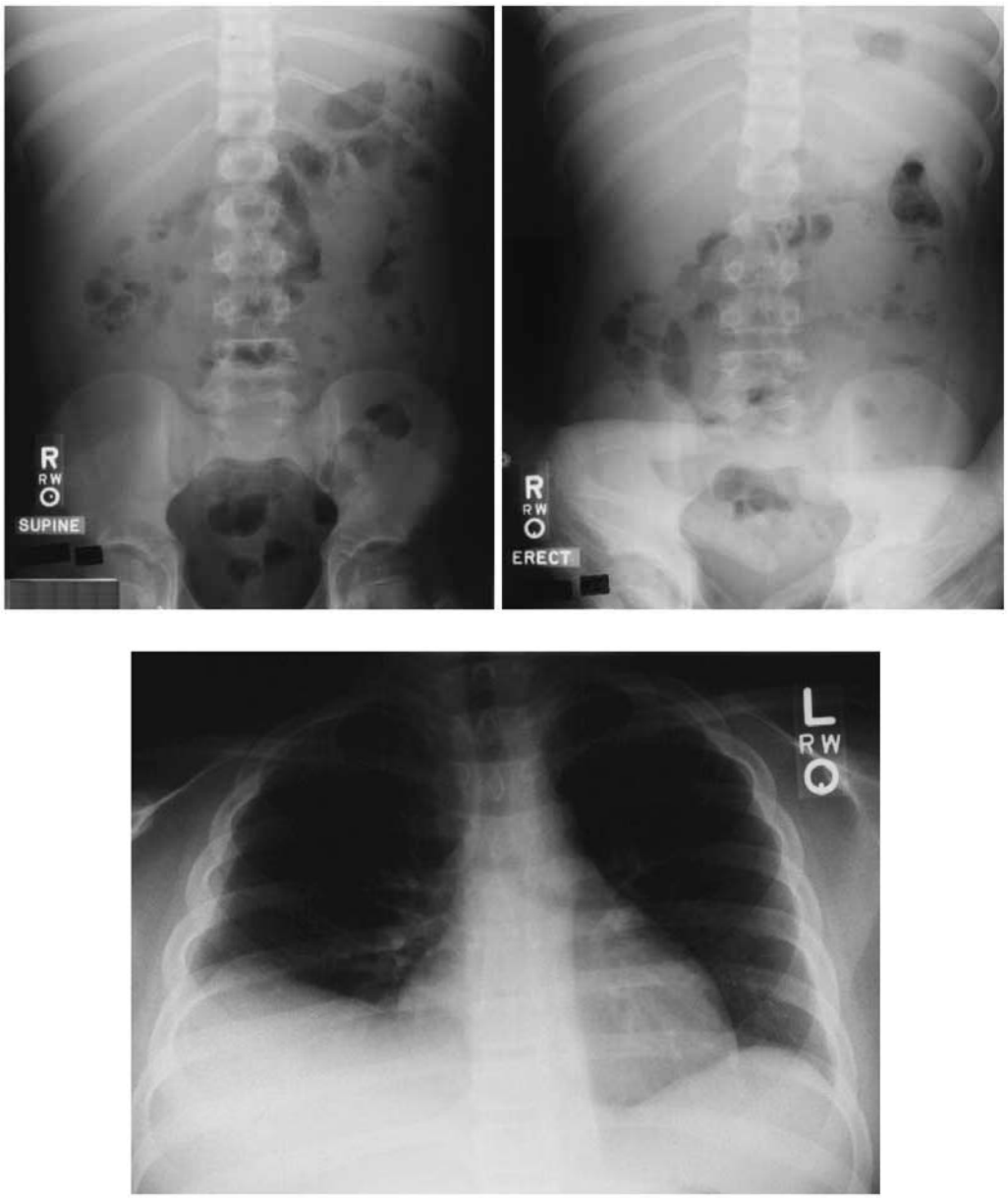
39. Pathophysiology of drowning includes all of the following except:

a. Hypoxia.
b. Aspiration.
c. Hyperthermia.
d. None of the above.

40. Initial management would include all of the following except:

a. Airway assessment and management.
b. C-spine protection.
c. Treatment of hypoxia.
d. Active fluid drainage from the lungs.

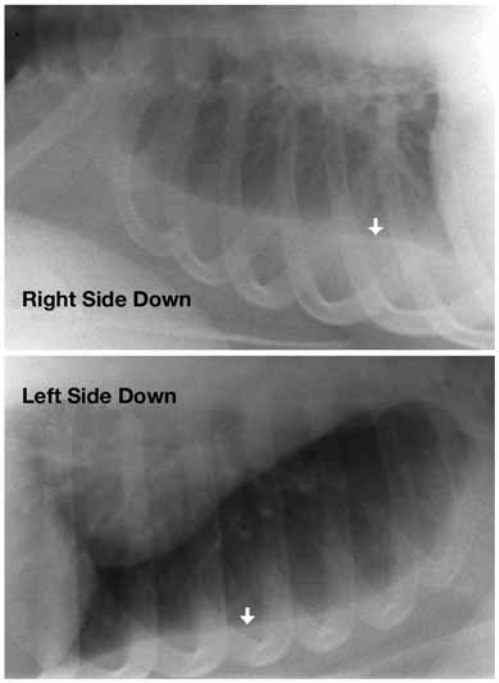
QUESTIONS 41–44: A 10-year-old male with 4 to 6 episodes of vomiting at home and school today continues to feel ill and had a brief fainting episode, prompting parents to pick the child up and bring him to the emergency department for further evaluation. He is obese, reports poor appetite, and had a low-grade fever at home. Vital signs: pulse 110, respiratory rate 22, temperature of 98.4°F, pulse oximetry 95%. Physical exam is otherwise unremarkable, including distant breath sounds in this obese child. Because of parents' and nurses' observation of a possibly distended abdomen, you obtain the following X-rays.



41. Your interpretation of these X-rays is:

a. Right pleural effusion.
b. Right pneumothorax.
c. Right lower lobe infiltrate.
d. Normal.

In addition to the right-sided abnormalities, the left diaphragm concerns you. The following two films are obtained.



42. These X-rays are consistent with:

a. Right pleural effusion.
b. Bilateral pleural effusions.
c. Right pneumothorax.
d. Bilateral pneumothorax.

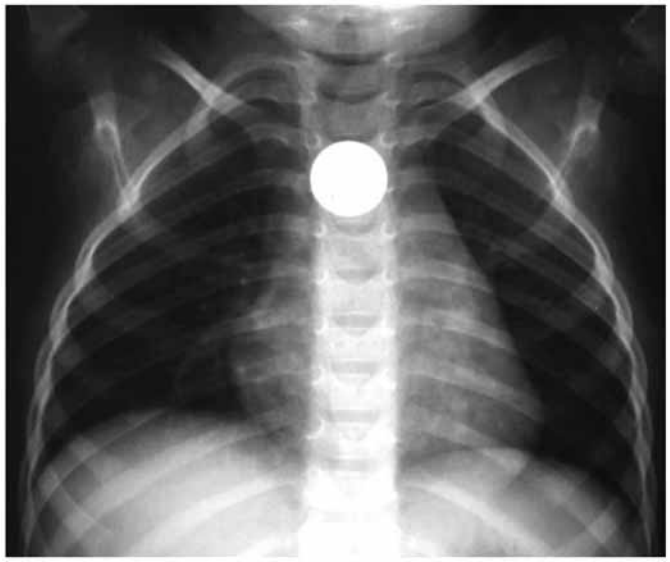
43. All of the following criteria define a pleural effusion as an exudate except:

a. Lactate dehydrogenase fluid to blood ratio higher than 0.6.
b. Protein fluid to blood ratio higher than 0.5.
c. Glucose higher than 80.
d. Lactate dehydrogenase higher than 200 U.

44. Potential causes of pleural effusion include all of the following except:

a. Rheumatic heart disease.
b. Pneumonia.
c. Tuberculosis.
d. Malignant disease.
e. Glomerulonephritis.

QUESTIONS 45–49: A 25-month-old female presents to the emergency department with parents complaining of an episode of hemoptysis that evening. The child has had a 3- to 4-week history of coughing and wheezing and has been seen three separate times by various care providers. She was initially treated with albuterol syrup and amoxicillin with some improvement and is currently on augmentin for continued symptoms. The family is alarmed by the episode of bloody cough. Physical exam reveals pulse 130, respiratory rate 40, temperature of 99.9°F rectally, pulse oximetry 99–100% on room air. She appears nontoxic and in no acute distress. Lungs have good aeration with mild wheezing; there is a dry cough, but the remainder of the exam is normal. The following X-ray is obtained.



45. Your interpretation of this X-ray is:

a. Tracheal foreign body.
b. Normal.
c. Esophageal foreign body.
d. Error in film processing.

46. Complications can include all of the following except:

a. Airway compromise.
b. Esophageal rupture.
c. Erosion into the mediastinal structures.
d. Heavy metal poisoning.

47. Definitive management of this child should include:

a. Admission and serial X-ray examination for passage with cardiovascular surgery for backup.
b. Emergent endoscopy for removal.
c. Glucagon injection.
d. Syrup of ipecac.

48. Common sites of foreign body impaction in children include all of the following except:

a. Cricopharyngeal narrowing at level C6.
b. Tracheal bifurcation at level T6.
c. Ileocecal valve.
d. Hiatal narrowing of esophageal valve.

49. What percentage of foreign bodies pass without intervention?

a. Less than 10%.
b. 20%.
c. 50%.
d. Greater than 80%.

2 Lateral Neck Radiographs

The following chapter will focus on radiographs of the lateral neck. Pertinent questions, answers, and rationale will be reviewed.

Key Words: Soft tissue; airway; vertebrae; fracture; dislocation; retropharyngeal.

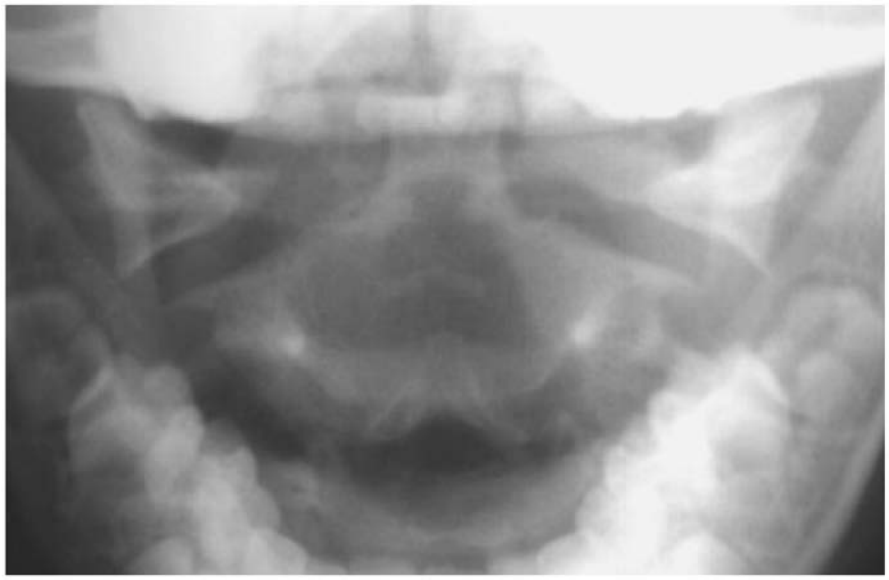
QUESTIONS 1–5: A 7-year-old female presents after being pulled semiconscious from a pool into which she had dove headfirst. Her airway is cleared and she begins to regain consciousness. She is fully immobilized and brought to you. She has a normal exam and no complaints at this time. You order a C-spine film, as shown below.

1. What is your diagnosis?

a. Normal.
b. Subluxation at C5–C6.
c. Soft-tissue swelling.
d. Poor film; will need to redo.

From: *Pediatric Radiology Review*
Edited by: M. D. Pappas, L. G. Yamamoto, and A. Okechukwu © Humana Press Inc., Totowa, NJ

You then order an odontoid view (below).



2. What is your main concern?

a. I have no concern.
b. There is lateral mass widening.
c. There is a mandibular fracture.
d. None of the above.

3. What is your diagnosis?

a. Hangman's fracture.
b. Dens fracture.
c. Jefferson fracture.
d. Normal.

4. What percentage of Jefferson fractures is associated with other cervical spine fractures?

a. 80%.
b. 33%.
c. Less than 1%.
d. None of the above.

5. Your patient develops peripheral tingling, which progresses to parasthesia and paralysis of the upper and lower extremities. What should your initial treatment be?

a. Mannitol and neurosurgical (NS) consultation alone.
b. NS consultation only.
c. Steroids and NS consultation.
d. None of the above.

QUESTIONS 6–9: A 2-year-old female presents to the emergency department with respiratory distress, drooling, and temperature of 103.8°F for 14 hours. A lateral neck film is obtained (below).

6. What is your interpretation of this film?

a. Croup.
b. Epiglottitis.
c. Retropharyngeal abscess.
d. Normal.
e. None of the above.

7. The best therapeutic approach to this patient is:

a. Humidified blow-by and steroids.
b. Controlled intubation in the operating room.
c. Ear, nose, and throat specialist consult.
d. Observation and antibiotics.

8. Which of the following additional clinical findings is/are consistent with this disease process?

a. Tripod position.
b. Stridor.
c. Dysphagia.
d. All of the above.

9. The most likely organism involved in this disease process is:

a. Parainfluenzae.
b. *Haemophilus influenzae* type B.
c. *Candida albicans*.
d. *Staphylococcus epidermidis*.
e. None of the above.

QUESTIONS 10–13: A 5-year-old male presents with fever, sore throat, and hoarse voice for 3 days. Past medical history is significant for asthma. The child is alert but uncomfortable, with the following vital signs: heart rate 110, respiratory rate 26, temperature of 101.7°F, and oxygen saturation of 99% on room air.

10. What is your impression?

a. Retropharyngeal swelling.
b. Subglottic swelling.
c. Epiglottic edema.
d. Normal.

11. What would be your initial treatment?

a. Observation, supportive care, and humidified room air.
b. IV placement, fluid boluses, and sepsis workup.
c. Bag and mask for 2 minutes to decrease CO_2 buildup.
d. None of the above.

12. What is your diagnosis?

a. Laryngotracheobronchitis.
b. Epiglottitis.
c. Retropharyngeal abscess.
d. Normal.
e. None of the above

13. Which of the following would be the most appropriate next therapeutic modality?

a. Intubation and ventilation.
b. Intubation only.
c. Intravenous steroids.
d. All of the above.
e. None of the above.

QUESTIONS 14–18: A 5-year-old boy is brought to the emergency department in C-spine immobilization. He was an unrestrained passenger when his car was struck broadside by another car. The boy's head struck the dashboard and he sustained multiple lacerations to his face and trunk. On exam, he is alert and crying. The following lateral neck X-ray is obtained.

14. What is your interpretation?

a. Pseudosubluxation.
b. Jefferson fracture.
c. Hangman's fracture.
d. Pedicle fracture of C3.
e. None of the above.

15. The mechanism of injury in this child is:

a. Hyperflexion of the head.
b. Hyperextension of the head.
c. Lateral spiralization of the cervical vertebrae.
d. None of the above.

16. The most common cause of this injury is:

a. Automobile accident.
b. Accidental hanging.
c. Trampoline injury.
d. Gymnastic injury.
e. None of the above.

17. What is the main difference between a pseudosubluxation and a hangman's fracture?

a. A hangman's fracture has a more benign mechanism of injury.
b. A child with a hangman's fracture will suffer less overall trauma than a child with pseudosubluxation.
c. A pseudosubluxation is seen only on a lateral neck film that is positioned without extension.
d. The observation of a visible fracture rules out a hangman's fracture.

18. Which of the following would be the most useful in distinguishing pseudosubluxation from a hangman's fracture?

a. Observation for 24–48 hours.
b. CT scan of the cervical spine.
c. Palpation of the cervical vertebrae.
d. None of the above.

QUESTIONS 19–23: Carefully study the following lateral neck X-rays and specifically comment on the parameters requested, including bony alignment (BA), vertebral bodies and disk spaces (VB), C1–C2 anatomy (C), positioning (P), preverterbral spacing (PS), anatomy of the epiglottis (E), subglottic airway (SG), and the presumptive final diagnosis (Dx).

19. BA: _____

VB: _____

C: _____

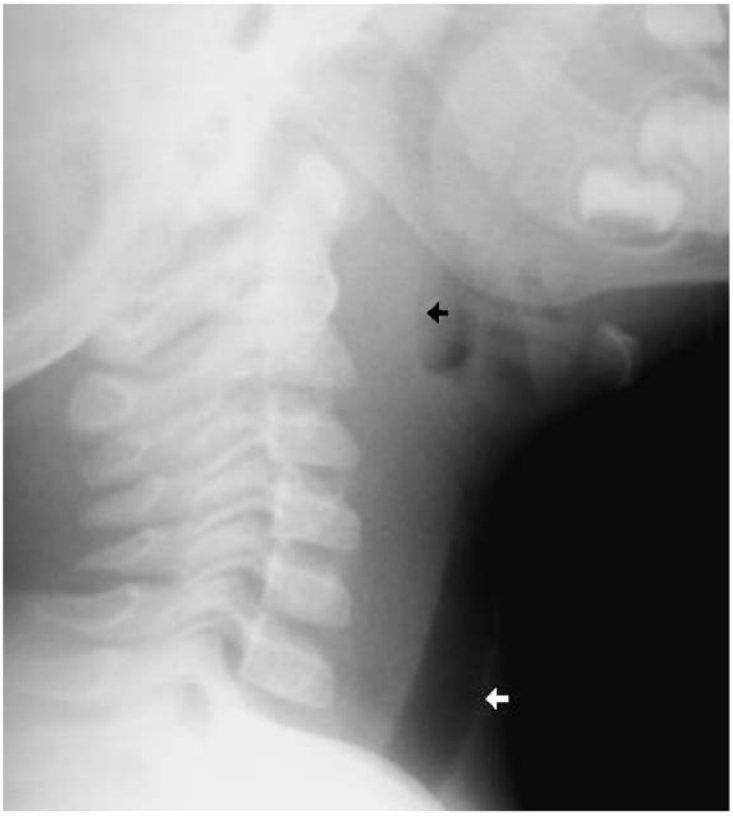
P: _____

PS: _____

E: _____

SG: _____

Dx: _____



20. BA: _____

VB: _____

C: _____

P: _____

PS: _____

E: _____

SG: _____

Dx: _____

21. BA: _____

VB: _____

C: _____

P: _____

PS: _____

E: _____

SG: _____

Dx: _____

22. BA: _____

VB: _____

C: _____

P: _____

PS: _____

E: _____

SG: _____

Dx: _____

23. BA: _____

VB: _____

C: _____

P: _____

PS: _____

E: _____

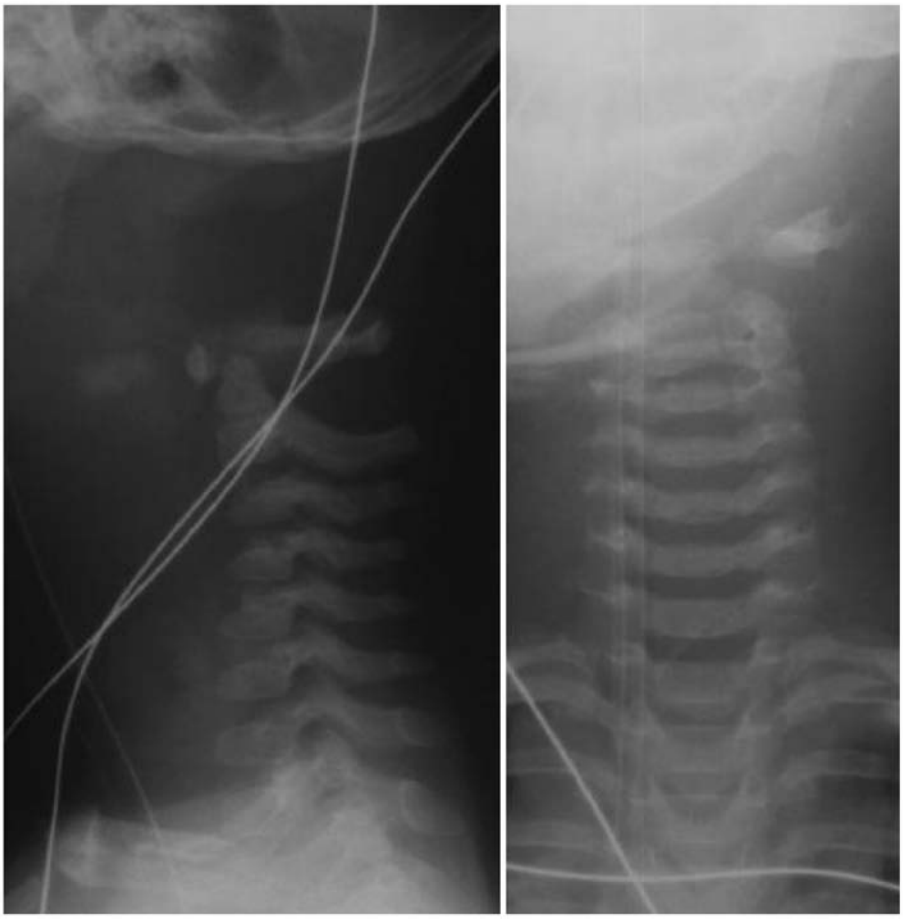
SG: _____

Dx: _____

QUESTIONS 24–30: Match the following lateral cervical spine films to their correct corresponding interpretations. Responses may be used more than once or not at all.

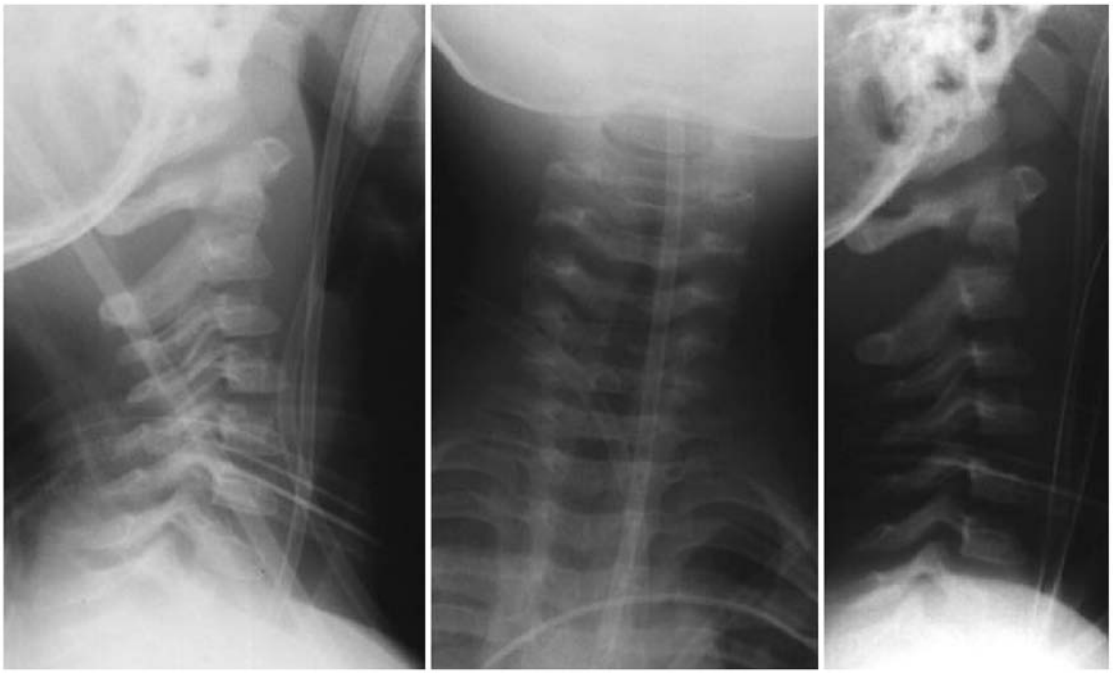
24. _____

a. C2–C3 true subluxation.
b. Avulsion of C6.
c. Atlanto-occipital dislocation.
d. C7 spinous fracture.
e. Pseudosubluxation.
f. Avulsion fracture of the anterior inferior line of C2 and slight displacement of C2.
g. Odontoid fracture.
h. C7 spinous fracture.
i. Compression fracture of C4–C5.
j. C4–C5 subluxation.



25. _____

a. C2–C3 true subluxation.
b. Aulsion of C6.
c. Atlanto-occipital dislocation.
d. C7 spinous fracture.
e. Pseudosubluxation.
f. Avulsion fracture of the anterior inferior line of C2 and slight displacement of C2.
g Odontoid fracture.
h. C7 spinous fracture.
i. Compression fracture of C4–C5.
j. C4–C5 subluxation.



26. _____

a. C2–C3 true subluxation.
b. Avulsion of C6.
c. Atlanto-occipital dislocation.
d. C7 spinous fracture.
e. Pseudosubluxation.
f. Avulsion fracture of the anterior inferior line of C2 and slight displacement of C2.
g. Odontoid fracture.
h. C7 spinous fracture.
i. Compression fracture of C4–C5.
j. C4–C5 subluxation.

27. _____

a. C2–C3 true subluxation.
b. Avulsion of C6.
c. Atlanto-occipital dislocation.
d. C7 spinous fracture.
e. Pseudosubluxation.
f. Avulsion fracture of the anterior inferior line of C2 and slight displacement of C2.
g. Odontoid fracture.
h. C7 spinous fracture.
i. Compression fracture of C4–C5.
j. C4–C5 subluxation.

28. _____

a. C2–C3 true subluxation.
b. Avulsion of C6.
c. Atlanto-occipital dislocation.
d. C7 spinous fracture.
e. Pseudosubluxation.
f. Avulsion fracture of the anterior inferior line of C2 and slight displacement of C2.
g. Odontoid fracture.
h. C7 spinous fracture.
i. Compression fracture of C4–C5.
j. C4–C5 subluxation.

29. _____

a. C2–C3 true subluxation.
b. Avulsion of C6.
c. Atlanto-occipital dislocation.
d. C7 spinous fracture.
e. Pseudosubluxation.
f. Avulsion fracture of the anterior inferior line of C2 and slight displacement of C2.
g. Odontoid fracture.
h. C7 spinous fracture.
i. Compression fracture of C4–C5.
j. C4–C5 subluxation.

30. _____

a. C2–C3 true subluxation.
b. Avulsion of C6.
c. Atlanto-occipital dislocation.
d. C7 spinous fracture.
e. Pseudosubluxation.
f. Avulsion fracture of the anterior inferior line of C2 and slight displacement of C2.
g. Odontoid fracture.
h. C7 spinous fracture.
i. Compression fracture of C4–C5.
j. C4–C5 subluxation.

QUESTIONS 31–35: A 20-month-old female presents with a history of fever, cough, noisy breathing, and drooling. Symptoms began approximately 24 hours earlier, but cough is worsening and fever reached 102.1°F maximum at home. The cry is also described as more raspy now than at home. Physical exam reveals temperature of 101.9°F rectally, pulse 170, respiratory rate 30. The child is nontoxic-appearing, and does not seem to favor an upright or tripod position. Excessive drooling is not noted to be present. Neck has some mild and cervical lymphadenopathy. Inspiratory stridor is noted when crying but the remainder of the exam is normal. The examiner feels that the cough is not a definitive harsh croupy cough and orders the following X-ray.

31. Your interpretation of this X-ray is:

a. Tracheal foreign body.
b. Normal.
c. Epiglottitis.
d. Retropharyngeal abscess.
e. Tracheomalacia.

32. Common causes of stridor include all of the following except:

a. Aspiration of foreign body.
b. Epiglottitis.
c. Viral croup.
d. Retropharyngeal abscess.
e. None of the above.

33. Definitive management of this child should include:

a. Continuous albuterol nebulizers.
b. Ears, nose, and throat consultation for surgical incision and drainage.
c. Dexamethasone intramuscularly and aerosolized racemic epinephrine.
d. Aggressive suctioning for culture and Gram-stain of secretions.

34. All of the following are consistent with bacterial tracheitis except:

a. Typically 2–7 days of viral symptoms preceding.
b. Inspiratory and expiratory stridor.
c. Toxic appearance.
d. Excessive drooling.

35. All of the following are consistent with retropharyngeal abscess except:

a. Thick sputum production.
b. Toxic-appearing child.
c. Abrupt onset over several hours.
d. Stridor and dysphagia.

3 Abdominal Radiographs

The following chapter will focus on radiographs of the abdomen. Pertinent questions, answers, and rationale will be reviewed.

Key Words: Gas; bowel; obstruction; intestines; ileus; perforation.

QUESTIONS 1–5: An 11-month-old male presents to the emergency department with vomiting. His mother states that he had "stomach flu" 2 weeks ago and has had five episodes of vomiting since the previous night (without blood or bilious material). He has been crying intermittently, every 10–20 minutes. He has had three loose stools without blood or mucus. On exam he appears nontoxic and his vitals are temperature of 97.7°F axillary, pulse 118, respiratory rate 40. His exam is normal, including abdomen and genitourinary, with the exception of heme-positive stool. You order an abdominal series.

1. Based on this child's history and the X-rays shown, what is the most likely diagnosis?

a. Ileus.
b. Bowel obstruction.
c. Intussusception.
d. Appendicitis.
e. Meckel's diverticulum.

2. What is present on the X-ray that makes this diagnosis more likely?

a. Paucity of bowel gas.
b. Absent liver edge.
c. Distended loops of small bowel.
d. Air in the rectum.

3. True or False? Positive stool hemoccult is present in almost every one of these cases.

a. True.
b. False.

4. What is the gold standard for diagnosis of this condition?

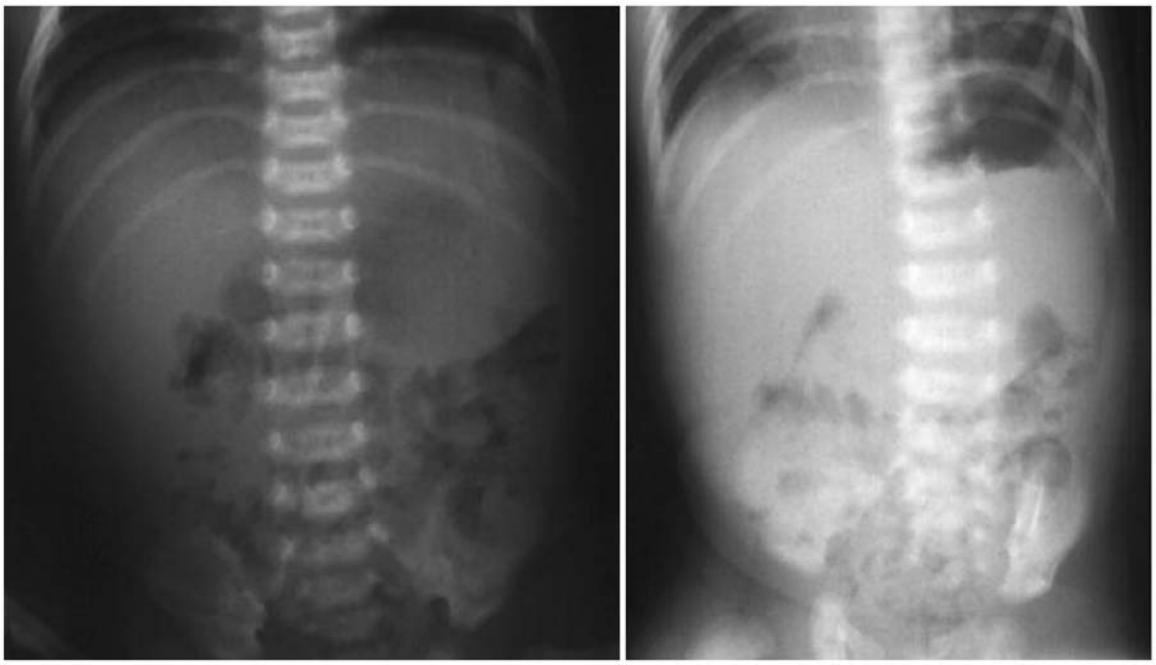
a. Abdominal plain films.
b. CT scan.
c. Surgical exploration.
d. Contrast enema.
e. Ultrasound.

5. All of the following are usual symptoms consistent with this child's most likely diagnosis, except:

a. Episodic cramping pain.
b. Vomiting.
c. Passage of bloody, mucusy stool.
d. Constant pain.
e. Sausage-shaped mass in the right quadrant.

From: *Pediatric Radiology Review*
Edited by: M. D. Pappas, L. G. Yamamoto, and A. Okechukwu © Humana Press Inc., Totowa, NJ

QUESTIONS 6–10: A 3-week-old male with vomiting for 3 days presents to the emergency department. Mother states that the vomiting is forceful, nonbloody, nonbilious, and occurs only after eating. Exam shows a nontoxic-appearing infant with the following vital signs: temperature of 97.7°F, pulse 140, respiratory rate 37, blood pressure 91/38. Physical exam is unremarkable. There is no palpable mass in the abdomen and the infant appears well hydrated. You obtain an abdominal series.



6. Based on the clinical history and the X-ray above, what is the most likely diagnosis?

a. Bowel obstruction.
b. Necrotizing enterocolitis (NEC).
c. Ileus.
d. Pyloric stenosis.
e. Volvulus.

7. Common characteristics with this condition are all of the following, except:

a. Bilious projectile vomiting.
b. Between 2 and 8 weeks of age.
c. Palpable mass in the epigastrium.
d. Possible weight loss.

8. The best test to confirm the diagnosis is:

a. Plain X-ray.
b. CT scan.
c. Exploratory lap.
d. Ultrasound.
e. Upper gastrointestinal series.

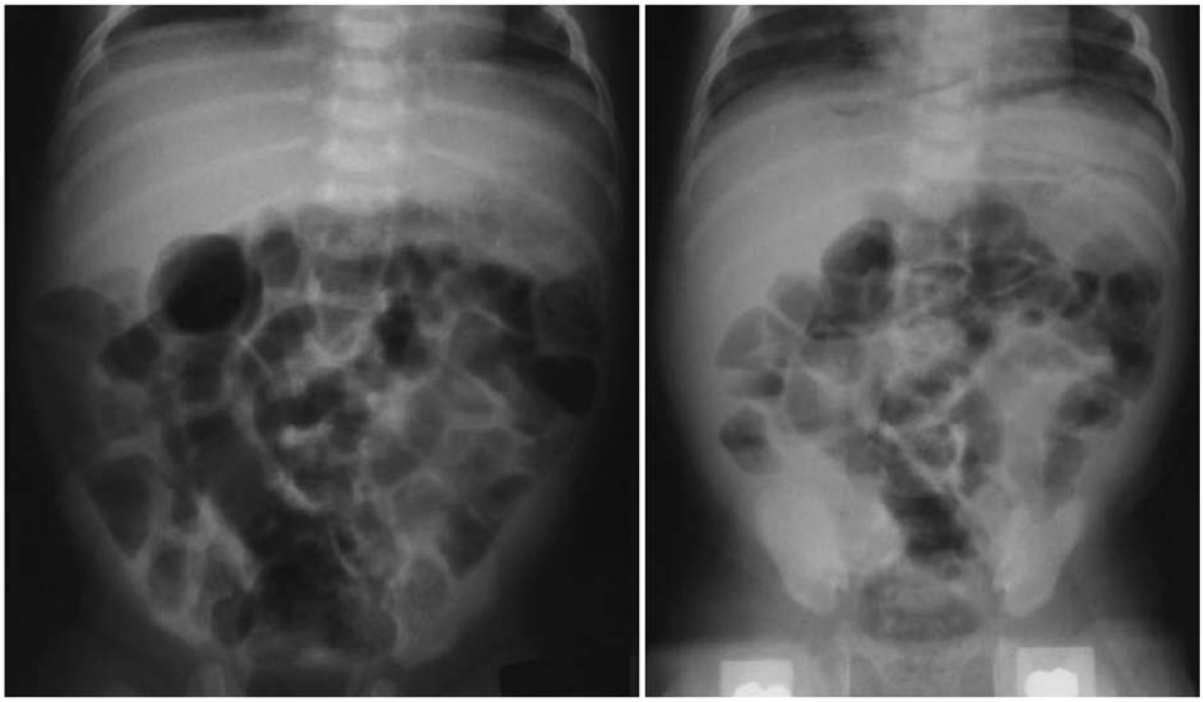
9. Complications of this condition are the following, except:

a. Dehydration.
b. Hypochloremic alkalosis.
c. Hyperchloremia.
d. Hyponatremia.
e. Hypokalemia.

10. Definitive treatment for this condition is:

a. Surgery.
b. Barium enema.
c. Supportive measures.
d. Serial exams.
e. G-tube placement.

QUESTIONS 11–14: A 1-month-old female presents to the emergency department with nonbilious vomiting for the past couple of days. The vital signs are normal and the infant appears well hydrated. You obtain abdominal X-rays.



11. What is the correct interpretation of this X-ray?

a. Small bowel obstruction.
b. Ileus.
c. NEC.
d. Normal abdominal X-ray.
e. Volvulus.

12. This condition can occur most commonly after:

a. Incarcerated inguinal hernia.
b. Recent abdominal surgery.
c. Adhesions.
d. Volvulus.
e. Intraluminal mass.

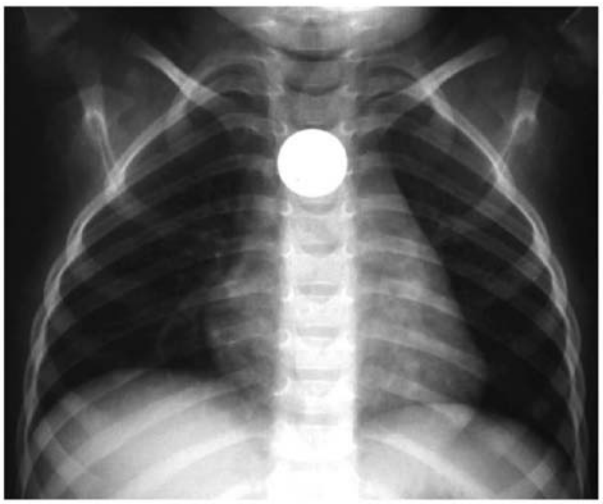
13. Which condition shows preferential collection of air?

a. Obstruction.
b. Ileus.

14. Adynamic ileus can result from:

a. Intussusception.
b. Inflammatory process (i.e., sepsis, pneumonia, appendicitis).
c. Ladd's bands.
d. Tumors.
e. Bezoars.

QUESTIONS 15–20: A 20-month-old female presents to the emergency department after the patient's mother claims the child was playing with some coins and may have swallowed one of them. The patient is in no distress. She is not coughing or vomiting. The vital signs are normal and the physical exam is unremarkable. You obtain the following X-ray.



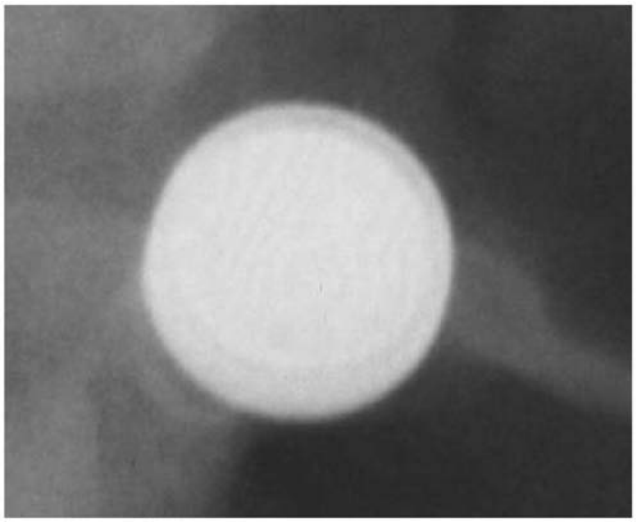
15. Where is the coin?

a. Esophagus.
b. Trachea.
c. Mediastinum.

16. What are the common areas in which coins come to rest in the esophagus?

a. Cricoid.
b. Tracheal bifurcation.
c. Gastroesophageal junction.
d. All of the above.

Given the same patient presentation and review of the following close-up X-ray, answer the questions below.



17. True or False? Any foreign body in the esophagus of unknown duration needs to be removed by endoscopy.

a. True.
b. False.

18. True or False? Most foreign bodies will pass once they make it beyond the pylorus.

a. True.
b. False.

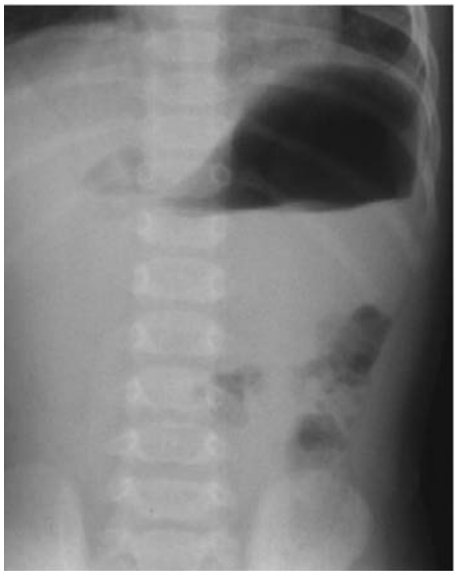
19. This is most likely a:

a. Quarter.
b. Dime.
c. Button battery.
d. Nickel.
e. Poker chip.

20. All of the following are true except:

a. Disc batteries in the esophagus can cause direct pressure necrosis, caustic injury, or low-voltage burns.
b. Mercuric oxide batteries can potentially cause mercury poisoning but usually do not.
c. Coins in the esophagus appear in the sagittal plane.
d. Induction of emesis may be potentially harmful.
e. No exceptions; all are true.

QUESTIONS 21–28: A 7-week-old male is brought in by his mother after a few episodes of bilious vomiting. The patient's exam is benign. There is no abdominal tenderness and the patient's vital signs are normal. You obtain the following abdominal X-rays.



21. What is the correct interpretation of these X-rays?

a. Ileus.
b. Volvulus.
c. Appendicitis.
d. Pneumatosis intestinalis.
e. Nonspecific.

22. True or False? The bowel gas pattern is normal in these X-rays.

a. True.
b. False.

23. All of the following are true with regard to this disease, except:

a. This is the most common development abnormality.
b. This may lead to ischemia and necrosis.
c. Cecum incompletely rotates to the left lower quadrant.
d. Midgut volvulus can form.
e. May need surgery to resect small bowel.

24. If no strangulation is occurring, what study is best to diagnose this condition?

a. Upper gastrointestinal or barium enema.
b. Ultrasound.
c. CT scan.
d. Plain films.
e. Serial exams.

25. Which of the following statements is/are true?

a. Most cases present in the neonatal period.
b. The younger the patient and the longer the duration of symptoms, the higher the risk for complications.
c. May be asymptomatic with a catastrophic volvulus occurring at any age.
d. Mortality of midgut volvulus is 10–20%.
e. All are true.

26. All of the following are true with this condition except:

a. Symptoms include vomiting (ultimately becoming bilious) with or without abdominal distention.
b. It can be life-threatening.
c. The vast majority occur in infants more than 2 months old.
d. Usually occurs in previously healthy children.
e. Time interval from symptom onset to gangrenous bowel may be only a few hours.

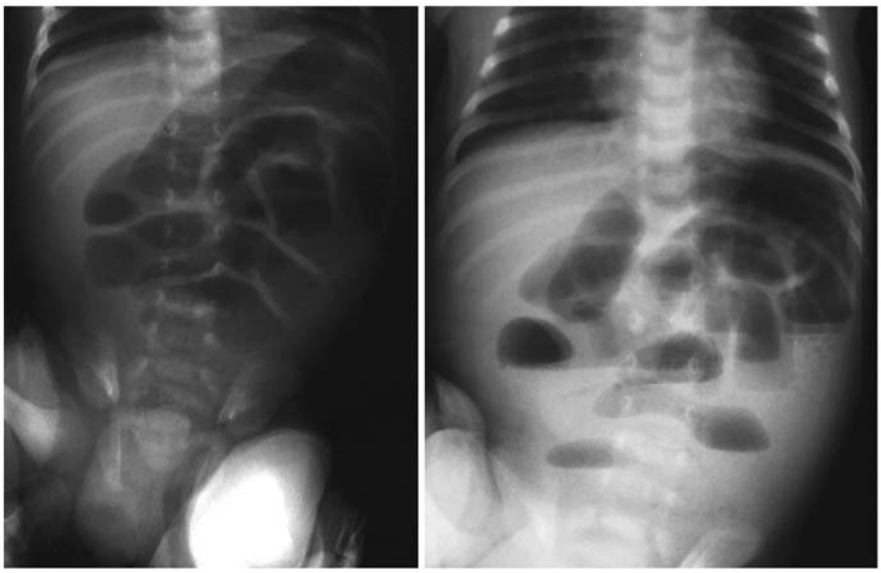
27. Treatment for this includes:

a. Prompt surgical evaluation.
b. Fluid resuscitation.
c. Admission to the hospital.
d. Nasogastric tube placement.
e. All of the above.

28. Complication of this congenital anomaly in children is:

a. Midgut volvulus.
b. Cecal volvulus.
c. Sigmoid volvulus.
d. Inguinal hernia.
e. All of the above.

QUESTIONS 29–33: A 1-month-old male presents to the emergency department with poor feeding and occasional vomiting. Comparison of his birthweight to his current weight shows poor weight gain. The patient's vital signs are as follows: temperature of 98.6°F, heart rate 146, respiratory rate 40, blood pressure 96/49. The exam was unremarkable and the patient was admitted for failure to thrive. The vomiting then became bilious and the following abdominal series was obtained.



29. What is the correct interpretation of these X-rays?

a. Obstruction.
b. Ileus.
c. Normal.
d. Nonspecific bowel gas pattern.
e. Toxic megacolon.

Based on this X-ray, a barium enema was ordered. Prior to the enema the radiologist noticed an inguinal bulge. The barium enema was done and did not reveal a malrotation or volvulus.

30. True or False? An inguinal hernia is more common in females.

a. True.
b. False.

31. True or False? An inguinal hernia is caused by a weakness in the processus vaginalis.

a. True.
b. False.

32. Treatment for this would consist of:

a. Supportive care.
b. Herniorrhaphy.
c. Barium enema.
d. Nothing by mouth, intravenous fluids, antibiotics.
e. Serial exams.

33. True or False? It is possible to have bowel ischemia without obstruction in the presence of a hernia.

a. True.
b. False.

QUESTIONS 34–37: A 4-year-old male is seen in the emergency department, referred by his primary care physician (PCP) for abdominal pain. The patient has had abdominal pain for 3 days and today is the first time he was seen by his PCP. The mother states that the patient has not had any vomiting or diarrhea and has not been running a fever. Vital signs are as follows: temperature of 98.6°F, heart rate 106, respiratory rate 26, blood pressure 100/70. Physical exam reveals a slightly uncomfortable child who is consolable. The patient cannot say exactly where the abdominal pain is but has maximal tenderness to the right lower quadrant. You obtain the following abdominal series.

34. The correct interpretation of this X-ray is:

a. Ileus versus small bowel obstruction.
b. Perforated viscus.
c. Volvulus.
d. Normal abdominal series.
e. Constipation.

35. Because you are an expert at reading abdominal X-rays at this point, you correctly point out the abnormal peritoneal fat stripes on this X-ray. This gives you the correct diagnosis of:

a. Volvulus.
b. Appendiceal abscess.
c. Perforated viscus.
d. Small bowel obstruction.
e. Nonspecific bowel gas.

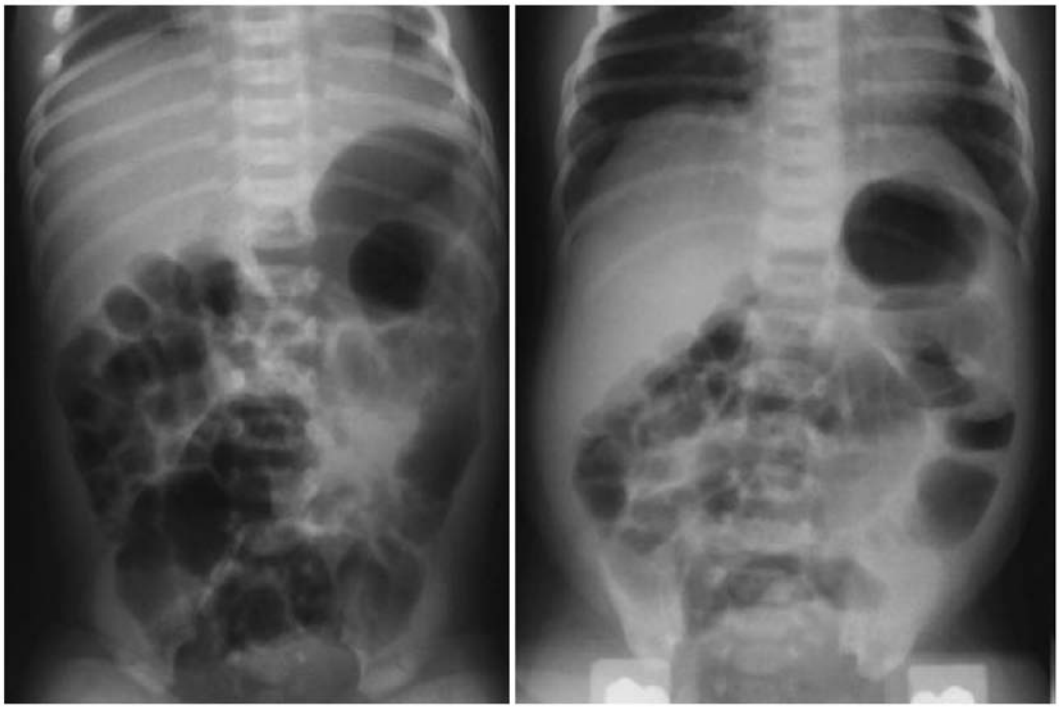
36. All of the following are true regarding the most likely diagnosis, except:

a. Temperature may be normal.
b. Common in children younger than 2 years old.
c. White blood count may be normal.
d. Anorexia may not be present.
e. Vomiting and diarrhea may be present.

37. Given this clinical setting and diagnosis, what is the preferred treatment?

a. Intravenous fluids, nothing by mouth, serial abdominal exams.
b. Surgery.
c. Intravenous antibiotics.
d. Supportive care.
e. Discharge home, follow-up tomorrow.

QUESTIONS 38–42: A 3-day-old female is brought in by her parents with vomiting and fussiness. Her vital signs are normal but she does appear to cry more with palpation of the abdomen. There are no abdominal masses and the rest of the physical exam is normal. You obtain the following X-rays.



38. What is the correct interpretation of this X-ray?

a. Volvulus.
b. Ileus.
c. Obstruction.
d. Normal bowel gas.
e. Pseudo-obstruction.

39. Which of the following causes an appearance of dilated bowels with smooth bowel walls resembling sausage?

a. Obstruction.
b. Ileus.

40. Sentinel loops are short segments of bowel dilation next to areas of inflammation (i.e., right lower quadrant loops suggesting appendicitis, right upper quadrant suggesting cholecystitis, pyelonephritis, etc.) that usually represent which of the following?

a. Ileus.
b. Obstruction.

41. True or False? With regard to air fluid levels, ileus—in comparison with obstruction—characteristically shows fewer air fluid levels that are not dilated.

a. True.
b. False.

42. With regard to arrangement of bowel loops, which has a more orderly appearance?

a. Ileus.
b. Obstruction.

QUESTIONS 43–47: A 3-year-old female is brought into the emergency department with vomiting and some abdominal pains. She has vomited four times in the last 2 days. The vomiting is nonbilious and nonbloody. Her parents gave her a little Pepto-Bismol®, but it has not improved her symptoms. You obtain the following abdominal X-ray.

43. What is the most correct interpretation of this X-ray?

a. Pseudo-obstruction.
b. Cholelithiasis.
c. Nephrolithiasis.
d. NEC.
e. Normal bowel gas, no free air.

44. What other findings do you see on this X-ray?

a. Lots of stool.
b. Faint calcifications in right upper quadrant.
c. Phleboliths.
d. Both a and b.
e. All of the above.

45. After correctly identifying the pertinent findings on this X-ray, what is your next plan of action?

a. Stat surgery consult.
b. Gallbladder ultrasound.
c. Liver function tests (LFT's), complete blood count (CBC), chem 7.
d. Ask parents about possible heavy metal ingestion.
e. Urinalysis, if heme-positive, order an intravenous pyelogram.

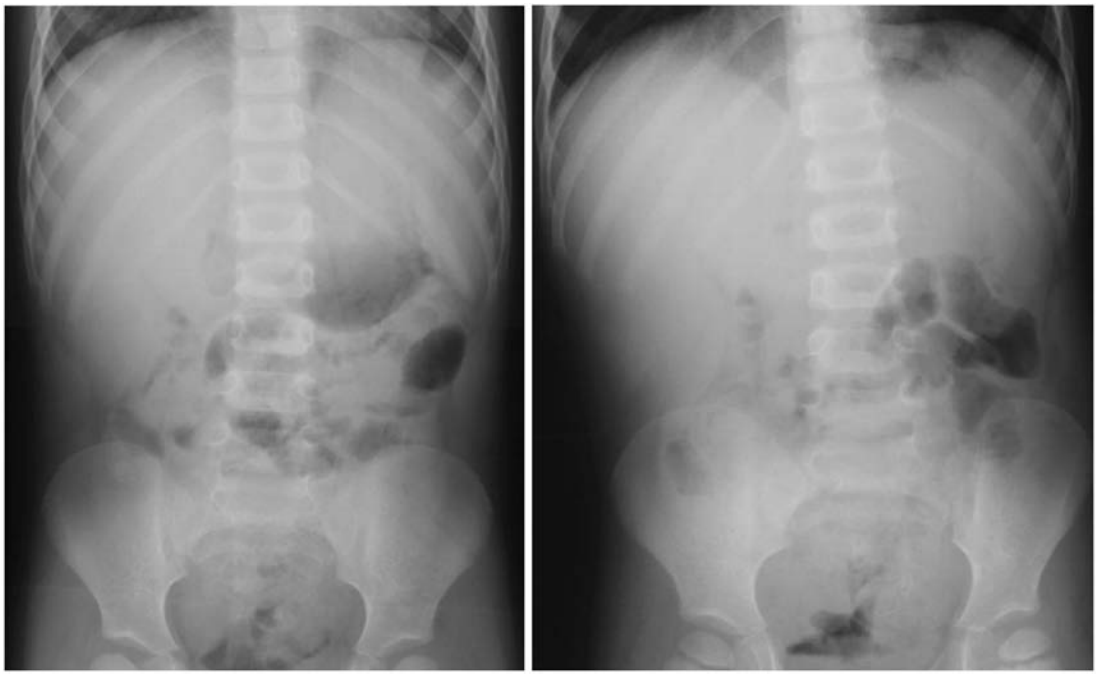
46. You do notice that the patient has a large amount of stool on X-ray. While you are deciding your plan, you have the nurse give the patient an enema. The patient passes a large amount of stool and feels better. What do you do now?

a. Repeat abdominal series.
b. Tell the nurse she should have done a barium enema.
c. Send patient home with vomiting and abdominal pain instructions, outpatient follow-up.
d. Page surgery again.
e. Administer deferoxamine.

47. What can be radiopaque on X-ray?

a. Dirt, sand, dental debris.
b. Chloral hydrate and calcium.
c. Heavy metals (lead, arsenic, iron, etc.).
d. Phenothiazines and psychotropics.
e. All of the above.

QUESTIONS 48–52: A 3-year-old male is brought into the emergency department following a 5-minute tonic-clonic seizure associated with a high temperature. The fever started yesterday and he had a few episodes of vomiting the previous night. Parents report that his appetite is poor and he was complaining of some right-sided abdominal pain. Vital signs are as follows: temperature of 103.6°F, heart rate 152, respiratory rate 23, blood pressure 112/72. Physical exam reveals an uncomfortable child who starts crying when you approach him. He has no signs of menigismus; heart and lung sounds are normal. His abdomen is soft and nondistended, with active bowel sounds. He is difficult to examine but you believe he has some tenderness in the right lower quadrant. His gait is normal. You obtain the following X-rays.



48. What is the correct interpretation of these X-rays?

a. Ileus.
b. Obstruction.
c. Fecalith.
d. Kidney stone.
e. Normal abdominal X-ray.

49. Given the clinical picture along with X-ray findings and your superb examination skills, the most likely diagnosis is:

a. Renal colic.
b. Small bowel obstruction.
c. Intussusception.
d. Appendicitis.
e. Volvulus.

50. All of the following are true, except:

a. Appendicitis begins with obstruction of lumen, increased pressure leading to vascular compromise, and epithelial breakdown, causing bacterial invasion from bowel flora.
b. Peritonitis is from perforation and spillage of infected contents in peritoneum.
c. More than 50% of appendices are retrocecal.
d. Classic presentation is pain before vomiting, periumbilical pain migrating to right lower quadrant.
e. A pelvic appendix may irritate bladder or rectum, causing suprapubic pain and/or dysuria.

51. True or False? Presence of white blood cells (WBCs) and/or red blood cells in UA will rule out appendicitis.

a. True.
b. False.

52. Radiological signs of appendicitis include:

a. Appendicolith.
b. Dilated loops of bowel in right lower quadrant.
c. Non-pecific gas distribution.
d. Obliteration of psoas shadow.
e. All of the above.

QUESTIONS 53–57: A 5-month-old male presents to the emergency department with vomiting. He is assessed to have mild gastroenteritis and mild dehydration. He is given fluids and discharged home. He develops bloody diarrhea over the next 2 days and returns to the ED. He is found to be lethargic and moderately dehydrated. Labs were drawn, intravenous fluid was started, and the following abdominal series was obtained.

53. What is the correct interpretation of this X-ray?

a. Obstruction.
b. Ileus.
c. Volvulus.
d. Malrotation.
e. NEC.

54. What is the classic finding on this X-ray with this disease process?

a. Free air in the peritoneum.
b. Ascites.
c. Pneumatosis intestinalis.
d. Stepladder pattern of air–fluid levels.
e. "Bag of sausage" appearance.

55. All of the following regarding this diagnosis are true, except:

a. Usually occurs in full-term infants.
b. Signs and symptoms include hemoccult-positive stool, distension, tenderness, emesis, and decreased feeding.
c. Increased risk for sepsis, bowel necrosis, perforation, and disseminated intravascular coagulation.
d. Hematemesis and bowel obstruction may be present.
e. Exact cause is unknown.

56. Initial management of this condition includes:

a. Bowel rest and serial exams.
b. Nothing by mouth, nasogastric tube decompression, intravenous fluids, intravenous antibiotics, pan culture, and possible surgical repair.
c. Nothing by mouth, barium enema, serial exams.
d. Parenteral nutrition, close observation for 48 hours.
e. Oral antibiotics, clear liquid diet, and follow-up in 24 hours.

57. Which is/are true regarding this condition?

a. There is a genetic predisposition.
b. Prevalence is about 4%.
c. Condition occurs more in females.
d. Highest incidence in patients with birth weight higher than 750 g.
e. Condition occurs most frequently 2–3 months after birth.

QUESTIONS 58–64: A 10-year-old male presents with 2 days of abdominal pain that is worse today. The pain is periumbilical and there is no associated vomiting or diarrhea. He has trouble walking because of the pain and his appetite is poor. His vital signs are normal. His physical exam reveals guarding and tenderness over the periumbilical region. When asked to cough he does, but this causes a moderate amount of pain. You obtain the following abdominal X-rays.

58. What is the correct interpretation?

a. Ileus.
b. Obstruction.
c. Pseudo-obstruction.
d. Normal gas pattern, medially displaced ascending colon.
e. Volvulus.

An abdominal ultrasound is done, which shows a fluid- and gas-containing structure next to the umbilicus. This is consistent with Meckel's diverticulitis.

59. What is the most common ectopic tissue present in Meckel's?

a. Duodenal.
b. Colonic.
c. Gastric.
d. Pancreatic.
e. Ileal.

60. All of the following are true, except:

a. 2% of people born have Meckel's.
b. 2% Manifest symptoms around age 2 years.
c. Diverticulum is usually 2 in. long.
d. In symptomatic cases, it is more common in females.
e. Risk of complication is around 4%.

61. The most common presentation is:

a. Peritonitis.
b. Painless intestinal bleeding.
c. Bilious vomiting.
d. Acute abdomen.
e. Constipation.

62. All of the following are true, except:

a. Uncommonly presents as bowel obstruction.
b. Base of Meckel's can be leading edge for ileal intussusception.
c. If Meckel's is attached to anterior abdominal wall, this can lead to volvulus.
d. Peritonitis is rarely found.
e. Acute abdomen may be present.

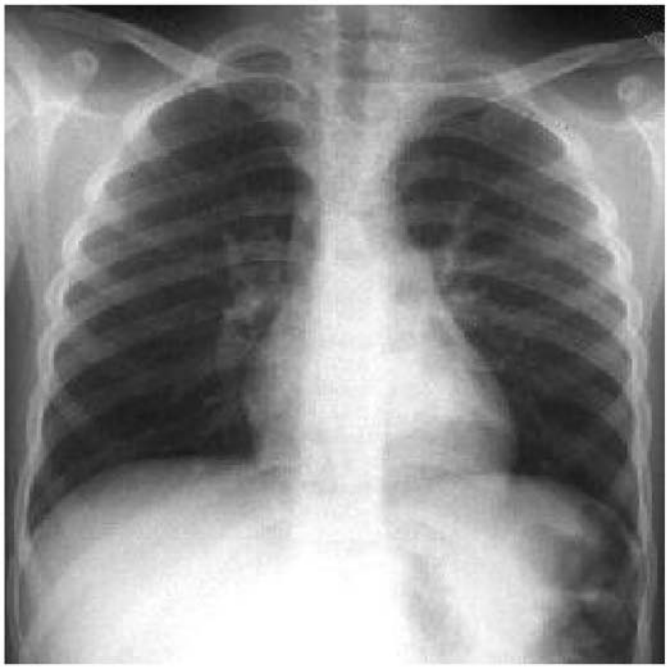
63. What is the best diagnostic test to perform to rule in Meckel's?

a. Standard X-ray.
b. Meckel's scan with radioisotope for gastric mucosa.
c. Barium enema.
d. Upper GI series.
e. Red-cell tagged scan.

64. What is the current treatment?

a. Supportive care.
b. Surgical removal.
c. Surgical removal only if ectopic tissue present.
d. Intravenous fluids, intravenous antibiotics, serial exams.
e. Oral antibiotics, close follow-up.

QUESTIONS 65–68: A 6-year-old male presents to the emergency department with complaints of fever and stomach pain for 1 day. He has not had any vomiting or diarrhea. His last bowel movement was 3 days ago. Vital signs are as follows: temperature of 100.5°F, heart rate 134, respiratory rate 24, blood pressure 113/61. Physical exam reveals an alert active male in no acute distress. Heart sounds are normal, lungs clear, abdomen positive for tenderness in the epigastrium. Rectal exam was normal. You obtain the following abdominal series.



65. What is the most correct interpretation of these X-rays?

a. Ileus.
b. Obstruction.
c. Perforated hollow viscus.
d. No acute abdominal pathology.
e. Volvulus.

66. What would be the most useful study you would want next in this patient?

a. LFTs.
b. Amylase, lipase.
c. Pulse oximetry.
d. CT abdomen.
e. Barium enema.

67. What would be your next step in treating this patient?

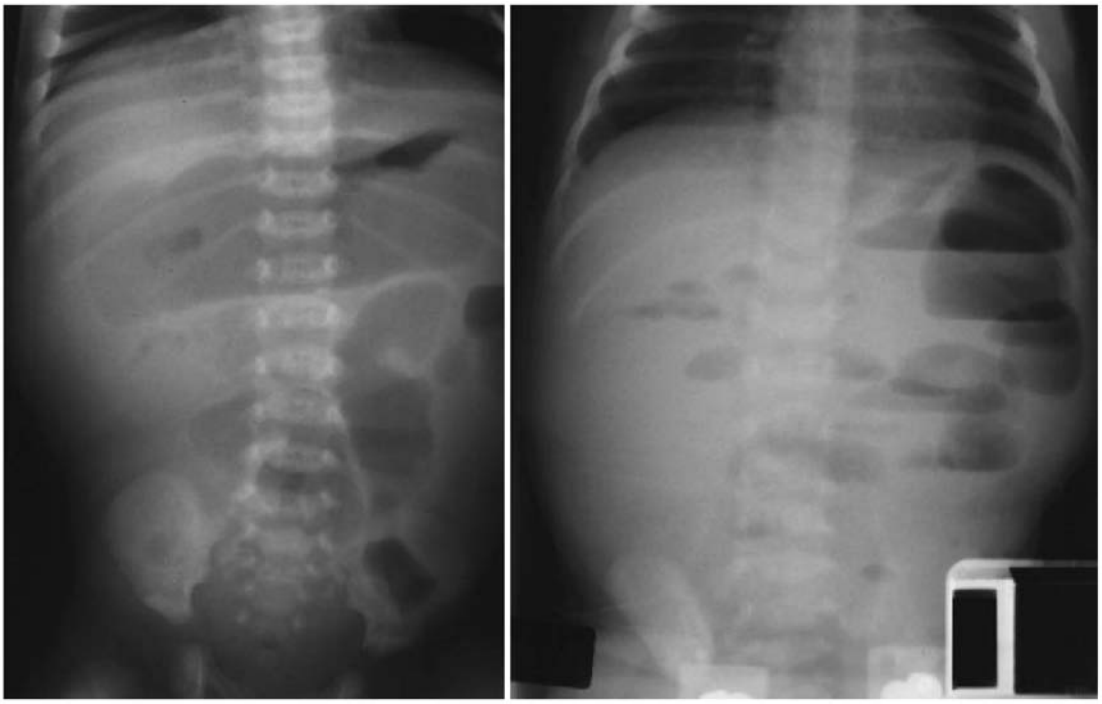
a. Surgery consult.
b. Therapeutic barium enema.
c. Nothing; follow up in office.
d. Antibiotics, admit if ill-appearing, follow up in 1 day.
e. Intravenous fluids, analgesics, then discharge home with antiemetics.

Further testing is ordered and includes: CBC, chem 7, LFTs, amylase, lipase, pulse oximetry, and CT abdomen. The CBC shows a slightly elevated WBC. The chem 7, LFTs, amylase, and lipase are normal. Pulse oximetry is 95%. The CT of the abdomen is normal. You consult surgeons, who are unimpressed and are of no help to you. The mother still insists that something is wrong with her child.

68. What is the correct diagnosis?

a. Inguinal hernia.
b. Ureteral stone.
c. Pneumonia.
d. Constipation.
e. Gallstones.

QUESTIONS 69–73: A 9-day-old male is brought into the ED with vomiting. The child appears well-hydrated but is fussy and crying. The vital signs are normal. The physical exam is unremarkable except for the fact that you have a difficult time determining any abdominal tenderness. You obtain the following abdominal X-rays.



69. What is the correct impression of this X-ray?

a. Bowel obstruction.
b. Ileus.
c. Normal bowel gas pattern.
d. Perforated viscus.
e. Appendicitis.

70. All of the following are potential causes of this, except:

a. Intussusception.
b. Inguinal hernia.
c. Malrotation.
d. Hirschsprung's disease.
e. Trauma.

A contrast enema was done, which demonstrated a transition zone (i.e., funnel-shaped area of intestine with normal distal area and dilated proximal area).

71. The most likely diagnosis is:

a. Bowel obstruction secondary to Hirschsprung's disease.
b. Bowel obstruction secondary to Meckel's diverticulum.
c. Ileus secondary to peritonitis.
d. Ileus secondary to gastroenteritis.
e. Idiopathic intestinal pseudo-obstruction.

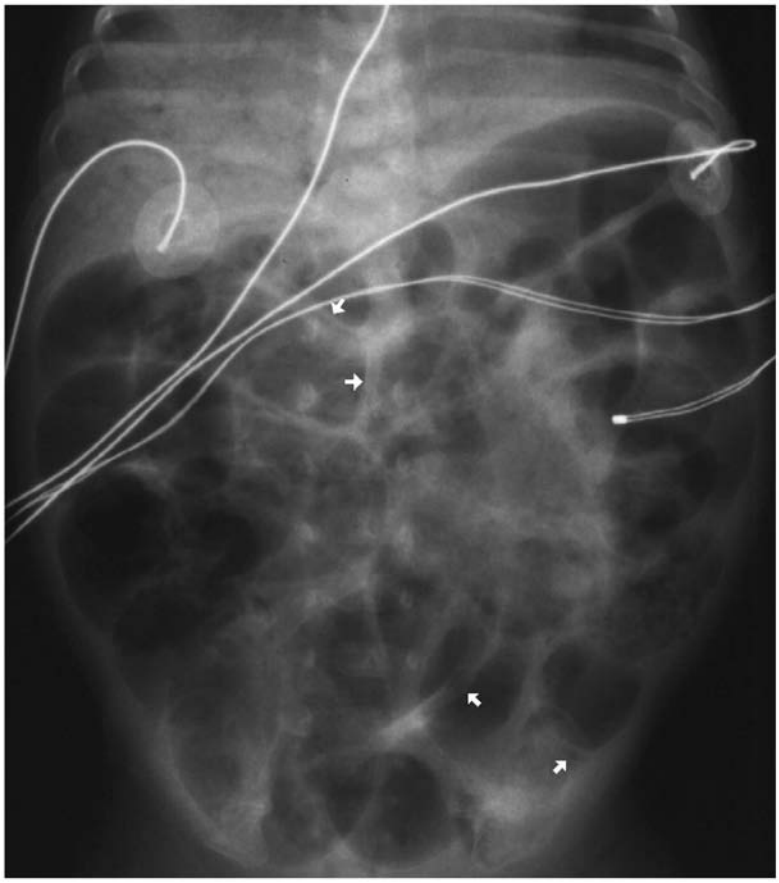
72. All of the following are true regarding this condition, except:

a. It is more common in females than males.
b. 3% of patients have associated Down syndrome, cardiac anomalies, and/or neuroblastomas.
c. Absence of Auerbach plexus.
d. Defect is failure of neural crest cell migration.
e. Most common cause of lower intestinal obstruction in neonates.

73. Treatment for this condition includes:

a. Nasogastric tube (NGT) decompression, antibiotics, saline enemas, and colostomy.
b. Oral antibiotics, serial exams.
c. Immediate surgery.
d. Intravenous fluids, then discharge home if nontoxic-appearing.
e. Supportive measures.

QUESTIONS 74–78: A 6-day-old presents to a rural emergency department with hematemesis. The child appears well but has approximately 40 cc of blood on the blanket brought in by the mother. He was born after an uncomplicated pregnancy without any problems at birth or with the circumcision. Vital signs are: temperature of 98.8°F, heart rate 128, respiratory rate 35, blood pressure 75/50. Physical exam reveals a slightly jaundiced, well-hydrated male in no acute distress. There is no bleeding from the nose or mouth. The rest of the physical exam is unremarkable. You obtain an abdominal series.



74. What is the correct interpretation of this film?

a. Volvulus.
b. Meckel's diverticulum.
c. NEC.
d. Ileus.
e. Obstruction.

You obtain a hemoccult of the red material on the blanket and the result is positive. You then obtain a fetal hemoglobin on the same material and it comes back negative. You realize that the blood did not come from the infant. Despite this, you had all along been suspicious of a potentially serious problem that can occur in neonates with hematemesis. Please answer the following questions:

75. With these abdominal X-rays, what would be the initial management of this condition?

a. Bowel rest and serial exams.
b. Nothing by mouth, nasogastoic tube, intravenous fluids, intravenous antibiotics, panculture, possible surgery.
c. Nothing by mouth, barium enema.
d. Parenteral nutrition, close observation for 48 hours.
e. Oral antibiotics, clear liquid diet, and follow up in 24 hours.

76. Complications of this disease include all of the following, except:

a. Bowel stricture.
b. Intussusception.
c. Fistula.
d. Abscess.
e. Malabsorption and failure to thrive.

77. Risk factors for developing this are:

a. Respiratory distress syndrome.
b. Patent ductus arteriosus.
c. Congestive heart failure.
d. Umbilical vessel cath.
e. Hypothermia.
f. All of the above.

78. Which one of the following is true regarding this condition?

a. Survival rate is 20–30%.
b. Early-onset form of this disease has a better prognosis than late-onset.
c. 80% of survivors grow up to be healthy.
d. 15% Have neurological impairment.
e. Birthweight has not been shown to be a predictor for severity.

QUESTIONS 79–84: A 6-year-old male presents to the emergency department with vomiting and abdominal pain. Vital signs are normal except for a temperature of 100.4°F. Physical exam reveals a healthy male in mild distress. He appears well hydrated but not very active. He has some mild diffuse tenderness on examination of the abdomen. Here is the abdominal series that you order.

79. What is the correct interpretation of this X-ray?

a. Ileus.
b. Obstruction.
c. NEC.
d. Ureteral stone.
e. Free air.

The nurse reports that the patient is having more pain now and you return to examine him. He has maximal tenderness to the right lower quadrant. A CBC shows a slightly elevated WBC. You recheck the abdominal X-rays and come to the correct diagnosis.

80. The most correct diagnosis is:

a. Renal colic secondary to ureteral stone on the right side.
b. Foreign body ingestion.
c. Ileus secondary to appendicitis with a fecalith.
d. Meckel's diverticulum.
e. Normal.

81. Proper workup may include which of the following?

a. CBC.
b. Surgery consult if high suspicion for appendicitis.
c. CT if low to moderate suspicion.
d. Ultrasound.
e. All of the above.

82. Which one of the following conditions can also cause pain and elevated WBC?

a. Gastroenteritis.
b. Meckel's diverticulum.
c. Ruptured ovarian cyst.
d. All of the above.
e. None of the above.

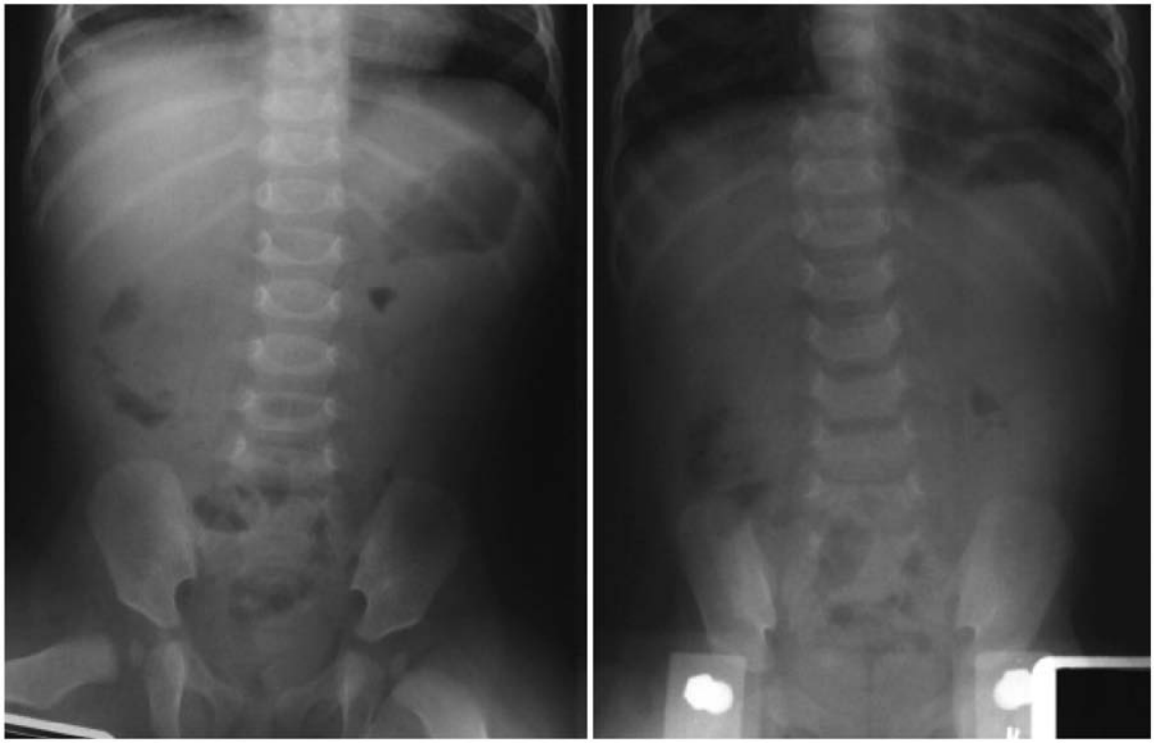
83. True or False? Perforation is more common in children with appendicitis.

a. True.
b. False.

84. Rovsing sign is:

a. Pain in left lower quadrant with palpation of right lower quadrant.
b. Pain with flexing the hip/knee and internally rotating the hip.
c. Pain in the right lower quadrant with palpation in left lower quadrant.
d. Pain with extension of right leg at the hip in left lateral decubitus position.
e. Tenderness on rectal exam.

QUESTIONS 85–90: A 7-month-old female presents to the emergency department with vomiting. She appears well hydrated and her vital signs are normal. She does seem to cry more when you palpate her abdomen. Here are the abdominal X-rays you get.



85. What is the correct interpretation of these X-rays?

a. Intussusception.
b. Meckel's diverticulum.
c. Volvulus.
d. Appendicitis.
e. Normal.

86. What is the best initial approach to the treatment of this condition?

a. Air contrast or barium enema.
b. Intravenous antibiotics, serial abdominal exams.
c. Immediate surgical repair.
d. Nothing by mouth, nasogastric tube, intravenous fluids.
e. None of the above.

87. If the gold standard for treatment of this condition is done within the first 12–24 hours, what is the success rate?

a. Less than 1%.
b. 20%.
c. 60%.
d. Greater than 99%.

88. If treatment is successful, what is the chance of the condition recurring?

a. 5–10%.
b. 15–20%.
c. 30–40%.
d. 50%.
e. Greater than 75%.

89. What would be the contraindication to the current gold-standard treatment for this condition?

a. Diarrhea.
b. Suspected bowel perforation.
c. Positive stool guaiac.
d. Vomiting.
e. Abdominal pain.

90. True or False? This condition is more common in females than in males.

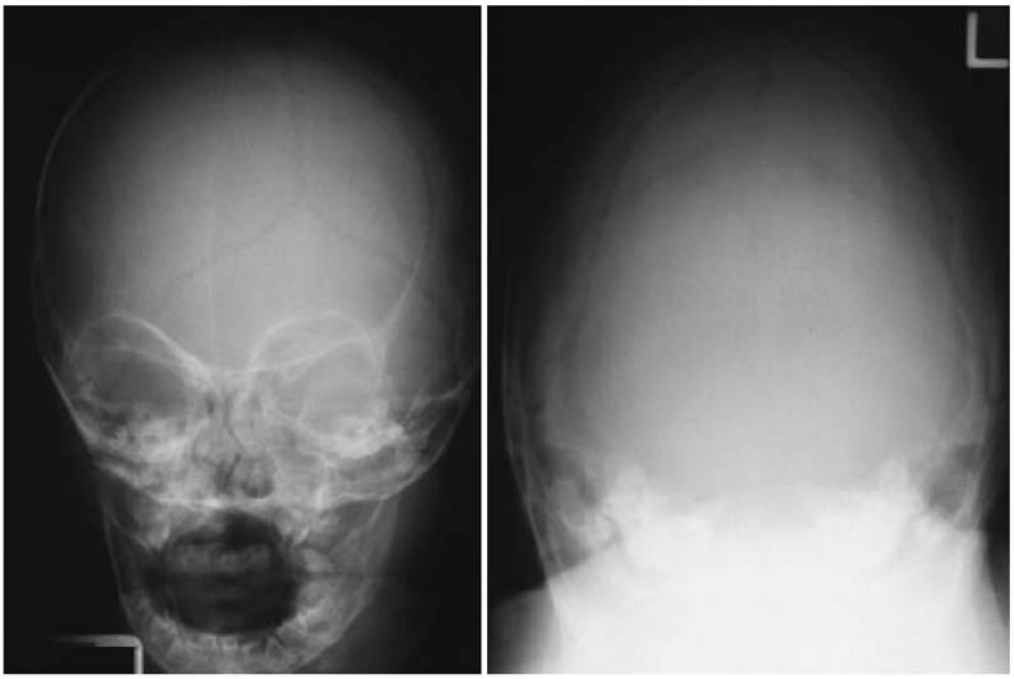
a. True.
b. False.

4 Skull Radiographs

The following chapter will focus on radiographs of the skull. Pertinent questions, answers, and rationale will be reviewed.

Key Words: Fracture; compression; linear; suture; trauma.

QUESTIONS 1–14: Plain-film radiographs of the skull are obtained in limited circumstances. In most instances, CT scanning of the head is more useful. Some hospitals and clinics do not have easy access to CT scanning; hence, they rely more on the use of clinical assessment, plain-film skull radiographs, and judicious referral to a center with a CT scanner. Interpreting skull radiographs in infants can be difficult. as their skulls have many normal lucencies. Sutures are generally sinusoidal in appearance and in their standard anatomic locations (coronal, sagittal, and lambdoidal). Fractures are rarely sinusoidal. Fractures are usually linear, stellate, or depressed. Review the following X-rays and answer the questions associated with each.



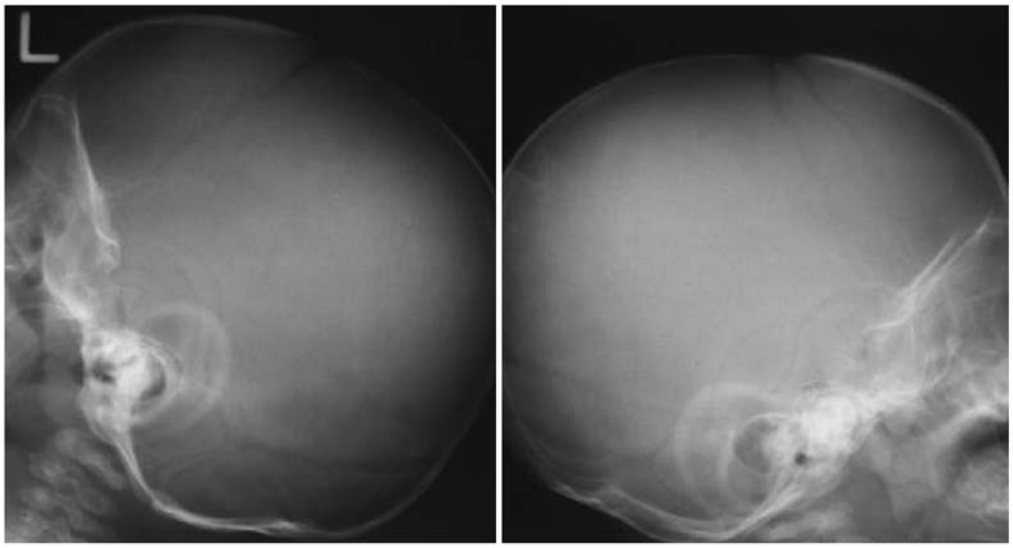
1a. Locate the coronal, sagittal, and lambdoidal sutures, the anterior fontanelle, and the parietomastoid and the occipitomastoid sutures on the skull radiographs shown here using the following key:

C, Coronal; S, Sagittal; L, Lambdoidal; P, Parietomastoid; O, Occipitomastoid

From: *Pediatric Radiology Review*
Edited by: M. D. Pappas, L. G. Yamamoto, and A. Okechukwu © Humana Press Inc., Totowa, NJ

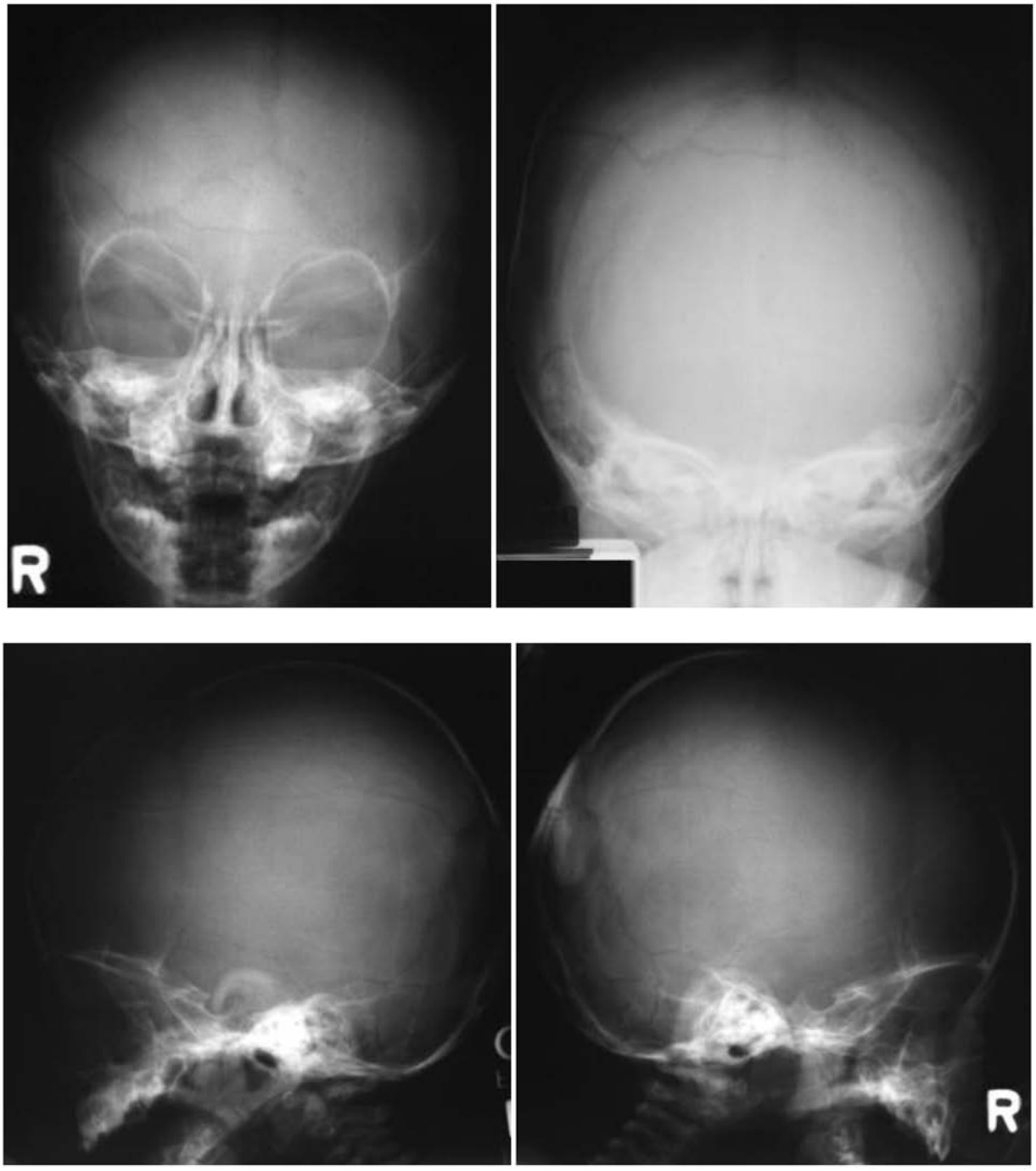
1b. Locate the coronal, sagittal, and lambdoidal sutures, the anterior fontanelle, and the parietomastoid and the occipitomastoid sutures on the skull radiographs shown here using the following key:

C, Coronal; S, Sagittal; L, Lambdoidal; P, Parietomastoid; O, Occipitomastoid.



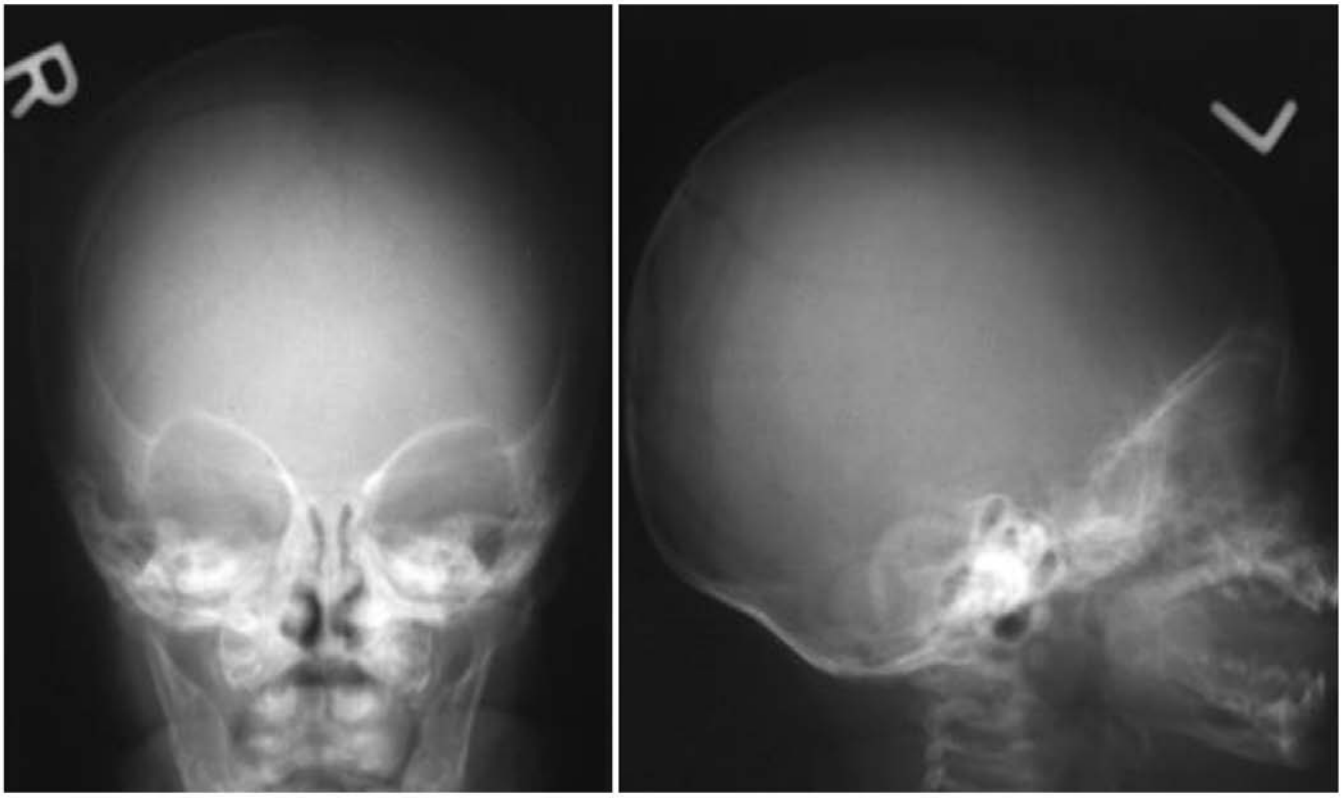
2. This 11-month-old infant fell and struck his head on a hard surface.

a. Identify the site of the fracture.
b. Which suture does the fracture cross?



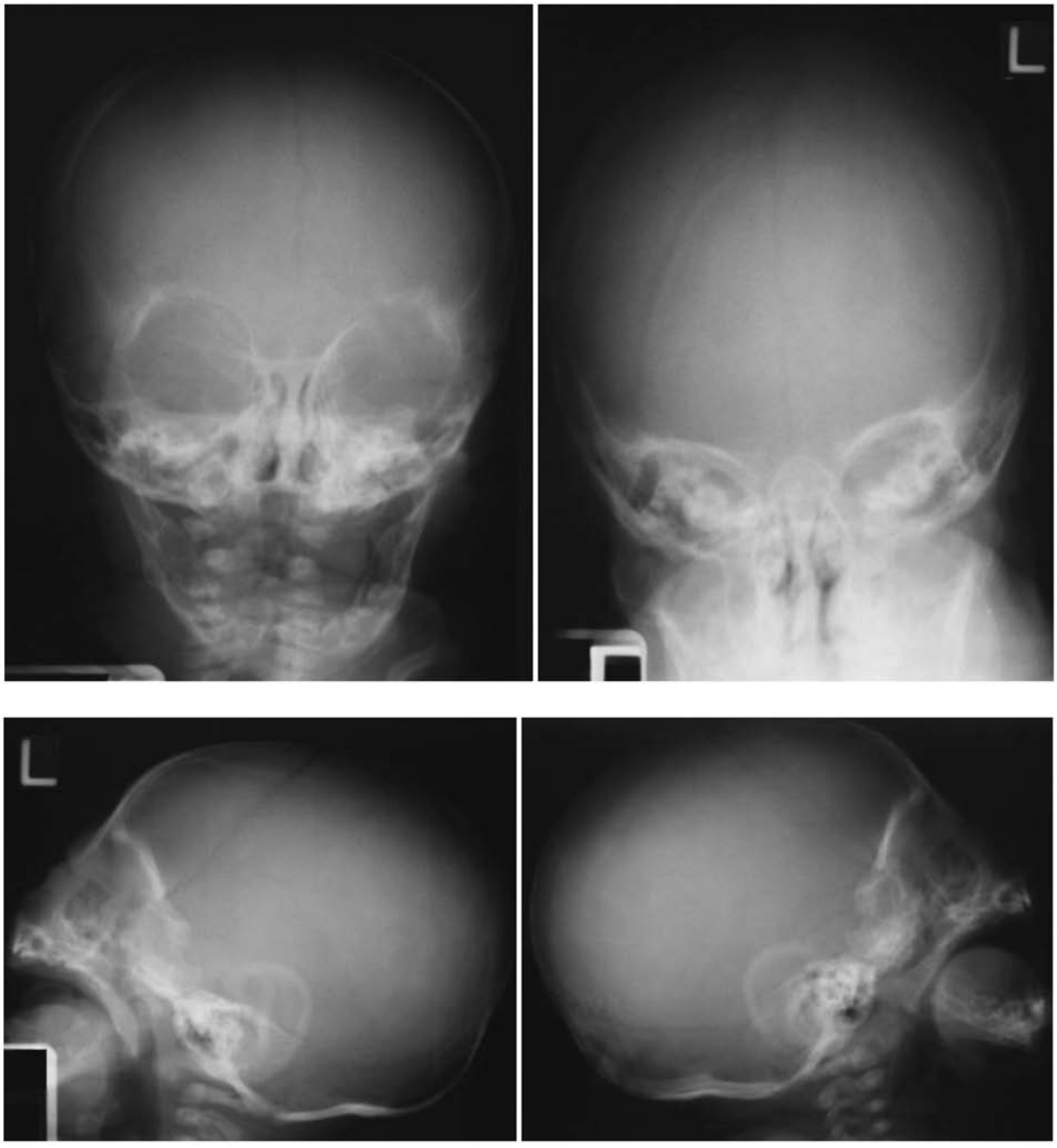
3. The history in this case is that this 2-month-old fell off a bed twice. It should be noted that this history is highly suspicious. A 2-month-old infant cannot move about very much. Although it may be possible for this 2-month-old infant to have fallen off a bed once, it is very unlikely that any parent would have allowed this to occur twice on the same day.

a. Identify the location of the fracture.



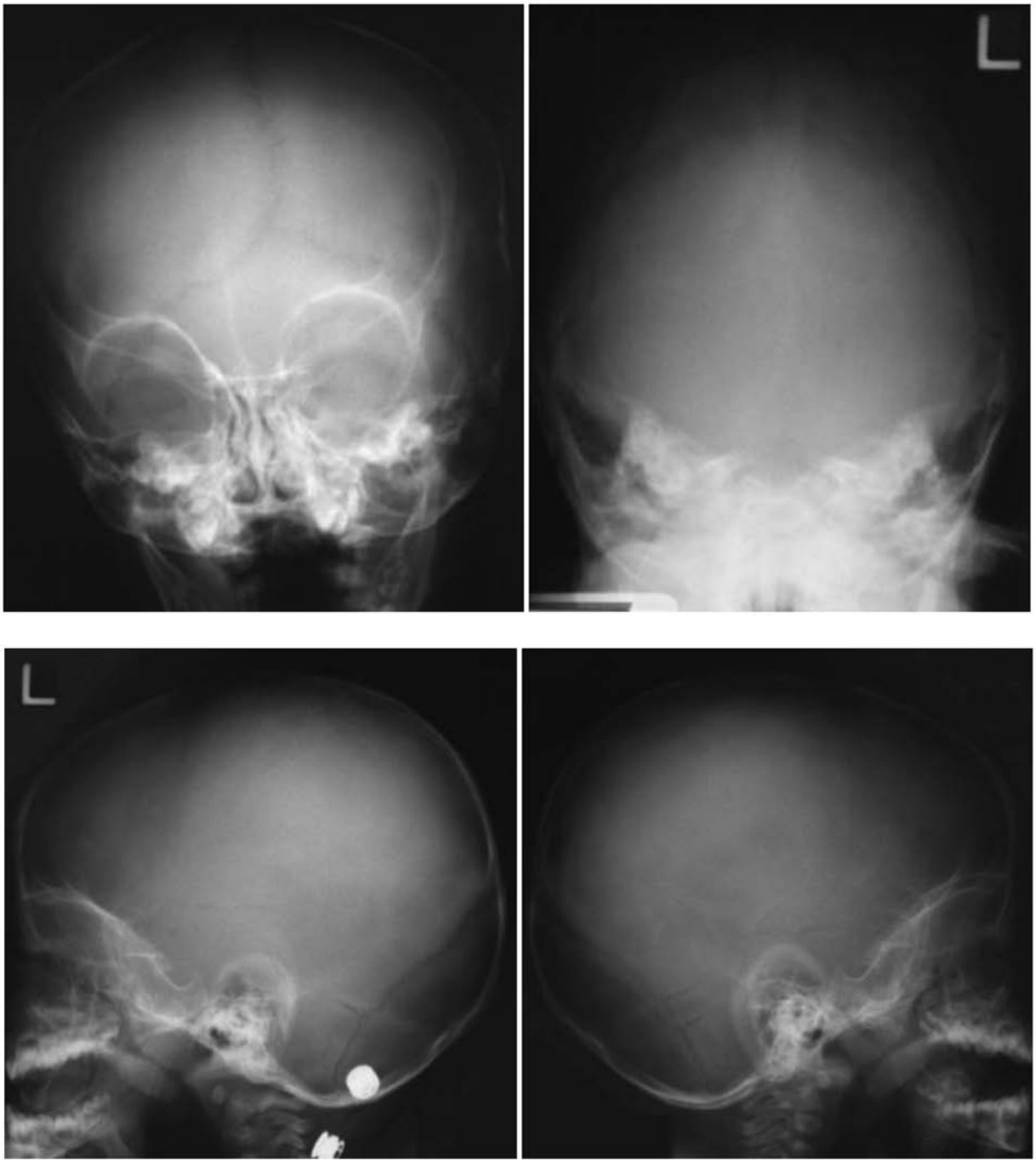
4. The mother of this 2-month-old infant fell onto a hard surface while she was carrying her infant.

a. Locate the fracture.



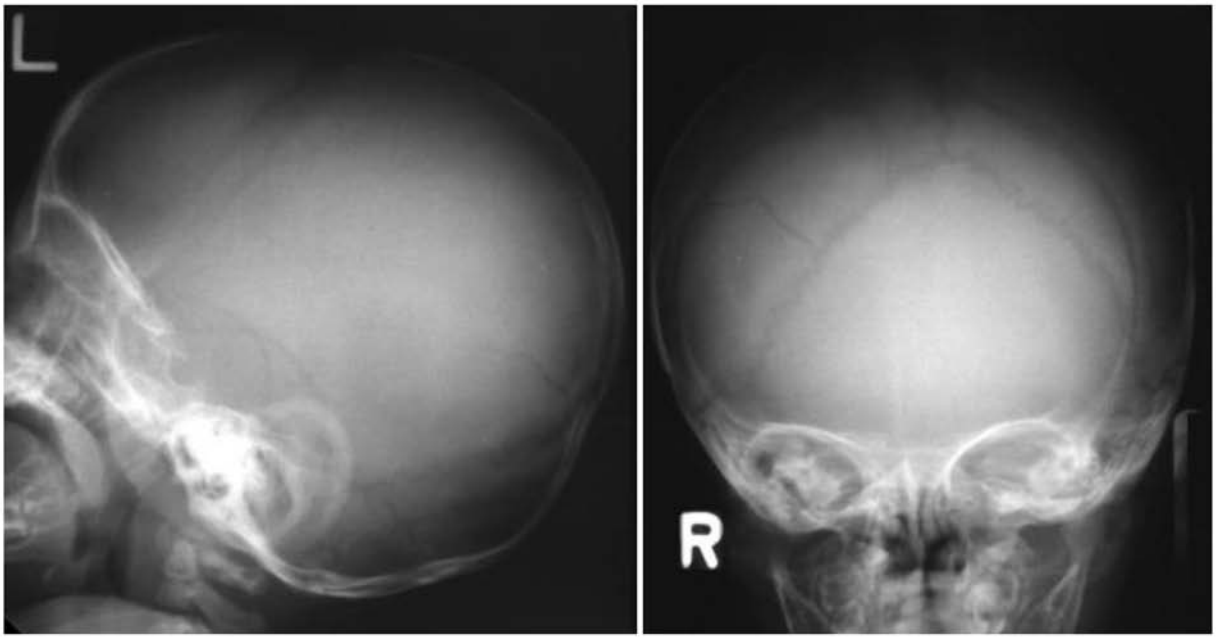
5. This 13-month-old infant was noted to have a soft swelling on his head 2 days following an episode of head trauma, following which his behavior was normal.

a. Identify the fracture.

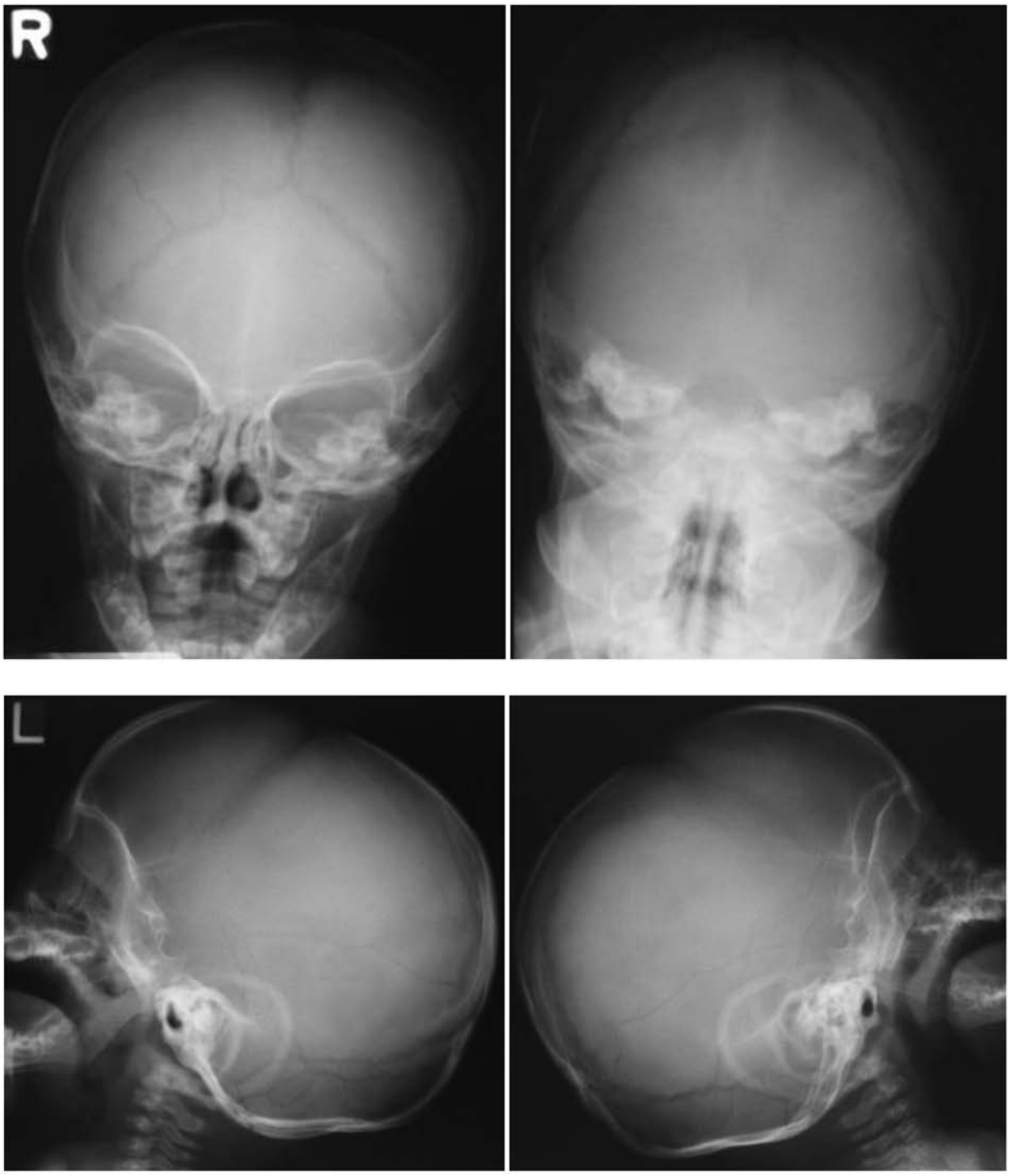


6. Identify the fracture in the radiographs below.

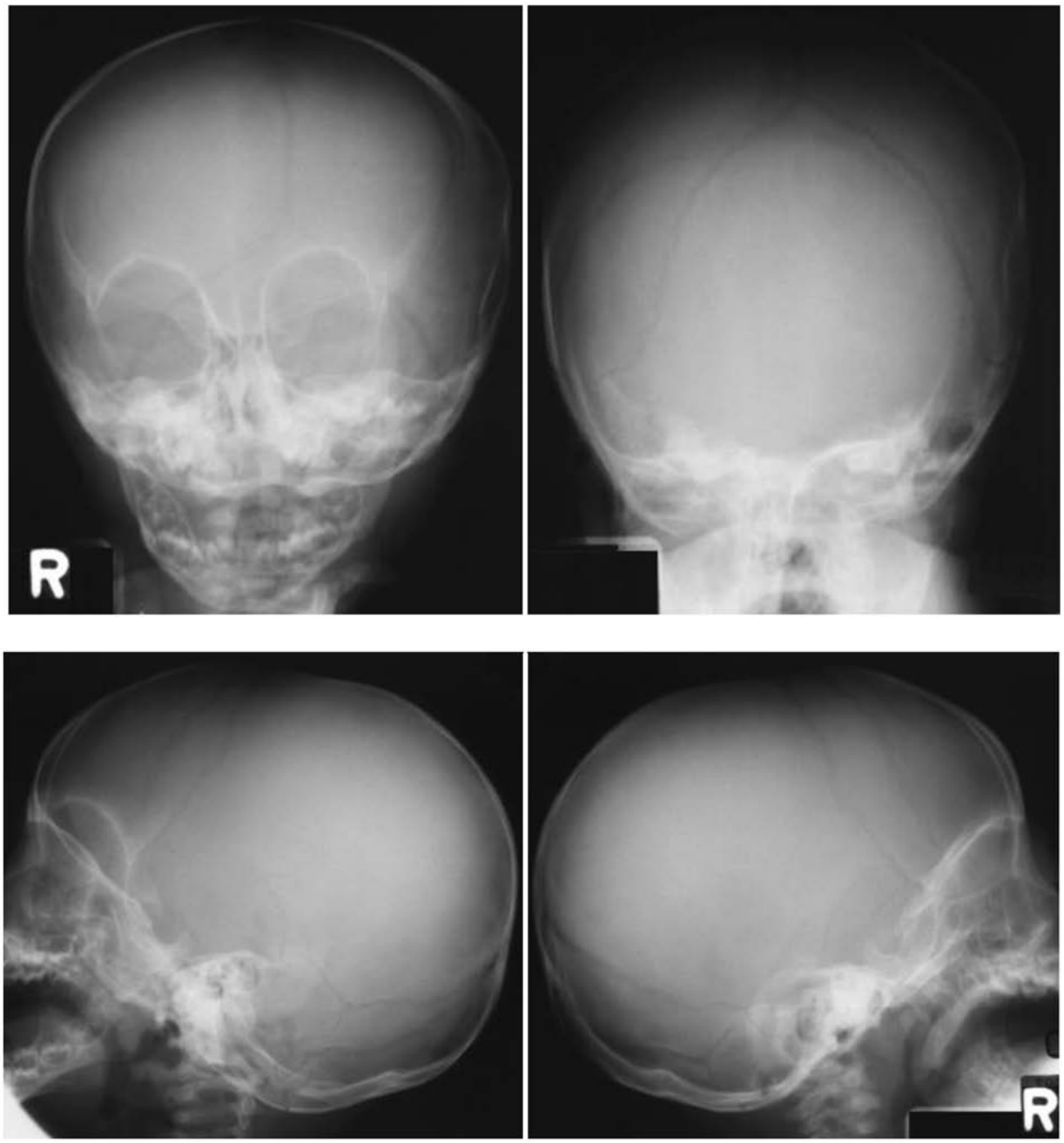
7. Identify the fracture in the radiographs below.



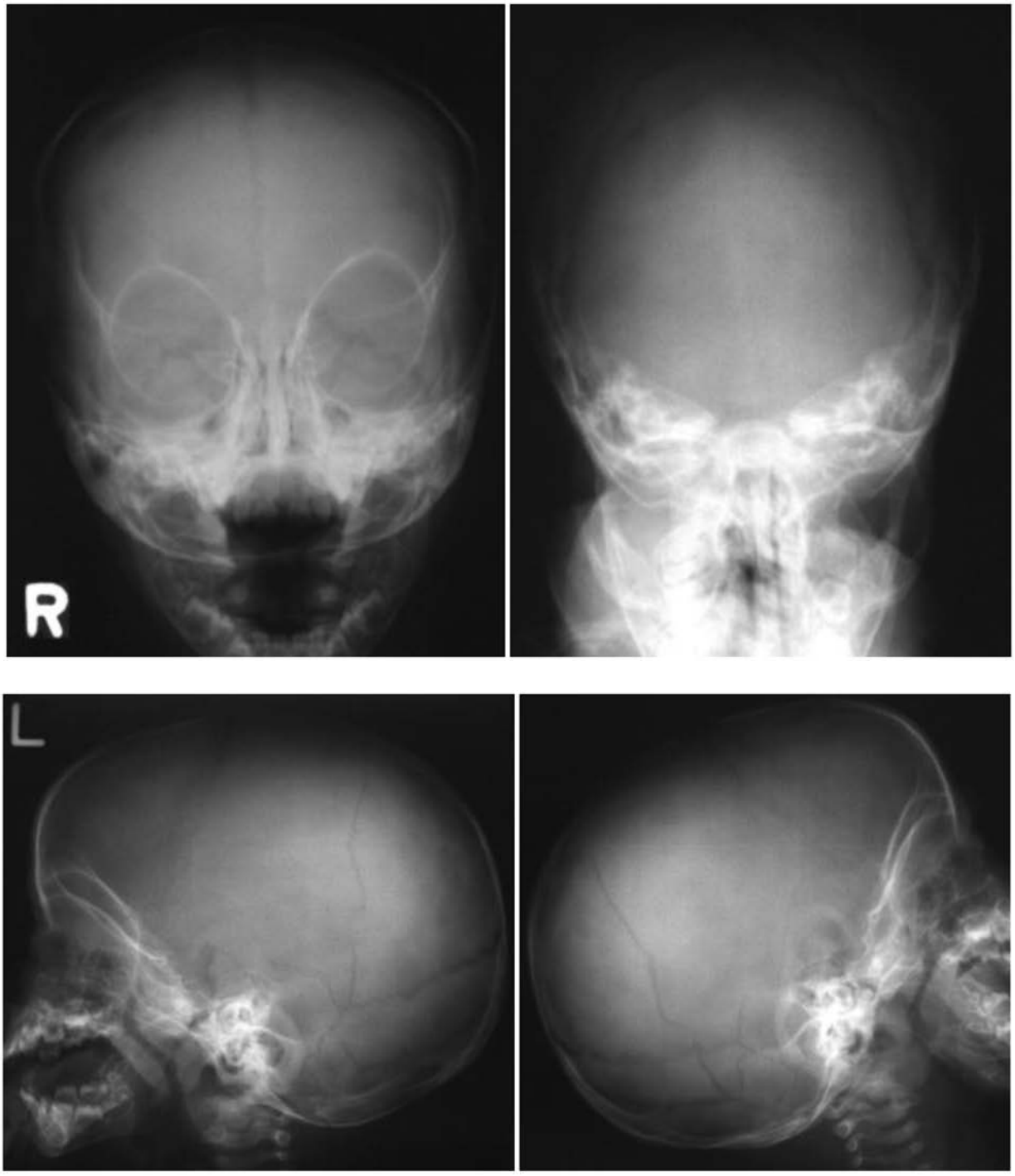
8. Identify the fracture in the radiographs below.



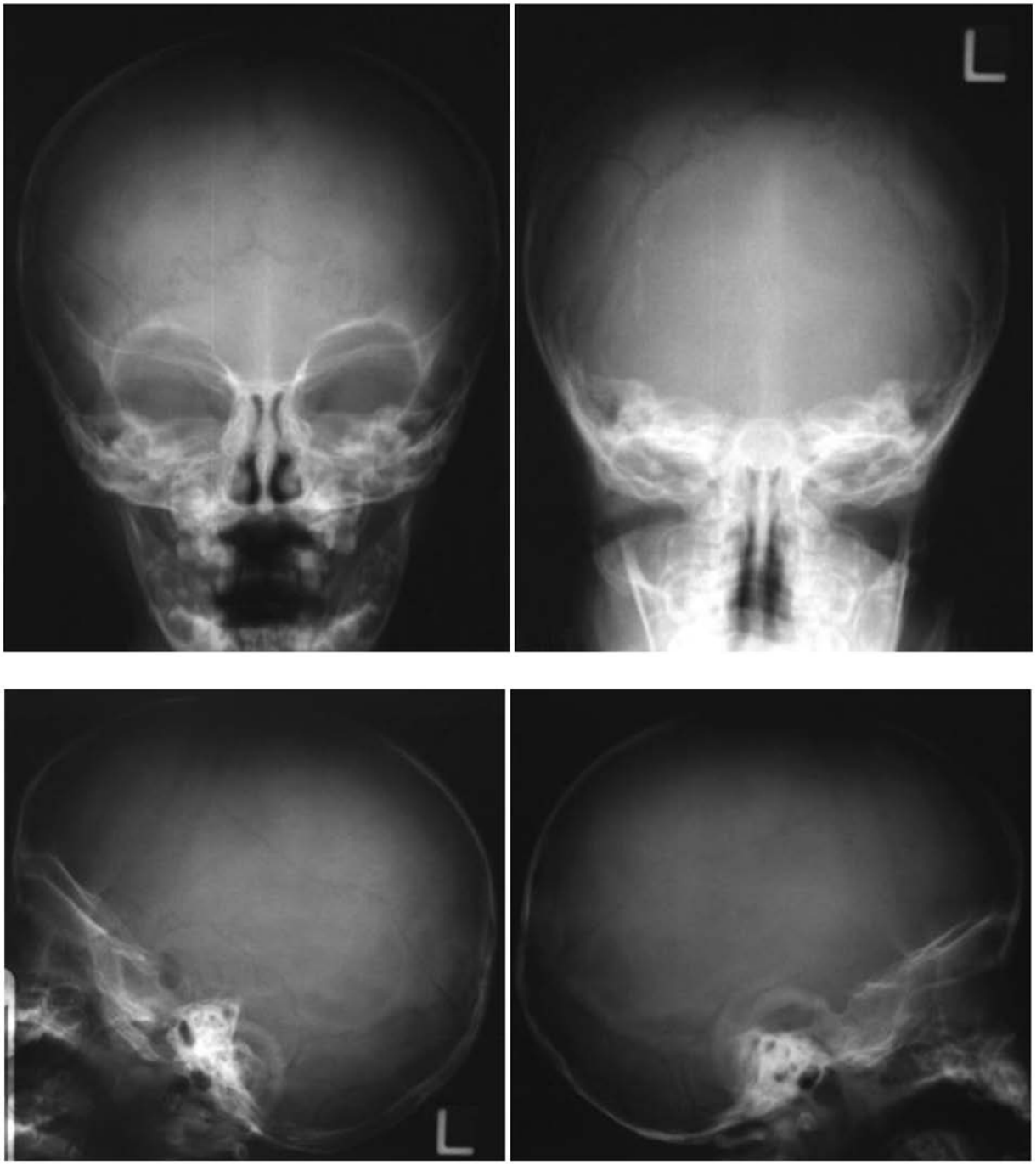
9. Identify the fracture in the radiographs below.



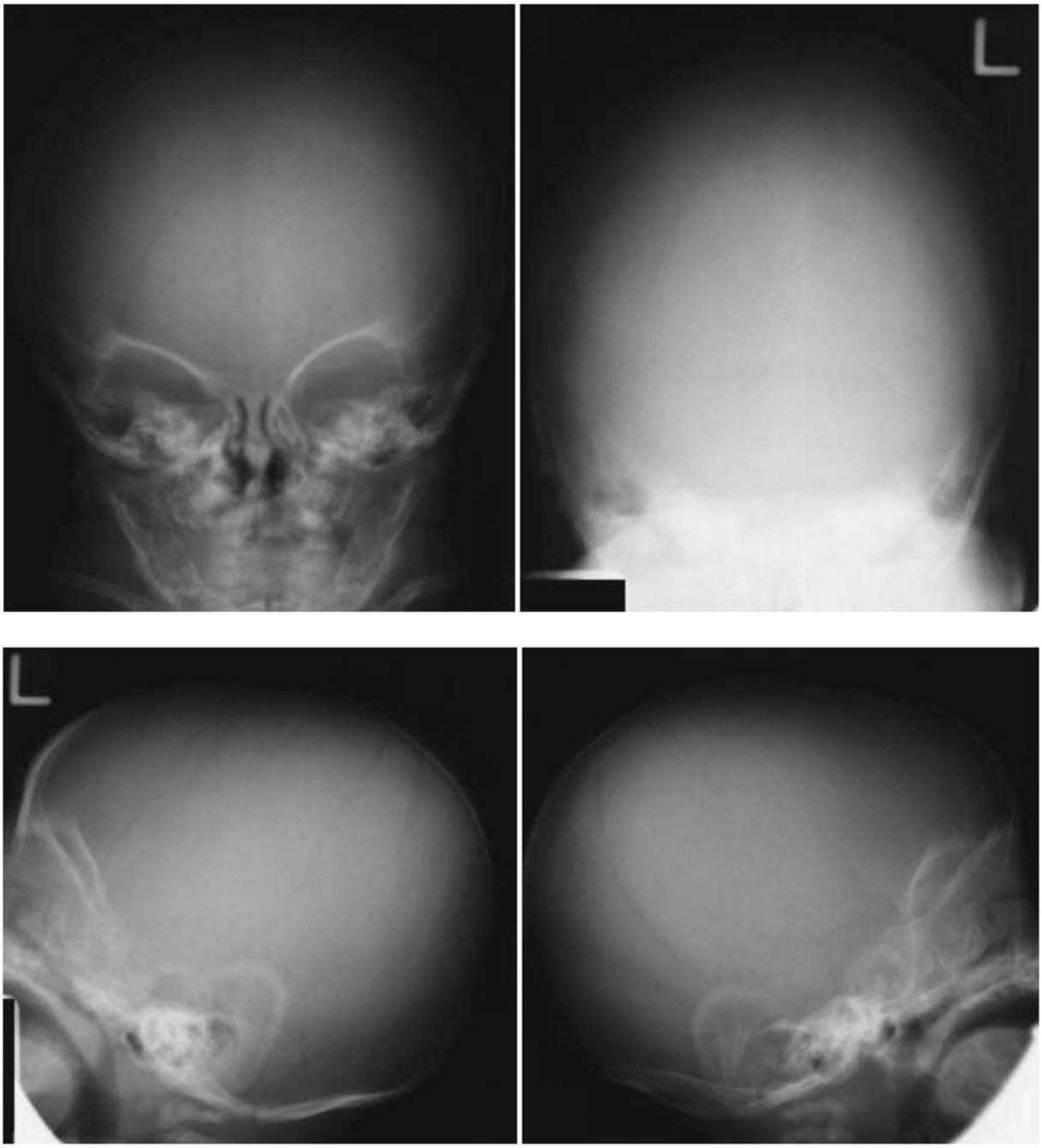
10. Identify the fracture in the radiographs below.



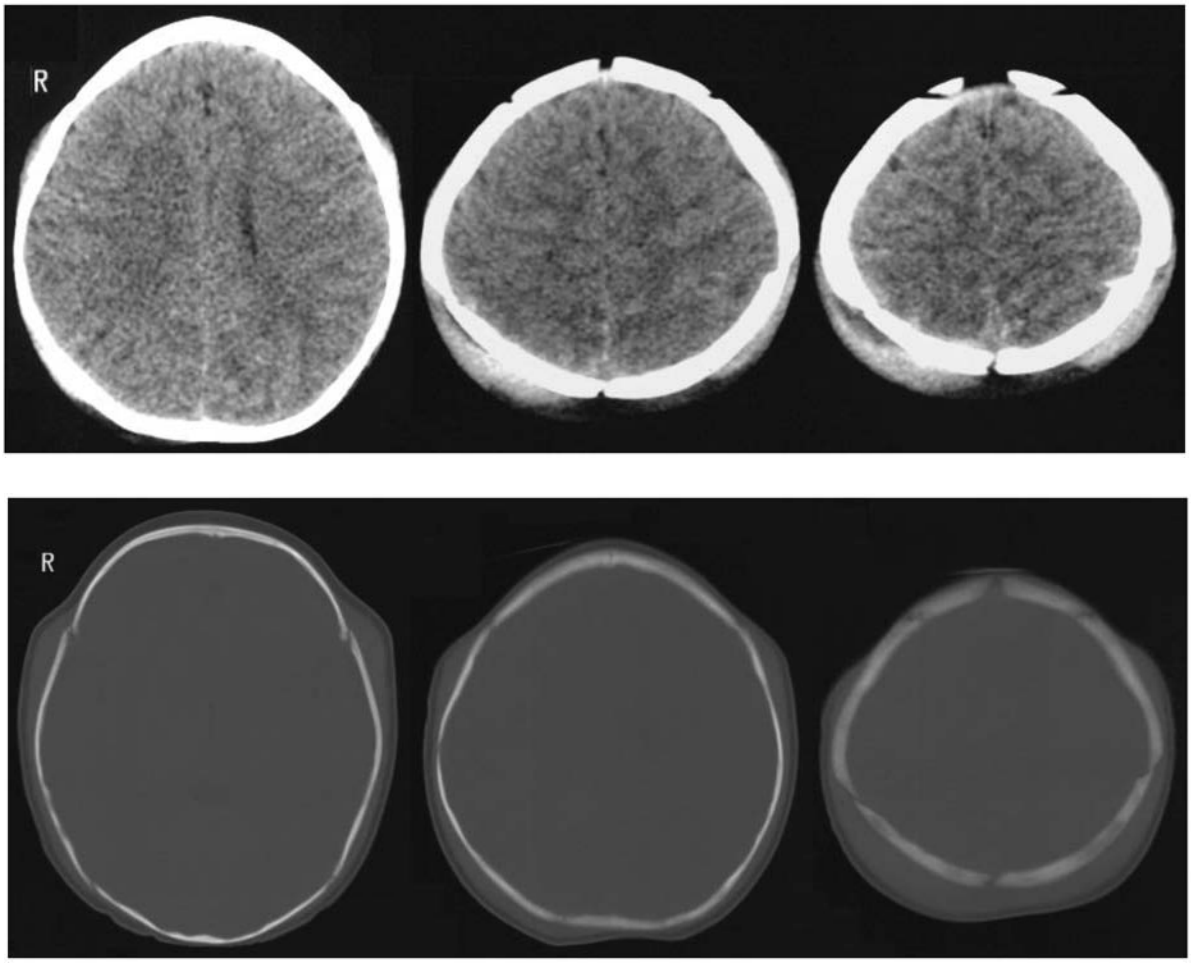
11. Identify the fracture in the radiographs below.



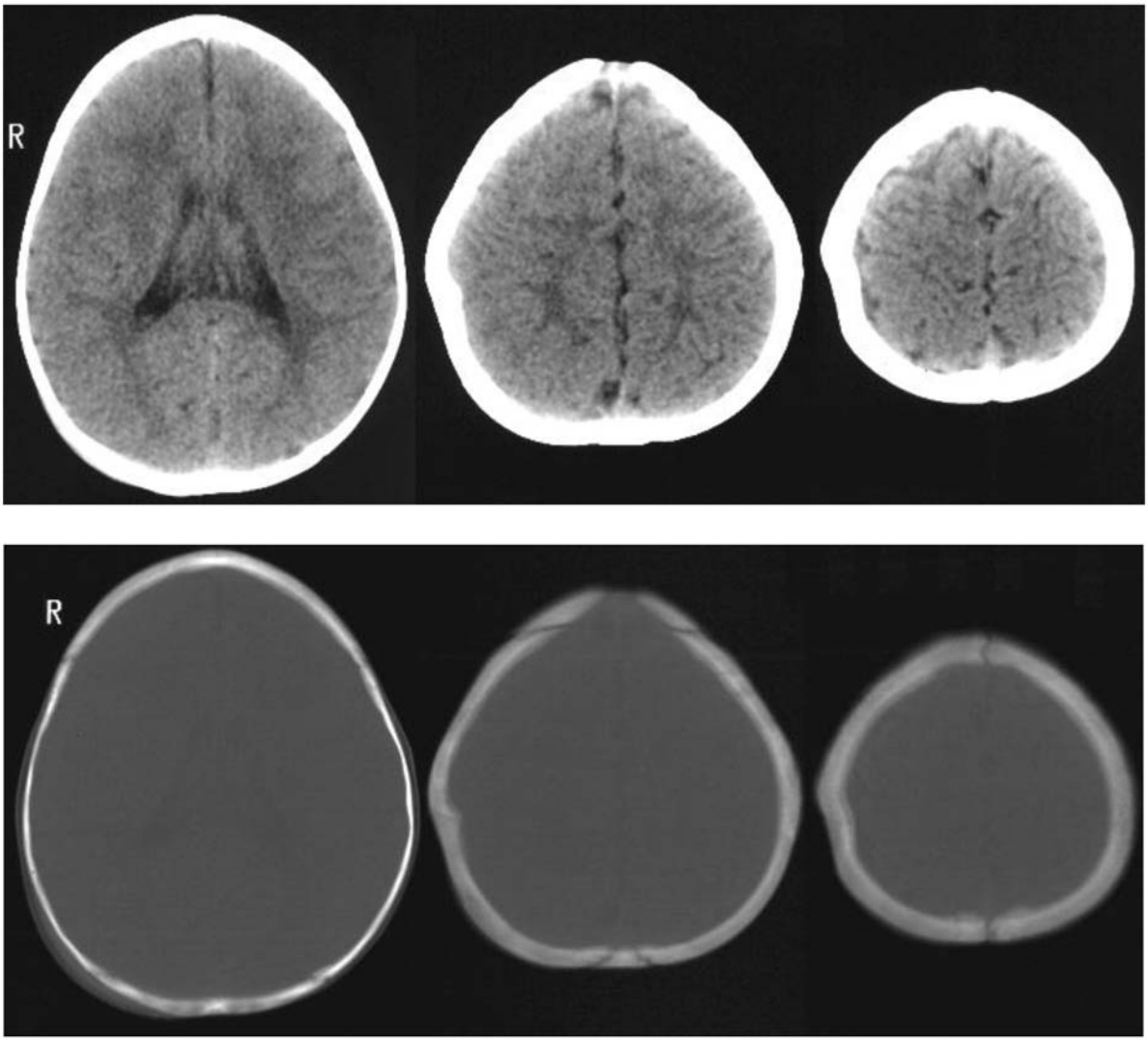
12. Identify the fracture in the radiographs below.



13. This is a CT scan image. Although this section has focused on plain-film skull radiographs, CT scans are often ordered in cases of significant head trauma. Radiologists will usually read CT scans. Identification of the sutures versus fractures on CT can be difficult without the knowledge of the usual appearance and location of sutures. Identify the swelling and fractures.



14. Identify the pathology in the CT scan below.



5 Long Bone and Extremity Radiographs

The following chapter will focus on radiographs of the long bones and extremities. Pertinent questions, answers, and rationale will be reviewed.

Key Words: Femur; humerus; radius; ulna; tibia; fibula; fracture; Salter-Harris.

QUESTIONS 1–5: A 17-year-old boy presents with rather severe forearm pain with angulated deformity after a mountain biking accident in which he landed on the palm of his hand. He has normal movement and sensation of the shoulder and fingers but is quite reluctant to move his elbow or wrist. Capillary refill time is less than 2 seconds. Plain films are shown below.

1. Is this type of injury more or less common in younger children?

a. More common in young children than adolescents.
b. Less common in young children than adolescents.
c. Equally common in young children and adolescents.
d. More common only in children with acute lymphocytic leukemia or other forms of leukemia.

2. What pathology is present at the distal tip of the ulna?

a. Fracture of styloid process with fracture of pisiform bone.
b. Salter-Harris type V fracture.
c. Salter-Harris type IV fracture with dislocation.
d. Salter-Harris type III fracture with dislocation.
e. Salter-Harris type I or II fracture with dislocation.

From: *Pediatric Radiology Review*
Edited by: M. D. Pappas, L. G. Yamamoto, and A. Okechukwu © Humana Press Inc., Totowa, NJ

3. In simple nonangulated torus-type fractures of the distal radius:
   a. This type of injury is unlikely.
   b. This type of injury is easier to identify clinically.
   c. This type of injury would be more difficult to find on plain films.
   d. A splint is not necessary.
   e. This is pathognomonic for child abuse.

4. Failure to recognize the ulnar injury often results in:
   a. Vascular compromise of the medial (ulnar) hand.
   b. Medial nerve entrapment.
   c. Radial nerve palsy.
   d. Painful joint effusions.
   e. Painful prominence of the distal ulna.

5. Treatment for this type of fracture:
   a. Usually requires immediate surgical open reduction.
   b. Requires immediate closed exam/reduction.
   c. Requires orthopedic follow-up within 2–4 weeks.
   d. Includes ice, elevation, compression, and nonsteroidal anti-inflammatory drugs.
   e. Often involves distal amputation.

QUESTIONS 6–11:

6. What type of radial fracture is seen in this view?
   a. Salter-Harris type I.
   b. Salter-Harris type II.
   c. Salter-Harris type III.
   d. Salter-Harris type IV.
   e. Salter-Harris type V.

7. What type of tibial fracture is seen here?

a. Salter-Harris type IV.
b. Salter-Harris type V.
c. Salter-Harris type II or type III.
d. Salter-Harris type I.
e. Osteoarthritis only.

8. A common complication from Salter-Harris type V fractures is:

a. Osteoarthritis.
b. Joint laxity, dislocations.
c. Osteopenia.
d. Arrest of growth.
e. Delayed osteoarthritis.

9. A common complication of some Salter-Harris fractures is arthritis and disability. Which ones have this complication?

a. Types III and IV.
b. Types IV and V.
c. Types I and V.
d. Types I and II.
e. Type V only.

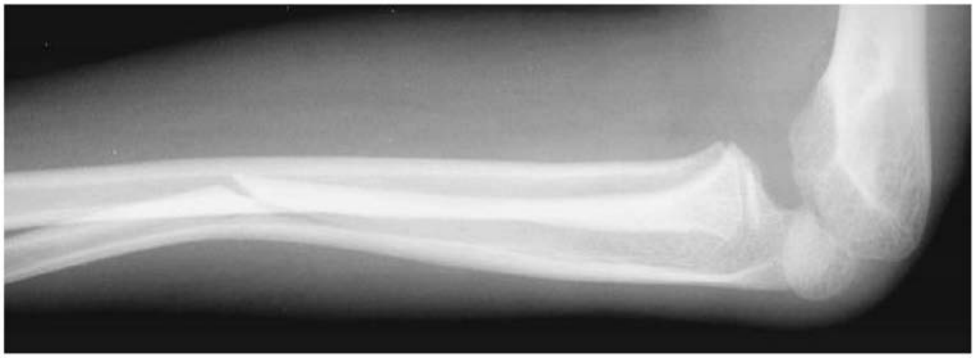
10. Some Salter-Harris fractures may commonly have a normal appearance on X-ray. Which ones appear normal?

a. Types I and II.
b. Types II and III.
c. Types IV and V.
d. Type V only.
e. Types I and V.

11. Mechanism of axial compression along the long bones with tenderness but without deformity is most consistent with which fracture?

a. Salter-Harris type I.
b. Salter-Harris type II.
c. Salter-Harris types III or IV.
d. Salter-Harris type V.
e. Pathological fracture.

QUESTIONS 12–17: These slides are from a 9-year-old boy who fell from a slide onto his outstretched arm. He presents with pain and swelling of the left proximal forearm. There was no head injury and his vitals are normal. The child cannot flex, extend, pronate, or supinate at the elbow. Range of motion, sensation, and circulation are normal at the shoulder, wrist, and hand. Shoulder, wrist, and hand are also not tender.



12. What injuries are visible on these plain films?

a. There are no visible injuries.
b. Ulnar fracture and dislocation of the radial head.
c. Ulnar fracture and ulnar dislocation at the elbow.
d. Ulnar fracture and prominent joint effusion.
e. Ulnar and radial fracture.

13. What is the most common mechanism of this type of injury?

a. Hyperextension of the wrist.
b. Hypersupination of the wrist.
c. Hyperextension of the elbow.
d. Direct blow to forearm.
e. External rotation at the shoulder.

14. What is the proper treatment in the emergency room?

a. Immediate call to local authorities to investigate child abuse.
b. Cast with plaster or ortho-glass covering wrist and elbow.
c. Sling, ice, and anti-inflammatory medications only.
d. Volar wrist splint and flexible wrap.
e. Immediate orthopedic consult for reduction.

15. What is the importance of the radiocapitellar line on plain film?

a. The anterior humeral line should cross the radiocapitellar line at 60°.
b. The radiocapitellar line helps to verify true lateral view.
c. The midline of the radius should pass through the mid-capitella in true lateral view only.
d. The midline of the radius should pass through the mid-capitella in all views.
e. Curve of the radiocapitellar line indicates joint effusion.

16. What nerve is most commonly injured in this type of injury?

a. Median nerve.
b. Medial nerve.
c. Distal ulnar nerve.
d. Proximal radial nerve.
e. Branch of radial nerve.

17. What are the most common complications of this type of injury?

a. Recurrent dislocation of radial head and limited range of motion at elbow.
b. Forearm deformities and chronic pain.
c. Forearm deformities and limited range of motion at wrist.
d. Forearm deformities and paralysis of median nerve.
e. Forearm deformities and vascular insufficiency.

QUESTIONS 18–22: An 8-year-old girl presents to the emergency room after falling from a tree, and complains of elbow pain. She has tenderness at the lateral aspect of the elbow and reduced flexion, supination, and pronation secondary to pain. There may be slight swelling compared to the other elbow but no obvious difference. The plain films are shown.

18. What is your diagnosis of the above X-ray?

a. Sprain/strain of the elbow.
b. Nursemaid's elbow.
c. Lytic lesion of distal humerus consistent with osteosarcoma.
d. Fracture of radial metaphysis.
e. Salter-Harris type IV ulnar fracture.

19. To totally rule out any fracture:

a. It is impossible.
b. It must be read as negative by an MD.
c. It must be read as negative by an orthopedic surgeon.
d. It must be read as negative by one radiologist.
e. It must be read as negative by two or more attending radiologists.

20. How should this injury be treated?

a. Immediate orthopedic consultation.
b. Counsel parents about repetitive motion injuries and/or possibility of abuse.
c. Closed reduction with or without conscious sedation with orthopedic follow-up.
d. Reassurance; aspirin as necessary for pain.
e. Occult fracture precautions, ice, immobilization, follow-up.

21. What view may demonstrate this lesion better?

a. True lateral with figure-eight sign.
b. Two views of wrist.
c. Oblique of elbow.
d. View of entire humerus.
e. Lateral view shot from medial side.

22. What other pathology is visible on the lateral film?

a. Prominent posterior fat pad.
b. Prominent anterior fat pad.
c. Subluxation of radial head.
d. Osteopenia.
e. Osteosclerosis.

QUESTIONS 23–26: An 8-year-old presents to the emergency room complaining of left elbow pain. He fell from a tree, a fall of approximately 7 feet, and landed on his left forearm. Tenderness localizes to the lateral aspect and the elbow has significant swelling. The child has normal neurovascular findings in the shoulder, wrist, and hand. Radiographs are shown below.

23. What obvious lesion do you see?

a. Radial head fracture.
b. Radial head dislocation.
c. No obvious lesions seen.
d. Monteggia's elbow.
e. Anterior sail sign.

24. What would be a reasonable next step?

a. Splint, sling, ice, occult fracture precautions, and follow-up.
b. Admission to floor with stat orthopedic consult.
c. MRI or nuclear bone scan, occult fracture precautions, follow-up.
d. Order more plain films.
e. Either a or d is reasonable.

You decide to order oblique films (shown here) based on clinical suspicion.

25. What new finding do you see?

a. No new finding is visible.
b. Posterior fat pad.
c. Proximal ulnar cortical buckle fracture.
d. Lateral condyle fracture.
e. Radial longitudinal fracture.

26. How would the oblique films change your treatment?

a. Would not change treatment.
b. Would offer the patient more reassurance
c. Would mandate orthopedic consult within 24 hours.
d. Would refer the patient for congenital connective tissue disease.
e. Would refer the patient for MRI or bone scan to rule out stress fracture.

QUESTIONS 27–31: A 10-year-old boy presents to his pediatrician complaining of bilateral heel pain, very mild on the left, but more painful on the right. The pain started about 3 months ago but the child is not sure of the exact date. He cannot remember any inciting injury, but first noticed the pain during soccer practice. Both feet are normal in appearance, without swelling or erythema. There is point tenderness at the insertion of the Achilles' tendon. Plantar flexion is slightly limited on the right. The rest of the physical exam, including vital signs, is normal. You obtain the following radiographs.

27. What pathology do you see on the radiographs?

a. No pathology seen.
b. Several calcaneal fractures are seen.
c. Boehler's angle less than 20° suggests calcaneal compression fracture.
d. Lisfranc fracture with dislocation.
e. Jones fracture.

28. What is the most likely mechanism of this injury?

a. Foot inversion.
b. Foot eversion.
c. Repetitive axial load on soft bones.
d. Repetitive microtrauma at insertion of Achilles' tendon.
e. Lack of vitamin D or calcium and/or lack of weight-bearing exercise.

29. How often does this injury occur bilaterally?

a. About 20%.
b. About 60%.
c. About 80%.
d. 90–95%.
e. 100% by definition.

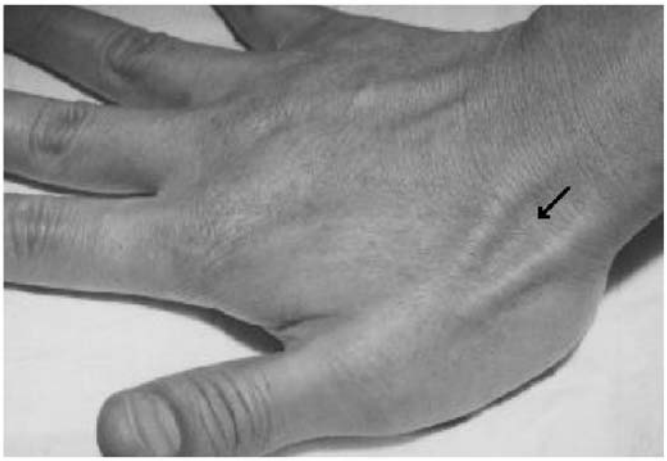
30. What treatment should the pediatrician recommend?

a. Limit playing soccer until the pain resolves.
b. Foam heel pads to elevate the heel.
c. Short leg cast.
d. Any of the above (a–c) may be appropriate.
e. Splint to immobilize ankle and knee with orthopedic follow-up.

31. What is the difference between an epiphysis and an apophysis?

a. There is no anatomic difference; the terms are interchangeable.
b. An epiphysis is associated with a growth plate, whereas an apophysis is not.
c. An apophysis growth plate does not contribute to the length of a bone.
d. Proximal joints have epiphyses, whereas distal joints have apophyses.
e. An apophysis will continue to grow after puberty, whereas an epiphysis will close.

QUESTIONS 32–38: A 15-year-old male presents to the emergency room after falling on an outstretched hand. He complains only of pain at the wrist. There is no swelling and physical exam is normal except for palmar abrasions and point tenderness in the area indicated in this figure (**Note:** photo is of a model, not the actual patient).



The point tenderness is increased with wrist flexion, extension, and radial deviation. The following anterior–posterior (AP) and oblique films were taken.

32. What is the diagnosis?

a. Clinical strain/sprain of the wrist.
b. Avascular necrosis of the pisiform bone.
c. Salter-Harris fracture type I.
d. Presumptive fracture of the scaphoid bone.
e. Salter-Harris fracture type V.

33. What is the most important treatment in the ER?

a. Plaster cast and shoulder sling with immobilization of wrist and elbow.
b. Nonsteroidal anti-inflammatory drugs and ice.
c. Volar wrist brace.
d. Immediate reduction by ER physician or by orthopedic surgeon if possible.
e. Thumb spica with radial gutter and wrap.

34. What other important film should be taken?

a. Scaphoid view.
b. Flexion extension films of the thumb.
c. AP and lateral elbow films.
d. Only MRI can diagnose this lesion.
e. No films are indicated; this is strictly a clinical diagnosis.

Here is a film of a patient with the same injury, but other injuries are also present. This patient presented with distal forearm pain.

35. What is the most common mechanism for this type of injury?

a. Forceful hyperextension of the thumb.
b. Thumb abduction.
c. Hyperextension of the wrist.
d. Hyperflexion of the thumb.
e. Direct longitudinal force on metacarpals (punching a wall).

36. What is the significance of tenderness in the anatomical snuff box?

a. Indicative of injury to the radial head.
b. Indicative of rheumatoid arthritis.
c. Indicative of injury to scaphoid bone.
d. Indicative of injury to hamate bone.
e. Indicative of ligamentous injury.

37. When this injury occurs proximally:

a. The patients tend to have symptoms earlier.
b. There is greater risk of avascular necrosis.
c. Elbow immobilization is indicated.
d. Immediate reduction is indicated.
e. Treat initially with methotrexate.

38. In children, this injury:

a. Is a strong indicator of abuse.
b. Does not require treatment.
c. Requires immediate surgical evaluation.
d. Cannot be seen on plain film.
e. Tends to occur more distally.

QUESTIONS 39–44: A 10-year-old boy presents to the emergency department complaining of right thigh pain radiating to the knee. He fell while playing basketball and is unsure of how he landed, but has been unable to walk without a limp since. The limp has not subsided now for 3 days. Pain is relieved by lying down. On exam he is found to be obese and tall for his age. He has proximal thigh tenderness and severe hip tenderness. Range of motion is normal at the knee but limited at the hip because of pain. He has no point tenderness at the pubic symphysis or knee. The rest of the physical exam, including vital signs, is normal. You order pelvic films.

39. What is the diagnosis?

a. Avascular necrosis of the femoral head.
b. Acetabular fracture.
c. Subcapital fracture of the femoral neck.
d. Posterior dislocation of the femoral head.
e. Slipped capital femoral epiphysis.

40. What population is most at risk for this type of injury?

a. Acute trauma victims.
b. Obese inactive male children.
c. Obese active male children.
d. Obese inactive female children.
e. Children with type 1 diabetes.

41. What clinical finding is especially suspicious for this injury?

a. Inability to fully internally rotate hip.
b. Inability to fully externally rotate hip.
c. Inability to fully extend hip.
d. Point tenderness at mid-thigh.
e. Diminished popliteal or posterior tibial pulses when compared with unaffected leg.

42. What is the proper treatment in the ER?

a. Measurement of compartmental pressures and orthopedic consult.
b. Bed rest and orthopedic consult.
c. MRI of hip and thigh and orthopedic consult.
d. Discontinue sporting activities and outpatient orthopedic follow-up if symptoms return.
e. Closed reduction in ER with follow-up as needed.

43. What other films are indicated?

a. AP of pelvis is the only film ever needed.
b. MRI is often used.
c. Films of lumbar spine should be obtained.
d. Skeletal survey to assess old fractures.
e. Occasionally lateral pelvis or CT scan of pelvis.

44. The child is at risk for what other injury?

a. Continued child abuse if no intervention is made.
b. Open-book fracture of the pelvis.
c. Diabetic neuropathy.
d. Same injury of contralateral hip.
e. Other connective tissue pathologies, such as aortic dissection.

QUESTIONS 45–49: An 18-month-old child presents with right-sided hip pain since a fall from a chair armrest the previous day. The child cried immediately and has refused to walk since the fall. He does not have fever, rash, swelling, or erythema. He holds his leg in normal anatomical position and does not seem to prefer any specific posture. He moves his hip as little as he can. He has normal reflexes and normal movement of the lower leg and contralateral leg. Pulses and cap refill are normal and symmetrical.

45. His history and presentation are most consistent with:

a. Cellulitis.
b. Simple fracture.
c. Comminuted fracture.
d. Dislocation.
e. Manipulation of his caretakers.

The child had AP, lateral, and oblique films of the pelvis and femur in the ER. The radiology resident and ER attending both viewed all films and saw no evidence of any pathology. These are the films:

46. What would be appropriate management at this point?

a. Closed reduction with conscious sedation in ER with outpatient orthopedic follow-up.
b. Reassurance.
c. Child psychology or psychiatric referral.
d. Outpatient orthopedic follow-up.
e. Consult police or children's protective service for abuse investigation.

After appropriate course in the ER, the patient followed up with an orthopedic surgeon, who reviewed the films and saw no pathology. He then ordered complete blood count (CBC), blood culture, erythrocyte sedimentation rate (ESR), ultrasound of the right hip, and a bone scan. The blood tests are normal.

47. What is the purpose of the ultrasound?

a. To detect joint effusion.
b. More sensitive than X-ray for dislocations.
c. More sensitive than X-ray for small fractures.
d. To examine ligamentous structures.
e. To evaluate testicular torsion.

48. What is the purpose of the bone scan?

a. To detect joint effusion.
b. More sensitive than X-ray for dislocations.
c. More sensitive than X-ray for small fractures.
d. To estimate growth rate of the bone marrow.
e. To estimate "bone age."

The ultrasound is normal and the bone scan showed slightly increased blood flow in a thin line along the length of the femur. A final, different oblique film is taken.

49. What is seen on this film?

a. Dislocation.
b. Salter-Harris fracture type V.
c. Salter-Harris fracture type II.
d. Salter-Harris fracture type I.
e. Small linear fracture.

QUESTIONS 50–53: *Patient A*: This is a 10-year-old male who was throwing a football with his friends in the morning while at a youth camp. He noted some shoulder pain following this, which worsened through the afternoon. The pain was not of sudden onset and it did not feel as if his shoulder popped out. He did not fall onto his shoulder and he was not struck in the shoulder by anyone. He was brought to the emergency department because of persistent pain and limited movement of his shoulder. He denied any numbness or tingling. His past history is unremarkable; specifically, it is negative for any fractures. Vital signs: temperature of 99.1°F, pulse 80, respiratory rate 18, blood pressure 120/70. He is alert and comfortable in no distress. His anterior left shoulder is swollen. The head of the humerus is prominent anteriorly. There is severe tenderness in this region. There is tenderness along the entire humerus. His clavicle is not tender. He is not tender over the elbow. Supination and pronation are intact. There is no visible deformity other than the shoulder. Pulses, perfusion, sensation, and finger movement are all intact distally. The remainder of his physical exam is unremarkable. The radiograph is presented in Fig. 1.

Patient B: In another case, a 9-year-old boy presents with severe shoulder pain after bumping his shoulder against a door as the door was closing. Radiographs are obtained (Fig. 2).

Fig. 1. Patient A.

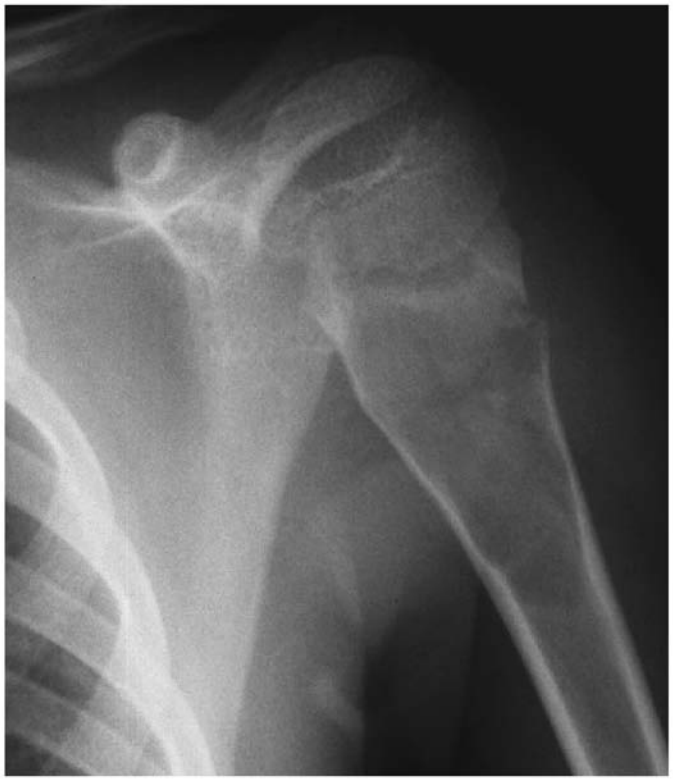


Fig. 2. Patient B.

50. The findings in Fig. 1 are which two of the following?
- a. Lytic unicameral bone lesion.
- b. Blastic unicameral bone lesion.
- c. Pathological fracture.
- d. Bone island.
- e. Acromioclavicular (AC) joint dislocation.
- f. Elevation of the periosteum.

51. The findings in Fig. 2 are which two of the following?
- a. Lytic unicameral bone lesion.
- b. Blastic unicameral bone lesion.
- c. Pathological fracture.
- d. Bone island.
- e. AC joint dislocation.
- f. Elevation of the periosteum.

52. Select whether the following properties are unicameral (U) or aneurysmal (A) bone cysts by placing a "U" or "A" on the line in front of each description.

____ a. Malignancy: clearly benign.
____ b. Malignancy: benign but difficult to distinguish from malignancy.
____ c. Location: proximal humerus and femur.
____ d. Location: proximal humerus, femur, and spine.
____ e. Effect on periosteum: elevates periosteum.
____ f. Effect on periosteum: no effect.

53. Classify the following diseases as causing either focal (F) or diffuse (D) weakness to bones by placing an "F" or "D" on the line in front of each description.

____ a. Osteogenesis imperfecta.
____ b. Neurofibromatosis.
____ c. Osteopetrosis.
____ d. Osteomyelitis.
____ e. Rickets.
____ f. Scurvy.
____ g. Metastatic lesions.

QUESTIONS 54–56: A 2-month-old male infant is brought to the ER at 10:30 PM with a chief complaint of crying and fussiness. His parents noted this since 9:00 PM when they returned home from shopping. His mother was carrying him in a padded fabric infant carrier over the front of her body. His mother was carrying a lightweight cardboard box as she opened the door to their home. When she turned on the house lights, the infant let out a scream and continued to cry inconsolably for a while. Initially, his parents thought that the light awoke him from a nap, although his crying seemed excessive. It was dark when they came through the door, so his parents are not sure if his arm was caught anywhere. Although he has calmed down since the incident, he still seems to be very irritable and uncomfortable. There is no history of fever, vomiting, or cold symptoms. Prior to 9:00 PM, he seemed to be fine. His past history is unremarkable. During various aspects of the exam, he is crying intermittently, but this appears to be a normal reaction to an examiner. The physical exam is generally within normal limits. His parents' concern appears to be sincere, but nothing is found on exam and his fussiness and crying seem to have resolved. His parents are told that his condition appears to be benign and perhaps he was having some abdominal cramps. The ER is very busy. His parents are told to wait in their assigned room for a 30-minute observation period, after which the physician would return for a reassessment. A later reassessment finds the patient to be active and alert, but his parents state that he still has occasional episodes of unusual crying. The possibilities of constipation and intussusception are discussed. There are no episodes of unusual crying witnessed. His parents are asked to report any crying to the nurses. An additional 1-hour observation period is planned. An hour later, the patient volume in the emergency department subsides. The patient's parents indicate that they fed him about 2 ounces, but he did not seem to feed with his normal vigor. He is now asleep while mother carries him. His abdomen is soft and nontender. His parents are instructed to check his abdomen periodically, as appendicitis may be a possible cause of his symptoms. His upper extremities are palpated and then his lower extremities are palpated. This time, crepitus is felt in his left thigh and the infant awakens crying. Radiographs of the left lower extremity are ordered (Figs. 3–5).

Fig. 3. Left lower extremity.

Fig. 4. Lateral of LLE.

Fig. 5. Upper extremities.

54. Is the history of this injury consistent with these radiographic findings?

a. Yes.
b. No.

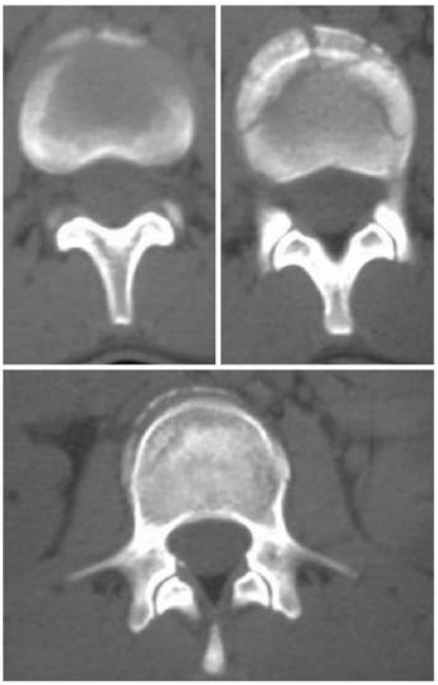
55. The family is informed that this case needs to be reported to child protective authorities. Should parents always be informed that a report to child protective authorities is about to be made?

a. Yes.
b. No.

56. If the radiologist noted the possibility of Wormian bones on the views of the skull (subtle finding not shown here) and also felt that the long bones were slightly demineralized, what is the likely underlying condition?

a. Hyperparathyroidism.
b. Hypoparathyroidism.
c. Cushing's syndrome.
d. Addison's disease.
e. Osteogenesis imperfecta.

QUESTIONS 57–61: A 16-year-old athletic female walked into the pediatric emergency department with a history of falling down 14 stairs, landing on her back. She complained solely of pain in the lower back. She denied any head trauma, loss of consciousness, vomiting, abdominal pain, or difficulty urinating. She had no past history of trauma to the back and had never been hospitalized. Exam found her to be alert and active but uncomfortable secondary to back pain. She is able to ambulate without any support. No neurological deficit is noted on neurological examination. On back examination, no focal tenderness over the lumbosacral spine was noted. There is mild to moderate tenderness over the right paraspinal region. There is no costovertebral angle tenderness, no abdominal tenderness; no bruises or ecchymosis. She is felt to have a soft-tissue injury of her back. Although there is a low suspicion for fracture, lumbosacral radiographs are shown along with a CT scan.



57. Which segment of the spine is most affected?

a. T12.
b. L1.
c. L2.
d. L3.
e. L4.

58. This type of fracture is best classified as a:

a. Translational fracture.
b. Flexion distraction fracture.
c. Chance fracture.
d. Burst fracture.
e. Compression fracture.

59. Ninety percent of all spinal fractures are in which of the following areas?

a. Cervical spine.
b. Thoracic spine.
c. Lumbar spine.
d. Thoracolumbar region.

60. Which of the following fractures is most associated with a lap seatbelt used in a high-speed automobile crash?

a. Translational fracture.
b. Flexion distraction fracture.
c. Chance fracture.
d. Burst fracture.
e. Compression fracture.

61. Although there are different models to describe the stability of the spine following an injury, the ___-column concept described by Denis in 1983 is the most accepted.

a. 1.
b. 2.
c. 3.
d. 4.
e. 5.

QUESTIONS 62–66: A 20-year-old male arrives ambulatory to the ER at 12:30 PM accompanied by friends. He is complaining of pain in his left forearm and hand. He states that he became drunk the previous night and fell off a barstool. He does not remember the event well. He awoke in the morning with pain in his left arm, from the mid-upper arm to his wrist. He complains that he cannot move his elbow, wrist, or fingers. He also complains that he has the sensation of pinpricks in his arm with decreased sensation, and numbness in his left hand. Exam: Vital signs were temperature 99.1°F, pulse 96, respiratory rate 20, blood pressure 158/89. He is generally alert, cooperative. and in no acute distress. Head, eyes, ears, nose, and throat are unremarkable. Heart is regular without murmurs. Lungs are clear. Abdomen is soft and nontender. There is no hepatosplenomegaly. In the left upper extremity, the AC joint and shoulder are nontender. His ability to move his fingers and wrist is minimal. His radial pulse is good. Capillary refill in the nailbeds is good. Pulse oximetry on all the fingers of his left hand demonstrates a good perfusion pulsation waveform. His forearm appears to be modestly swollen. The skin from his elbow to wrist is tense and warm with slight erythema and superficial peeling. No pallor is noted. Sensation in his wrist and hand is minimal. He also has a large patch of necrotic skin in the shape of a polygon over his left flank. You suspect compartment syndrome. Radiographs of his left forearm are obtained.

62. True or False? The presence of normal distal pulses rules out compartment syndrome.

a. True. b. False.

63. Of the "6 P's" used to clinically diagnose compartment syndrome, which three are the most reliable?

a. Pain.
b. Pulselessness.
c. Pallor.
d. Paresthesia.
e. Paresis.
f. Poikilothermia.

64. Of the following, what are the complications of compartment syndrome?

a. Loss of limb.
b. Permanent neuropathy.
c. Muscular infarct.
d. Renal failure.
e. All of the above.

65. True or False? The definitive therapy for compartment syndrome is diuresis.

a. True.
b. False.

66. Of the following two main pathways to increase intracompartmental pressure, what was the likely cause of this patient's compartment syndrome?

a. Increasing the fluid content within the compartment, either by hemorrhage or from edema.
b. Decreasing the compartment size, either by tissue constricture or by external compression.

QUESTIONS 67–73: A 17-year-old male presents to the emergency department 1 day after sustaining a "twisting" injury to his left ankle while playing soccer. The patient claims to have sustained a "twisted ankle" while he was running toward the goal. He does not recall exactly in which direction his ankle twisted. He did not feel or hear any "snaps," "pops," or "clicks." Although he was able to bear some weight on the ankle immediately after the injury, today he has much more pain and swelling about the anterior and lateral aspect of the affected ankle. Overnight he did not elevate the ankle, nor did he apply any ice to the injured ankle. He denies sustaining any other injuries and has not sustained any previous injury to his left ankle. This morning he is unable to walk on the ankle secondary to increased pain and swelling. On examination, he is barely able to bear any weight on the affected ankle secondary to pain. There is obvious swelling (without ecchymosis) to the anterior and lateral aspect of the ankle joint. Distally, his toes are pink, with brisk capillary refill and intact sensation to light touch. Tenderness can be elicited by palpation over the anterior aspect of the ankle joint (refer to Fig. 6, which is the ankle of a normal model and not of the injured patient).

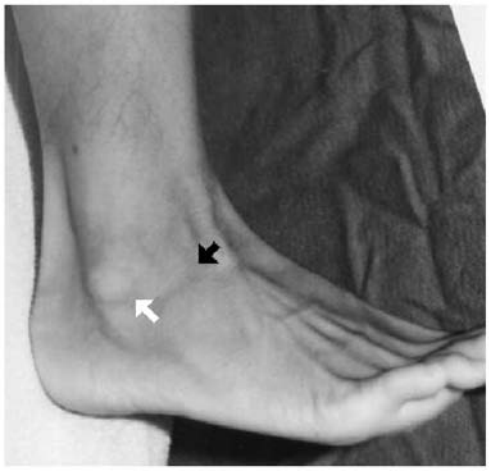


Fig. 6. Area of tenderness.

The black arrow in Fig. 6 points to the region of maximum tenderness. There is no tenderness along the inferior tip of the lateral malleolus or over the bony prominence of the lateral malleolus. There is no tenderness along the medial aspect of the ankle or along the proximal aspects of both the tibial and fibular shafts. The squeeze test over the distal tibia-fibula region does not produce any pain. Both the anterior drawer and talar tilt maneuvers are within normal limits when compared with the nonaffected ankle.

67. True or False? This patient has sustained a *typical* ankle sprain.

a. True.
b. False.

68. The typical mechanism of injury for the majority of ankle sprains sustained during sporting events is:

a. Dorsiflexion/eversion.
b. Plantar flexion/eversion.
c. Dorsiflexion/inversion.
d. Plantar flexion/inversion.
e. None of the above.

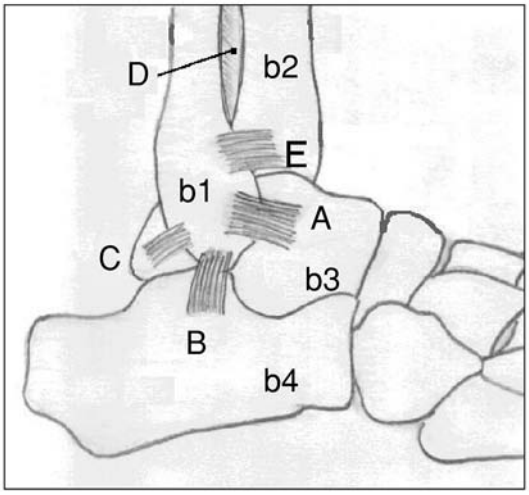


Fig. 7. Ankle anatomy.

69. Name the four bones (b1–b4) and the five ligaments (A–E) in Fig. 7.

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

70. Which ankle ligament is most commonly sprained during an inversion injury, and where on the ankle should one palpate to check for tenderness to this ligament?

a. Anterior talofibular ligament.
b. Calcaneofibular ligament.
c. Posterior tibiofibular ligament.
d. Intraosseous membrane.
e. Anterior tibiofibular ligament.

71. Describe the anterior drawer test; what structure in Fig. 7 does this maneuver test for?

72. Describe the talar tilt test. What specifically does this maneuver test for?

73. What is the syndesmosis, and how does one examine for possible syndesmotic injuries?

QUESTIONS 74–77: It is estimated that more than $500 million is spent each year on ankle radiographs. However the majority (up to 85%) of these radiographs are negative. In 1992, a Canadian study suggested the adaptation of the Ottawa ankle rules, which could be used to order ankle radiographs based on selected clinical criteria. (It is important to remember that this study excluded patients younger than 18 years of age. Therefore, because the Ottawa study did not include growth plate injuries, one should not strictly adhere to these rules when deciding whether or not to obtain a radiograph on a pediatric patient.) Based on these Ottawa ankle rules, clinical indications that would warrant a radiographic evaluation would include any one of the following criteria.

74. Which three of the following are clinical criteria that would warrant a radiographic examination of an injured ankle/foot?

a. Inability to bear weight both immediately after the injury and in the emergency department.
b. Bony tenderness over the posterior edge, tip or distal 6 cm of the lateral malleolus.
c. Tenderness over the navicular.
d. Tenderness over the base of the fifth metatarsal.
e. Excessive swelling.

75. What are the three standard radiographic views that are obtained on patients with ankle injuries?

_____

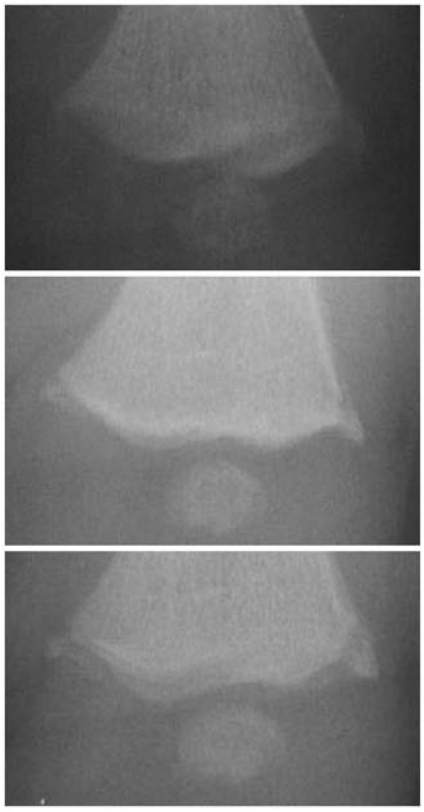
_____

_____

76. What is the finding in the following set of radiographs?

77. Does this patient require immediate orthopedic intervention or can he be sent home from the emergency department with an outpatient orthopedic referral?

QUESTIONS 78,79: This is a 2-month-old female who is brought to an acute care clinic for cough, runny nose, fussiness, and decreased movement of the left arm. The infant has mild nasal congestion, bilateral otitis media, and an angulated tender swelling in the left upper arm with minimal movement of the left arm. According to the mother, the infant cries a lot when she is dressed and has not been moving her arm for approximately 3 days. The mother also notes swelling, but is uncertain about the day of onset. She said that the father told her that while he was cleaning the house, he tripped over the infant's brother and accidentally stepped on the baby. She did not seek medical attention earlier because she thought the arm was just sore from the incident. The left distal femur metaphysis is shown here on the left (three images are displayed). The top image was taken on the day of presentation to the emergency department, the middle image taken 2 days later, and the bottom image taken 9 days later. The image on the right is the patient's left upper extremity.



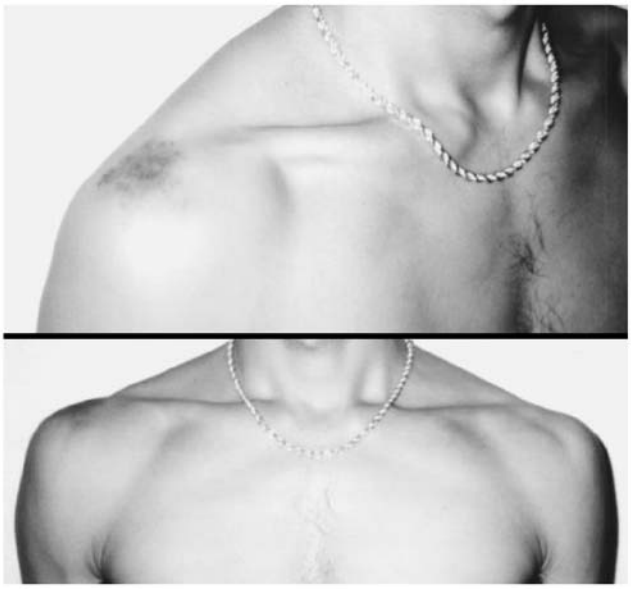
78. What is your interpretation of the patient's left distal femur?

79. What is your interpretation of the patient's left upper extremity

QUESTION 80: This is a 9-month-old who was brought to an acute care clinic after the child's babysitter, who was caring for him at the time, noted something wrong with the infant's arm after a toy was pulled away from him. (The mother was working at night.) Physical exam reveals a 9-month-old male, approximately 50th percentile for height and weight. A bruise at the lateral edge of the left eye and bruise of the left pinnae are noted. The child is clinging to the mother, quite apprehensively. The right elbow shows 2+ swelling. The child is reluctant to move the right elbow because of pain. The sensation and circulation to the hand appear normal. Above the right elbow, ecchymosis is noted anteriorly and posteriorly. No definite crepitus is detected. The infant holds the right elbow in full extension. Any flexion beyond 10 to 15° results in pain, with the child crying. Here is a composite radiograph of the patient's right elbow.

80. Describe your impression of the radiograph and its possible relationship (if any) to child abuse. Describe the typical fractures that are indicative of abuse.

QUESTIONS 81–89: An 18-year-old surfer presents to the emergency department complaining of right upper shoulder pain. He states that the tip of another surfer's board struck him on the top of his shoulder while he was paddling out to catch a wave. He immediately felt a pop when the surfboard struck his shoulder and states that he had difficulty paddling back to shore, secondary to the pain. He denies any other trauma to his head, neck, or chest. He also denies any paresthesias of his left hand. Upon presentation to the ER, he prefers to hold his right arm adducted against his body. Inspection of the right shoulder region is only significant for superficial abrasions and mild erythema over the superior aspect of the shoulder joint without any obvious swelling or deformity.



The angle (contour) of the right shoulder appears symmetric when compared with the left shoulder (i.e., there is no obvious drooping of the affected shoulder). There is no fullness or tenderness in the deltopectoral groove. There is no tenderness over the humeral head or neck. With the right arm in the adducted position, he is able to fully internally and externally rotate the right arm without any exacerbation of the shoulder pain. Palpation of the clavicle does not reveal any crepitus or obvious fractures. His distal neurovascular examination is intact.

81. Name the two ligaments that support the AC joint.

_____

_____

82. Describe the two most common mechanisms of injury that can cause an AC injury.

_____

_____

83. True or False? If the line connecting the inferior border of the distal clavicle to the inferior border of the acromion process is malaligned, this is by definition a type III AC separation.

a. True.
b. False.

84. True or False? Stress views are always required to radiographically confirm the diagnosis of a type III AC separation.

a. True.
b. False.

85. What is the most likely diagnosis based on the above history and clinical examination?

86. What radiographic view(s) would you obtain to confirm your clinical diagnosis?

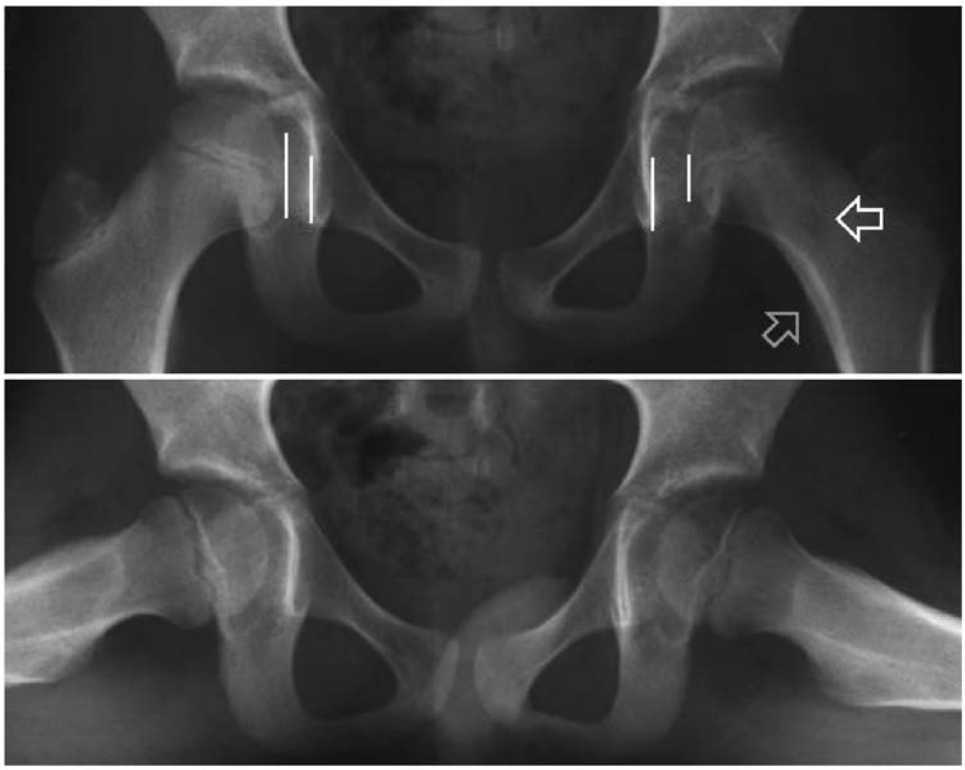
87. What is your radiological diagnosis?

88. You would classify this type of AC injury as which of the following separation types?

a. Type I.
b. Type II.
c. Type III.

89. How should this type of injury be treated?

QUESTION 90: This is a 7-year-old male who is seen in the acute care clinic with a history of recurrent pain in his left thigh for 3 months. He has seen his primary care physician on two occasions. Initially, this pain would awaken him at night, but it would subside on its own. He then began to complain of pain during the day. He was given acetaminophen without relief. His primary care physician prescribed ibuprofen, and this helped to relieve the pain temporarily. However, the pain continued to worsen and his parents decided to bring him to an acute care clinic after he complained of the pain all day in school. There is no history of fever, trauma, or pains in other bones or joints. On physical exam, vital signs are temperature of 98.6°F (oral), pulse 88, respiratory rate 28, blood pressure 100/50. He is of average height and weight. He is able to ambulate well, with a slight nonspecific limp to his gait. He complains of some pain while walking. He continues to complain of pain while he is sitting at rest. He localizes his pain by pointing to his proximal thigh. There is no position of comfort that completely relieves him of pain. His left hip has a diminished range of motion due to moderate tenderness. There is some tenderness on palpation to the hip joint, but it is not severe. There is no tenderness over his mid- and distal femur. His heart, lungs, and abdomen are unremarkable. His other joints are unremarkable. There is no lymphadenopathy. Radiographs of his hips are shown: AP (upper image) and frog (lower image).



90. The radiologist identifies some abnormalities as shown. Describe the significance of the white arrow, gray arrow, and vertical white lines.

QUESTIONS 91–96: The following CT scan and X-rays are from patients with a diagnosis of osteoid osteoma (Figs. 8–10).

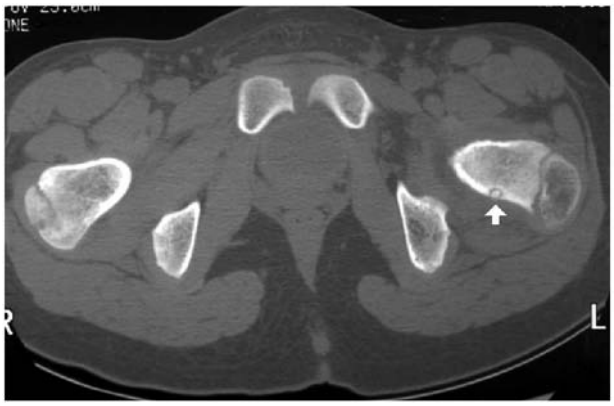


Fig. 8. CT of pelvis.

Fig. 9. AP of L hip.

Fig. 10. Frog-leg of L hip.

91. True or False? Preteens are more likely to get osteoid osteoma than adolescents.

a. True.
b. False.

92. True or False? Males are 10 times more likely to get osteoid osteoma than are females.

a. True.
b. False.

93. True or False? Aspirin relieves the pain associated with osteoid osteoma better than ibuprofen.

a. True.
b. False.

94. True or False? Osteoid osteoma has malignant potential.

a. True.
b. False.

95. True or False? Treatment always requires surgical intervention.

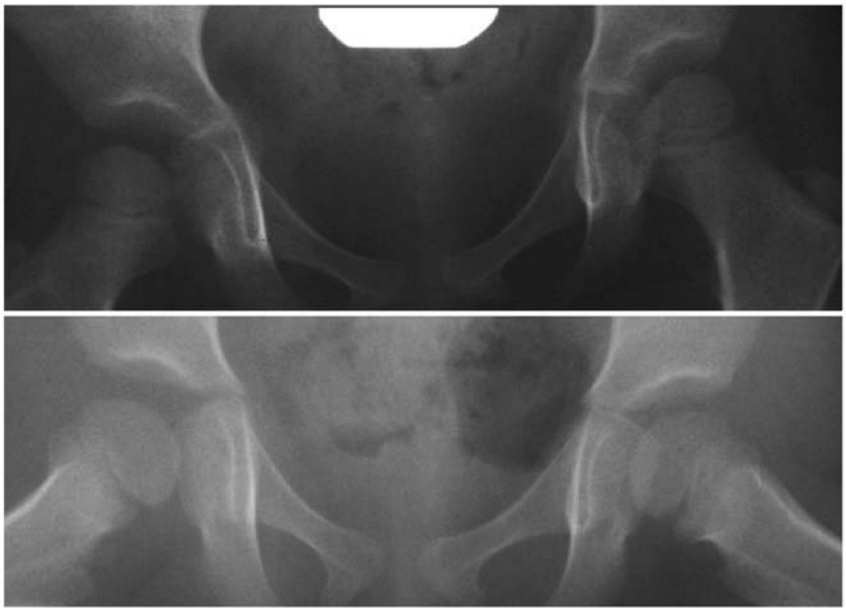
a. True.
b. False.

96. True or False? The classic findings for this condition are a well-defined, round (or oval) radiolucent lesion with a surrounding reactive sclerosis.

a. True.
b. False.

QUESTIONS 97–101: This is a previously healthy 4-year-old female who is brought to the emergency department by her mother because of fever and right leg pain since the previous night. The patient stated that she had been swimming the previous day, and had slipped in the pool, twisting her right leg. Immediately after that, however, she was able to walk around easily without pain. Later that night she developed a fever (temperature not measured), and her right leg began to hurt. She was taken to the ER because she had difficulty walking. She was diagnosed with a hip sprain and was sent home on ibuprofen. Her fever and leg pain worsened to the point that she was no longer able to ambulate, prompting a return to the ER. The exam shows temperature of 105.3°F, pulse 164, respiratory rate 40, blood pressure 139/84. She is anxious and in obvious discomfort, although she appears alert and nontoxic. She prefers to keep her right hip abducted and externally rotated, with the right knee flexed. She refuses to bear any weight on the right leg. Range of motion of the right hip is severely limited, especially internal rotation, adduction, and extension. The overlying skin is warm but not erythematous. Examination of the remainder of the right lower extremity, the left lower extremity, and spine are within normal limits.

Laboratory results are as follows: white blood cell 31,700 with 4% bands, 85% segs, 6% monos, and 5% lymphs. Hemoglobin 12.4; hematocrit 35.4; Platelet count 394,000; C-reactive protein 8.2; ESR 39. Hip radiographs were obtained. She is immediately given IV ceftriaxone and is started on an infusion of vancomycin.



Think about the most likely diagnosis at this time. Her general appearance shows her preferred position of comfort with her hip in external rotation.

97. What are your top three differential diagnoses?

98. What three organisms are the most common causes of septic arthritis?

99. True or False? The absence of joint space widening can be relied on to rule out septic arthritis.

a. True.
b. False.

100. True or False? Ultrasound is the most effective study in demonstrating the presence of a joint effusion acutely.

a. True.
b. False.

101. For children, is a septic joint more likely from direct inoculation or hematogenous spread?

QUESTIONS 102–106: A 20-month-old female is brought to the emergency department by her parents at about 9:00 PM with a complaint that she will not stand on her right leg since earlier this evening. Parents are unsure of any trauma. When she cries, her parents think that her pain is originating from her knee. There is no history of fever or prodromal symptoms, and there is no history of previous injuries. Her parents report that she is able to walk, but with a limp. Her past medical history is significant only for wheezing. Exam shows temperature of 98.6°F, pulse 127, respiratory rate 24, blood pressure 113/79, weight 28.2 lb. She is apprehensive on approach but alert and otherwise comfortable in no acute distress. Head, ears, eyes, nose, and throat are within normal limits. Neck is supple. Heart is regular without murmurs. Lungs are clear. Abdomen is soft, flat, nontender, with bowel sounds and no masses. Color and perfusion are good. Extremities show good range of motion of all joints, no deformities or effusions. No erythema, warmth, or abrasions are present. No definite area of tenderness can be determined on exam. On observing her gait, it is seen that she will not fully bear weight on the right leg. She takes a few steps, walking very slowly with a limp. Some laboratory studies are obtained. A blood culture is drawn. CBC, white blood cell 14.7, 29% segs, 66% lymphs, hemoglobin 13.3, hematocrit 36.7, platelets 494,000, ESR 23. Radiographs of both lower extremities are obtained. Although radiographs of hips, femurs, tibias/fibulas, and feet were actually obtained, only her right tibia/fibula radiographs are shown in Fig. 11.

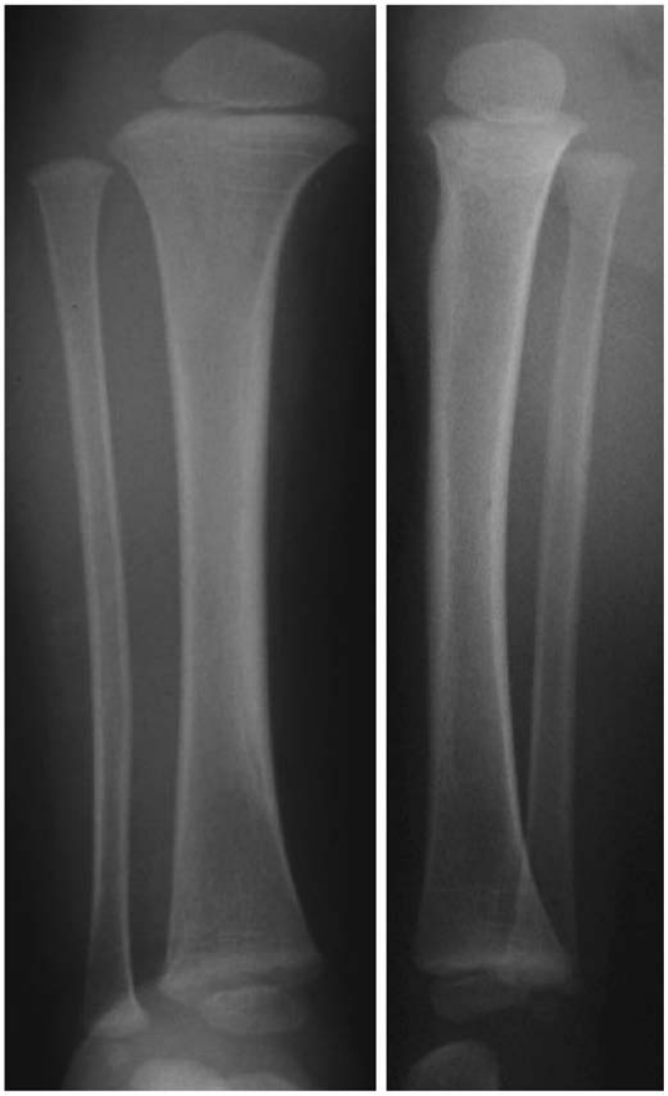


Fig. 11. Right tibia/fibula X-rays

AP and oblique views of the tibia and fibula are shown, as part of a lower extremity series (includes hips and femurs as well). A true lateral view of the tibia and fibula was not obtained. The lateral and oblique views failed to show any definite abnormalities. Only the AP view of the tibia is shown here.

102. What is your interpretation of this film?

103. True or False? With no known history of trauma, there is high suspicion of abuse injury in this child.

a. True.
b. False.

104. Name three medical conditions that predispose bones to fractures that can be mistaken for abuse.

105. Which of the following vitamins, either in excess or deficiency, predispose bones to fractures?

a. Vitamin A.
b. Vitamin D.
c. Vitamin E.
d. Vitamin K.
e. Vitamin C.

106. True or False? In order to best care for children, it is always reasonable to raise the issue of abuse early in the treatment of children with fractures and consult child welfare personnel.

a. True.
b. False.

QUESTIONS 107–109: This is a 15-year-old male who presents with left hip pain for 1 hour. He was sprinting during a track and field meet. He experienced a sudden pain in his left hip while running through a turn to the left. He noted cramping in his left leg as well. He denies falling onto his hip. His pain is now somewhat better, and he is able to stand. He reports a 1-week history of suffering from a left hip strain. He has been doing stretching exercises and applying ice to his hip. His past history is unremarkable. Vital signs are as follows: temperature of 99.1°F (oral), pulse 90, respiratory rate 18, blood pressure 128/69, weight 129.8 lb. He is of slim build and normal stature. He is alert and in no distress. He is able to stand. There are no signs of external trauma, such as abrasions or bruises. He has some tenderness to palpation of his left hip. His internal and external rotation about the hip are normal, and there is minimal pain. Most of the pain is elicited with flexion of his hip. His flexion is limited to approximately 45°. There is no warmth about the hip noted. There are no deformities or tender areas along the long bones. Neurovascular testing distally is normal. Radiographs of his hips are obtained.

107. What is your interpretation of the film?

108. Which attachment site is involved (anterior–inferior iliac spine, anterior superior iliac spine, or the ischial tuberosity)?

109. True or False? This type of injury can usually be treated on an outpatient basis with crutches, analgesics, and modified activity.

a. True.
b. False.

6 CT Scan Review

The following chapter will focus on the review of CT scans. Pertinent questions, answers, and rationale will be reviewed.

Key Words: Brain; parenchyma; hemorrhage; hydrocephalus; intracranial pressure.

QUESTIONS 1–5: A 2-year-old boy was brought to the emergency department for evaluation. The child's mother stated that approximately 45 minutes earlier, the child fell off a couch onto a tile floor. The child's mother reports that the child cried immediately after the fall then stopped crying, but is now less active and more quiet than usual. There is no history of loss of consciousness. The mother is extremely agitated and demands her child to have a head CT.

1. The correct interpretation of the above head CT is as follows:
   a. Right parietal epidural hematoma.
   b. Left parietal epidural hematoma.
   c. Right frontal epidural hematoma.
   d. Left frontal epidural hematoma.
   e. Right frontal subdural hematoma.

2. What finding on the head CT distinguishes this diagnosis from others?
   a. A lenticular (football-shaped) hypodense (dark) hemorrhage.
   b. As the bleeding expands, the dura bulges inward, giving it the biconvex or lens-shaped appearance.
   c. Generally crosses the suture lines.
   d. Does not extend across the venous sinus crossing the midline.

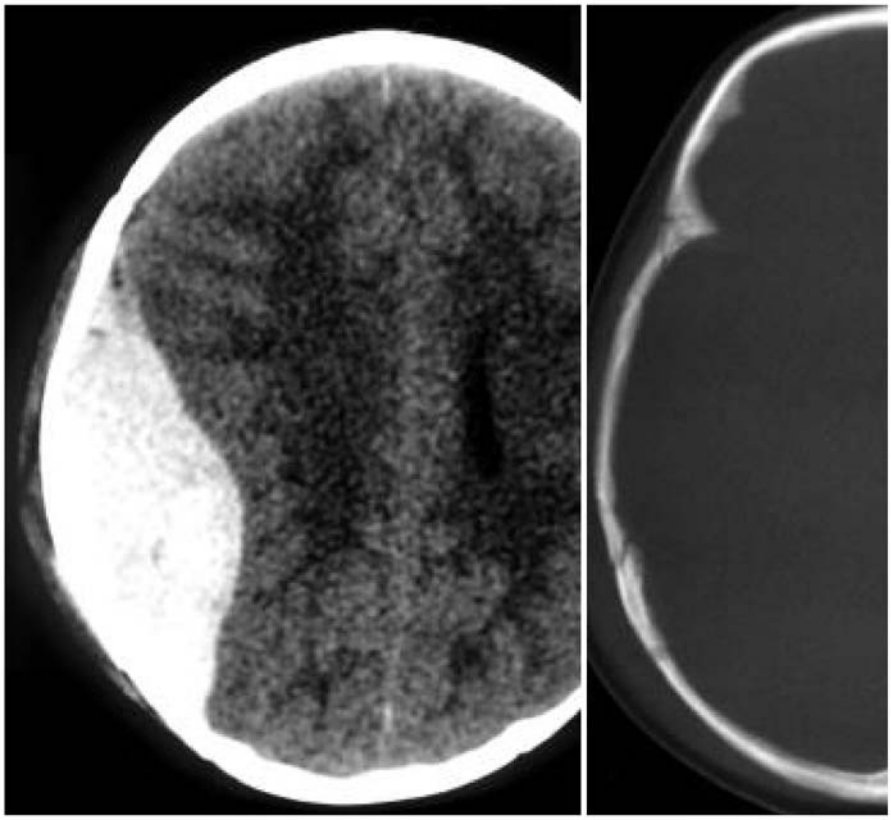
3. The following are characteristics of the diagnosis in question:
   a. Common injuries that can occur after minor trauma.
   b. Falls from heights less than 5 feet are associated with subdural bleeds in children 5 years or younger.
   c. Hemiparesis and seizures are early findings.
   d. Patients will rarely have associated vomiting and headache.
   e. Early identification is key for improved outcome.

4. The classic description that correlates with this child's diagnosis is as follows:
   a. No mental status deterioration; requires only supportive care.
   b. Presents with the complaint of a syncopal episode.
   c. Brief loss of consciousness followed by a lucid interval.
   d. Usually develops shock due to significant blood loss.
   e. Signs of increased intracranial pressure are usually present initially.

5. While this patient is under your care in the emergency department (ED), the patient's mental status changes abruptly. Which of the following answers is most *inaccurate* for this scenario?
   a. Consciousness becomes altered as the patient's intracranial pressure increases.
   b. The patient's ipsilateral pupil may dilate.
   c. Surgical drainage is not an option until the patient begins to seize.
   d. A stat neurosurgery consult is always required with this patient's CT finding.
   e. Subsequent clinical deterioration is relatively uncommon.

From: *Pediatric Radiology Review*
Edited by: M. D. Pappas, L. G. Yamamoto, and A. Okechukwu © Humana Press Inc., Totowa, NJ

QUESTIONS 6–10: A 9-month-old female is brought to your emergency department with history of closed head trauma yesterday. The mother stated that the child has been well until recently, when she developed increasing lethargy and emesis. The child has not seen any medical personnel prior to this visit. It is apparent on examination that the child has a right-sided scalp hematoma. You immediately order a head CT.



6. The correct impression of the child's head CT is:

a. Right temporoparietal epidural hematoma.
b. Left temporoparietal epidural hematoma.
c. Right temporoparietal subdural hematoma.
d. Left temporoparietal subdural hematoma.
e. Right occipital epidural hematoma.

7. What other findings are apparent on this head CT?

a. Right midline shift with compression of the right lateral ventricle.
b. A depressed left parietal skull fracture overlying the hematoma.
c. Left midline shift with compression of the right lateral ventricle.
d. A nondepressed right parietal skull fracture overlying the hematoma.
e. b and c.
f. c and d.

8. Which of the following statements is inaccurate regarding children and head injuries?

a. Head injuries are the most common cause of traumatic death in children.
b. The main causes of head injury in children include falls, motor vehicle accident, pedestrian accidents, and bicycle injuries.
c. Motor vehicle accidents are the most common cause of traumatic death from head injuries.
d. It is more of a challenge when treating head-injured adults than head-injured children in identifying the more acute from the stable patients.

9. Choose the inaccurate anatomical consideration that predisposes children to head injuries:

a. Large head-to-body ratio.
b. A relatively weak neck.
c. A thinner skull.
d. A smaller subarachnoid space.

10. The following is true regarding scalp hematomas:

a. Scalp lacerations usually do not need any medical attention.
b. The presence of a scalp hematoma has an association with an underlying linear skull fracture in infants.
c. Diagnostic imaging is not recommended for infants with an obvious scalp hematoma.
d. A leptomeningeal cyst is a very common complication of a skull fracture.

QUESTIONS 11–15: A 21-month-old child presents to the emergency department with unexplained vomiting and lethargy. The father states that the child has been living with the father's estranged wife since their separation a month ago. He was recently granted weekend visiting privileges. When the father picked the child up that morning, he noticed the child to be limp, and not active or playful. The father was quite concerned, especially knowing that the child had been under the care of the mother's new boyfriend while she was at work. On examination, you notice extreme tenderness over the child's left clavicle and left distal arm. In addition to a head CT, you order radiographic films to rule out a clavicular fracture and a radial and/or ulnar fracture.

11. What is the correct interpretation of this X-ray?

a. An acute subdural hematoma in the left frontotemporal region.
b. An acute subdural hematoma in the right frontotemporal region.
c. A chronic subdural hematoma in the left frontotemporal region.
d. A chronic subdural hematoma in the right frontotemporal region.
e. An epidural hematoma in the right frontotemporal region.

12. What other significant findings are seen in this head CT?

a. Compression of the right lateral ventricle with shift of the midline structures from right to left.
b. Compression of the left lateral ventricle with shift of the midline structures from left to right.
c. No midline shift.
d. A lenticular shape hematoma that is classically described with the finding in question.

13. A common cause of this child's most likely diagnosis is:

a. Severe acceleration–deceleration trauma.
b. Direct trauma.
c. Shaking injury.
d. a and b only.
e. a, b, and c.

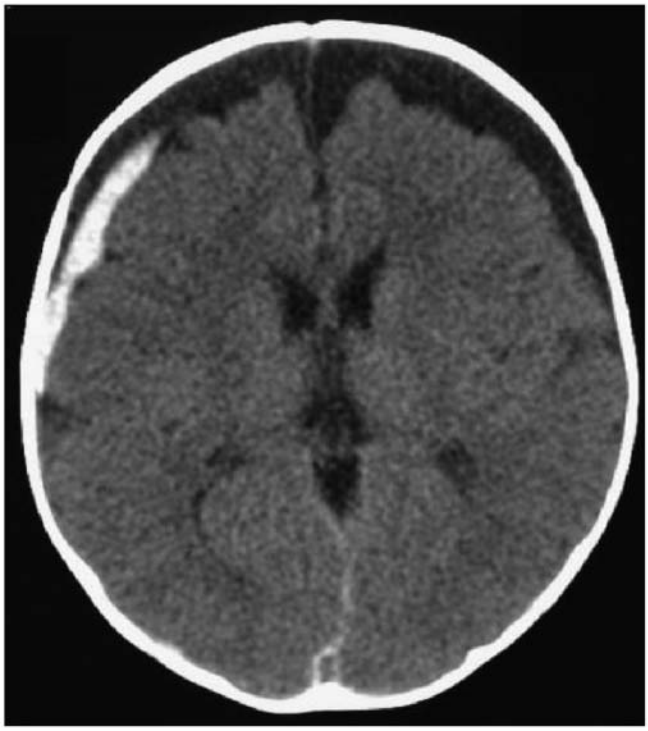
14. The following are characteristics of the diagnosis in question:

a. The brain tissue is not significantly injured, as the bleeding originates outside the brain parenchyma.
b. This is not a medical emergency.
c. The classic CT finding will show a crescent-shaped hyperdense (white) hemorrhage.
d. Evacuation of the clot is necessary to reverse the primary damage on the brain parenchyma.
e. The blood accumulates in the subarachnoid space.

15. When a child presents with unexplained vomiting and lethargy, what must be included in your differential diagnosis?

a. Possibility of child abuse.
b. Nonaccidental trauma.
c. Shaken baby syndrome.
d. All of the above.

QUESTIONS 16–20: You are summoned to the pediatric trauma bay to care for a 4-month-old child whom the paramedics recently brought in for respiratory failure. The babysitter stated she called 911 when she noticed the child's face turning blue. The babysitter was quite frantic and stated that she didn't mean to hurt the child; she stated, "Little Joey just wouldn't stop crying." The child was intubated in the field and now remains in your care. One of the pertinent physical findings on exam is retinal hemorrhages. You immediately order a head CT in addition to blood work.



16. The correct reading of this child's head CT is as follows:

a. An acute right temporoparietal subdural hematoma.
b. An acute left temporoparietal subdural hematoma.
c. An acute right frontal subdural hematoma.
d. An acute left frontal subdurual hematoma.
e. An acute right frontal epidural hematoma.

17. What other finding on the CT gives clue to the etiology of this child's illness?

a. A small amount of blood in the right ventricle.
b. A small amount of blood in the left ventricle.
c. A small amount of blood in the interhemispheric fissure posteriorly.
d. A small amount of blood in the interhemispheric fissure anteriorly.

18. The physical findings in infants with the diagnosis in question include:

a. Lethargy, poor sucking, and irritability.
b. Rhythmic eye opening and deviation.
c. Decerebrate or decorticate posturing.
d. Full fontanel and seizures.
e. All of the above.

19. The diagnosis in question may have which of the following associated brain injuries:

a. Retinal hemorrhage.
b. Acute and/or subdural hemorrhage.
c. Subarachnoid hemorrhage.
d. Interhemispheric blood.
e. All of the above.

20. Infants are prone to these types of injuries because of which of the following reasons?

a. Lower water content of the brain.
b. Good neck control.
c. Proportionally larger body size.
d. More demyelinated nerve cells.

QUESTIONS 21–25: A 5-year-old girl is brought to the emergency department after falling off a swing and hitting her head on the cement. The mother stated with confidence that there was no loss of consciousness and her behavior since the accident has been normal. After a thorough history is taken and the appropriate physical examination performed, you discuss with the mother options for this child's treatment plan.

21. The best diagnostic choice(s) in this case is/are:

a. Skull radiograph.
b. No radioimaging.
c. Cranial CT scan.
d. Cranial MRI.
e. Cranial ultrasonogram.

22. What treatment options are most indicated for this child?

a. Observation in the clinic, office, ED, or at home by a competent caregiver.
b. Observation in the clinic, office, ED, or at home by the 12-year-old babysitter.
c. Immediate neuroimaging to improve this patient's outcome.
d. Immediate skull radiographs because of their proven role in the evaluation of closed head injuries.

23. If this same child presented to your ED with a history of brief loss of consciousness, how would your treatment plan change?

a. A complete history and physical examination are unnecessary for this child.
b. There is a limited need to perform a complete neurological examination.
c. Immediate use of skull radiographs for the initial management of this child.
d. Cranial CT would also be used, in addition, to close observation of the child.
e. Call for a stat neurosurgical consult.

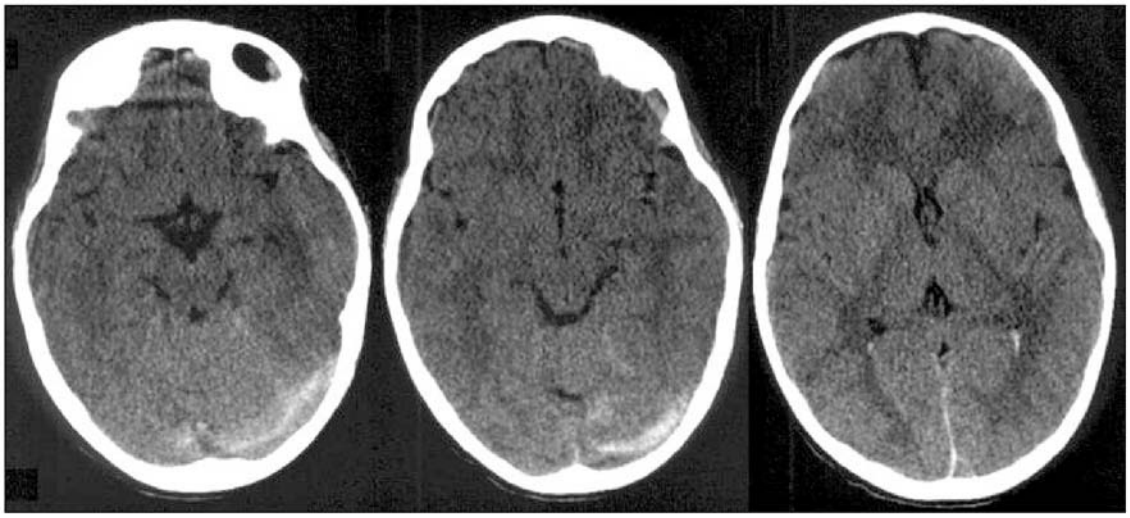
24. Which of the following is a correct statement regarding children with closed head injuries?

a. It is easy to distinguish, clinically, children with intracranial injury from children without such injury.
b. Nonspecific signs, such as vomiting and headache, are of limited predictive value of an intracranial injury.
c. All children with intracranial injury following a closed head injury will present exactly the same.
d. The most inaccurate means of detecting intracranial injury would be neuroimaging.

25. Which of the following is the *inaccurate* statement regarding the disposition of children with minor closed head injury?

a. Children who remain neurologically intact after minor closed head injury are at very low risk for deterioration in their condition.
b. Parents are instructed to have a high level of suspicion for any change in the child's actions up to several days following the insult.
c. The parents are instructed to wait until morning to have the child evaluated by a practitioner if they see any change in the clinical status.
d. All children should be discharged with a competent guardian who has access to adequate transportation.

QUESTIONS 26–30: A 6-year-old male presents to the pediatric urgent care center after colliding with a moving van while riding his bicycle. The father stated that the child was wearing his helmet, but was a bit dazed for approximately 30 seconds following the incident. Since the accident, the child is complaining of a headache, nausea, and vomiting. The patient's examination findings include nuchal rigidity with a depressed mental status. After assessing the stability of the patient's status, a noncontrast head CT is ordered.



26. The correct reading of this head CT is as follows:
- a. Subarachnoid hemorrhage in the posterior fossa, left greater than right.
- b. Subarachnoid hemorrhage in the posterior fossa, right greater than left.
- c. Epidural hemorrhage in the posterior fossa.
- d. Epidural hemorrhage in the anterior fossa.

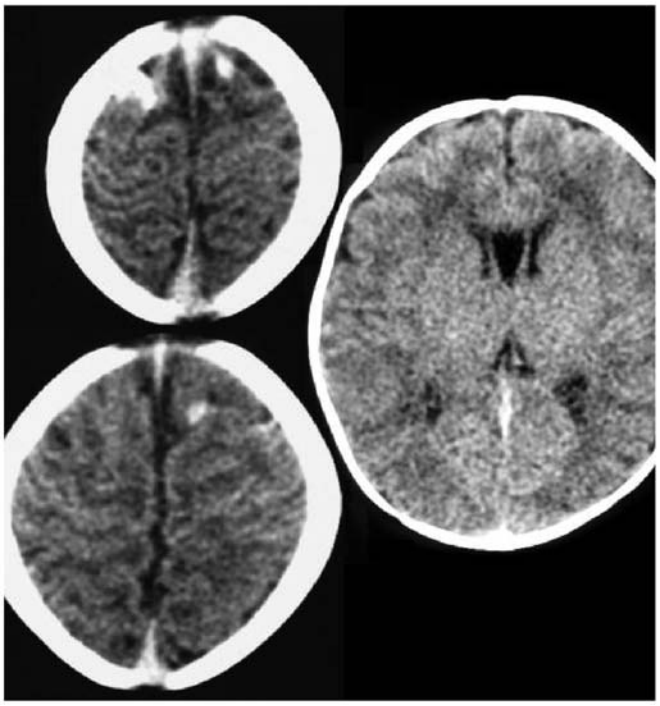
27. What other location is blood noticed on the head CT?
- a. The occipital horns of the medial ventricles.
- b. The occipital horns of the lateral ventricles.
- c. The fourth ventricle.
- d. The third ventricle.

28. Which of the following statements is true regarding the acute finding in the head CT above?
- a. A very rare finding after an acute head injury.
- b. The bleeding is usually arterial rather than venous in origin.
- c. Ruptured berry aneurysm is an uncommon cause.
- d. A result of severe blunt trauma to the head or as a result of significant shear forces.
- e. Results from the tearing of the large vessels of the dura mater.

29. Which is the *incorrect* statement regarding the clinical manifestation of the finding in question?
- a. The patients may present with a wide range of symptoms.
- b. Seizures are reported in 20% of the cases.
- c. Patients with the isolated finding usually present with a headache and mild meningeal signs.
- d. CT scans will generally be diagnostic for the finding 6–8 hours or more after the injury.

30. All of the following are true of the features on head CT of the finding in question except:
- a. Usually supratentorial.
- b. Usually does not cross the midline.
- c. Frequently seen in conjunction with traumatic subdural and epidural hematomas.
- d. Resolves spontaneously.
- e. Does not migrate into the cortical sulci and fissures.

QUESTIONS 31–35: As the physician on call, you are asked to evaluate a newborn infant who was recently delivered vaginally with the assistance of forceps after a prolonged labor. Three hours after delivery, the infant began to breastfeed, at which time the mother noticed the infant's body in extreme hyperextension. You perform a complete physical examination without any remarkable findings, with the exception of posturing with tactile stimulation. The posturing is described as the infant's head and heels bent backward with the body bowed forward. The following are the vital signs that were assessed in your presence: weight 7.7 lb, heart rate 140, respiratory rate 35, oxygen saturation at 100% on room air, and a temperature of 98.6°F. At this time you initiate a full sepsis workup in addition to ordering a head CT.



31. What is the correct impression of the head CT?

a. Unilateral parietal subarachnoid and subdural hemorrhages.
b. Unilateral frontal subarachnoid and subdural hemorrhages.
c. Bilateral parietal subdural hemorrhages.
d. Bilateral frontal subarachnoid and subdural hemorrhages.
e. Bilateral parietal epidural and subarachnoid hemorrhages.

32. The following are true in neonates regarding the finding in the head CT except:

a. Associated with birth trauma and perinatal asphyxia.
b. Risk factors include prolonged second stage of labor, precipitous labor, and forceps delivery.
c. May be as a result of a bleeding diathesis.
d. May be associated with arteriovenous malformations.
e. More often seen with vacuum extraction versus the use of forceps.

33. The posturing referred to in this case is referred to as:

a. Decerebrate posturing.
b. Opisthotonic posturing.
c. Decorticate posturing.
d. Reflex extension posturing.
e. Reflex flexion posturing.

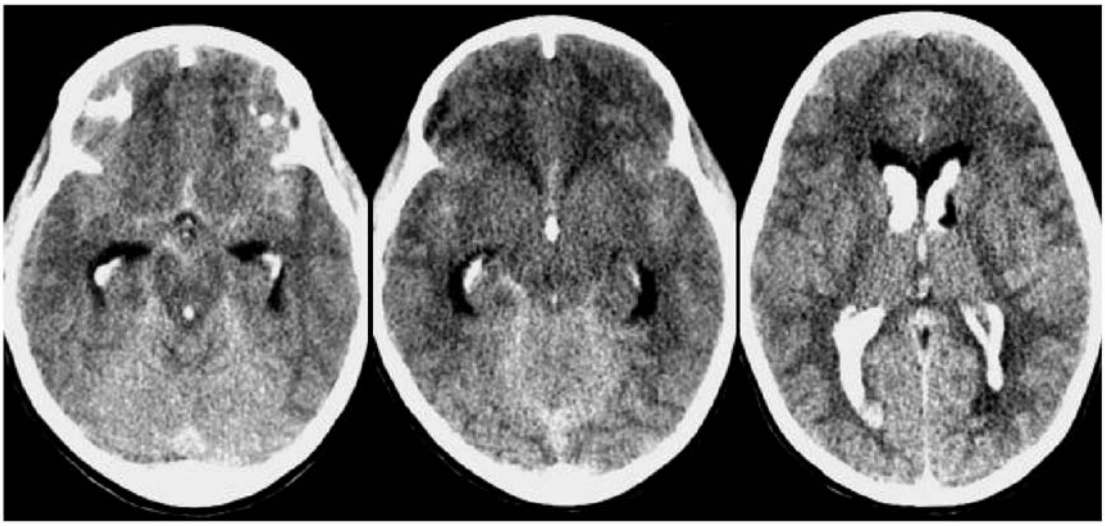
34. Causes of the above-mentioned posturing include which of the following?

a. Intracerebral or intraventricular hemorrhage.
b. Kernicterus.
c. Tuberous sclerosis.
d. Neonatal tetanus.
e. All of the above.

35. Which of the following findings from a *nontraumatic* lumbar puncture can help diagnose a subarachnoid hemorrhage?

a. Decreased protein levels.
b. Increased protein levels.
c. Minimal red blood cells.
d. Xanthochromia in the cerebrospinal fluid supernatant.
e. b and d.

QUESTIONS 36–40: While you are working in the ED, paramedics arrive while ventilating a patient using the bag valve mask. Paramedics were called to the local middle school for an unresponsive previously healthy 11-year-old girl. The school nurse reported that the child had complained of a headache all morning. She vomited twice and then became unresponsive, at which time 911 was called. When she arrived in your ED, you first notice her extensor posturing. Immediately you establish a definitive airway utilizing rapid sequence induction. Her vital signs remain stable. The remarkable physical findings include her extensor posturing, in addition to the sluggish reactivity of her pupils. You immediately call for a noncontrast head CT.



36. What is the correct impression on the above head CT?

a. Severe bilateral epidural hemorrhage.
b. Severe bilateral subdural hemorrhage.
c. Severe unilateral epidural hemorrhage.
d. Severe unilateral subdural hemorrhage.
e. Severe bilateral intraventricular hemorrhage.

37. What additional findings are noticed on the head CT?

a. Ventricular dilation.
b. Obliterated suprasellar cistern.
c. Obliterated quadrigeminal cistern.
d. All of the above.
e. None of the above.

38. All of the following are true of the workup for pediatric patients with abnormal neurological findings except:

a. The purpose of a diagnostic workup is to identify the true etiology.
b. The initial evaluation includes obtaining a thorough history.
c. Identifying reversible causes of neurological deficits can be postponed.
d. Emergent neuroimaging in necessary, but only after the airway is stabilized.
e. Never delay performing a complete neurological examination.

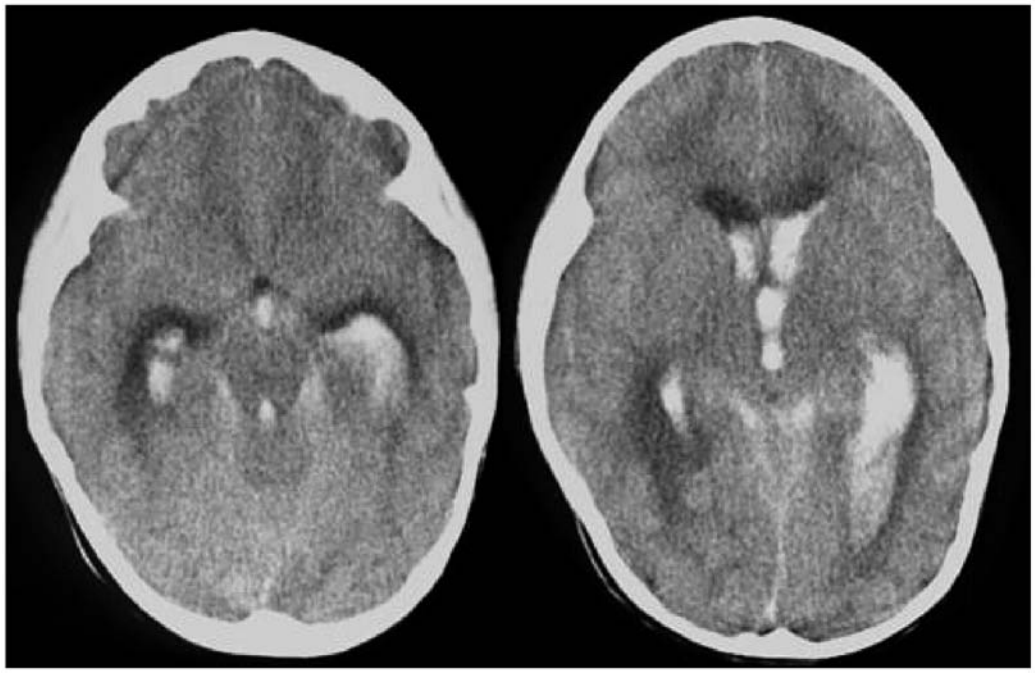
39. The following are true regarding neuroimaging in pediatric patients with neurological deficits:

a. Emergent CT is useful to rule out acute hemorrhage.
b. Obtaining an MRI is more readily available then that of a CT.
c. CT is more reliable than MRI for definitive anatomical abnormalities.
d. CT requires more time and a greater chance of the need of sedation than MRI.

40. Which statement is correct regarding the features of children with suspected childhood stroke?

a. Children present quite commonly to the ED with acute loss of function.
b. The early presentation of cerebrovascular disease in children can be subtle.
c. It is not essential to identify the cause of cerebrovascular disease.
d. When childhood stroke is suspected, no further diagnostic workup is necessary.

QUESTIONS 41–45: Following a head injury, a 4-year-old girl was brought to the emergency department with history of vomiting and a severe headache. The patient was poorly responsive, with a Glasgow Coma Scale of 6, prompting the need for immediate airway protection. Once a definitive airway was obtained, a noncontrast head CT was immediately ordered.



41. The correct impression of the child's head CT is:

a. Bilateral subdural hemorrhage.
b. Bilateral epidural hemorrhage.
c. Bilateral intraventricular hemorrhage.
d. Bilateral subarachnoid hemorrhage.
e. Bilateral interparenchymal hemorrhage

42. While in your ED, the child begins to show signs of seizure activity. What is the drug of choice to treat the active seizure?

a. Atropine.
b. Lidocaine.
c. Magnesium.
d. Benzodiazepine.
e. Lasix.

43. What is the goal of management of head injury in children?

a. To prevent secondary injury to the brain.
b. To prevent hypoxia.
c. To prevent ischemia.
d. To control intracranial pressure.
e. All of the above.

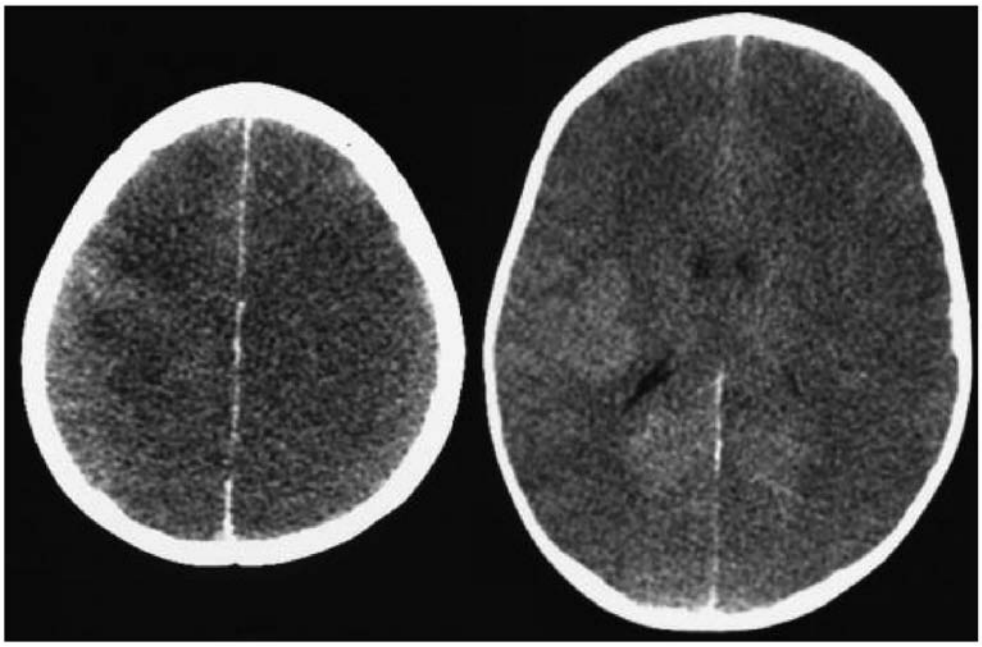
44. What are the three components used to evaluate a patient's Glasgow Coma Scale?

a. Ear, eye opening, voice.
b. Eye opening, verbal response, motor response.
c. Eye opening, vestibular response, motion detection.
d. Ear, nose, and throat, verbal commands, comprehension ability.
e. Eye opening, comprehension ability, intelligence level.

45. What score indicates severe neurological injury, and the need to obtain a definitive airway for the patient?

a. Less than 8.
b. Less than 9.
c. Less than 10.
d. Less than 11.
e. Less than 12.

QUESTIONS 46–50: While volunteering your medical services to the local life squad, you are called to respond to a medical 911 call. A frantic mother called when she found her 14-month-old child unresponsive in the crib. It was eventually unveiled that there was history of a recent closed head injury: the child fell off the neighbor's trampoline onto the cement sidewalk. Utilizing rapid sequence induction, the child was intubated and transported to the children's emergency department. Pertinent physical examination findings included dilated pupils and bradycardia. A noncontrast head CT was immediately performed.



46. What is the correct impression for the above head CT?

a. Cerebral edema.
b. Epidural hemorrhage in the basal cisterns.
c. Subdural blood in the interhemispheric space.
d. a and b.
e. a and c.

47. What finding on the head CT suggests the final impression?

a. Larger ventricles.
b. Enlargement of sulci.
c. Preservation of basal cisterns.
d. Loss of gray–white differentiation.
e. Preservation of subarachnoid spaces.

48. What is the common manifestation of head trauma, especially in pediatrics, that is of primary concern for this child?

a. Diffuse brain swelling.
b. Jugular venous distension.
c. Tachycardia.
d. Hyperpyrexia.
e. Splenic laceration.

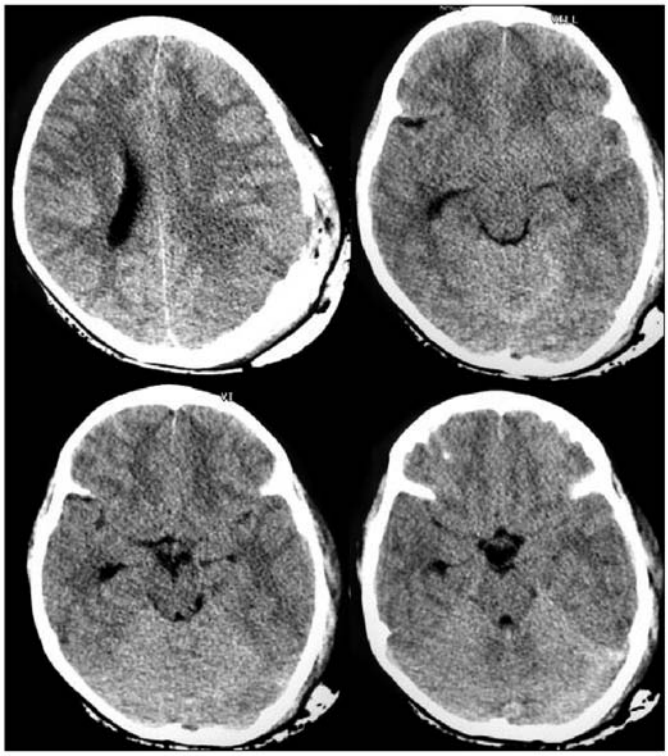
49. Which is the *incorrect* match for the appropriate usage of rapid sequence intubation drugs?

a. Atropine, for children younger than 8 years old; lessen vagal response.
b. Lidocaine; blunt airway reflexes.
c. Thiopental; decrease cerebral metabolism.
d. Ketamine; decrease intracranial pressure (ICP).
e. Vecuronium; nondepolarizing paralytic agent that does not cause fasciculations.

50. Which of the following is true regarding the medical treatment when increased ICP is suspected?

a. Treatment should not be initiated until there is absolute certainty of increased ICP.
b. Promote venous drainage by keeping the head in a midline position.
c. Remember not to blunt the patient's coughing or choking response, because it may impair venous drainage.
d. Hypoventilation also decreases ICP by decreasing the volume of the intracranial vasculature.

QUESTIONS 51–54: A 7-year-old male is brought to the emergency department because of new-onset seizure activity. The patient's father stated that the child had been complaining of a severe headache followed by vomiting, which the father assumed to be just the flu. Upon obtaining a thorough history, it is noted that the child's past medical history includes hemophilia. After stabilizing the patient, you obtain a head CT.



51. What is the correct interpretation of the above head CT?

a. Left parietal and occipital subdural hematoma with midline deviation.
b. Right parietal and occipital subdural hematoma with midline deviation.
c. Left parietal and occipital subdural hematoma without midline deviation.
d. Right parietal and occipital subdural hematoma without midline deviation.
e. Left frontal and temporal subdural hematoma with midline deviation.

52. What specific finding is noted on the left upper head CT?

a. Right subdural hematoma with ipsilateral ventricular compression.
b. Left subdural hematoma with contralateral ventricular compression.
c. Right subdural hematoma with contralateral ventricular compression.
d. Left subdural hematoma with ipsilateral ventricular compression.
e. Midline shift to the left.

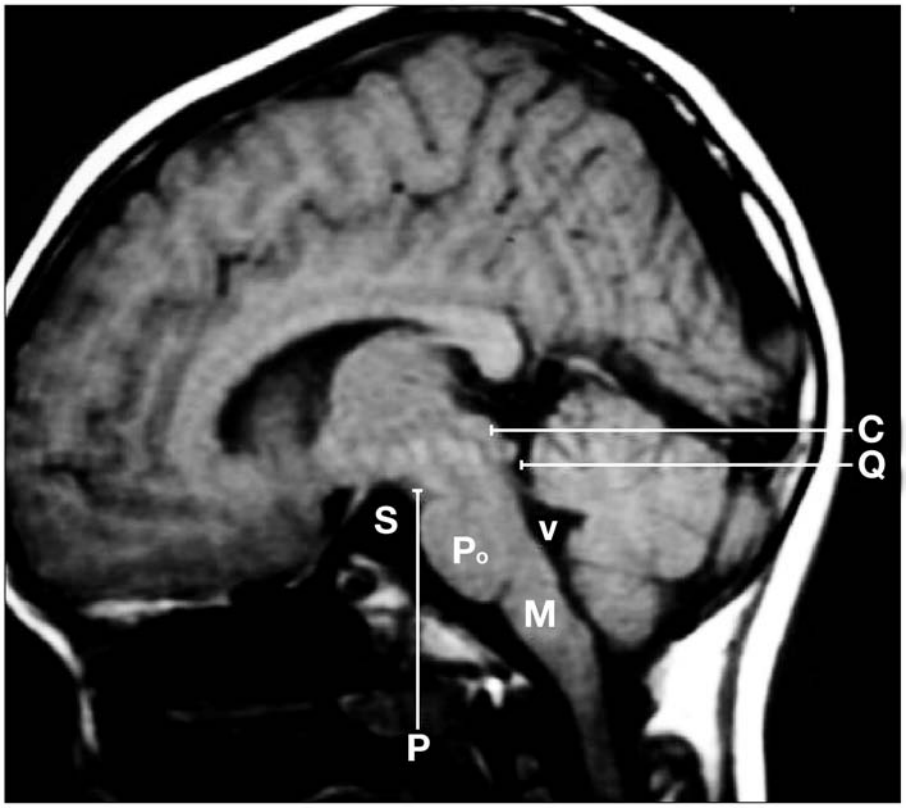
53. What specific finding is noted on the right upper head CT?

a. Quadrigeminal cistern size decreased because of compression.
b. Quadrigeminal cistern size within normal limits.
c. None of the above.
d. All of the above.

54. What specific finding is noted on the left lower head CT?

a. Suprasellar and quadrigeminal cisterns compressed.
b. Suprasellar cistern well preserved.
c. Suprasellar cistern compressed and the quadrigeminal cistern preserved.
d. Suprasellar cistern compression.

QUESTION 55: Below is a midline sagittal cut of a MRI scan of the brain. View the midline anatomic diagram of the brain and identify the following structures.



55. Match the anatomic structure with the correct corresponding letter as you see labeled on the above MRI scan:

_____ Suprasellar cistern

_____ Pons

_____ Midbrain (cerebral peduncles)

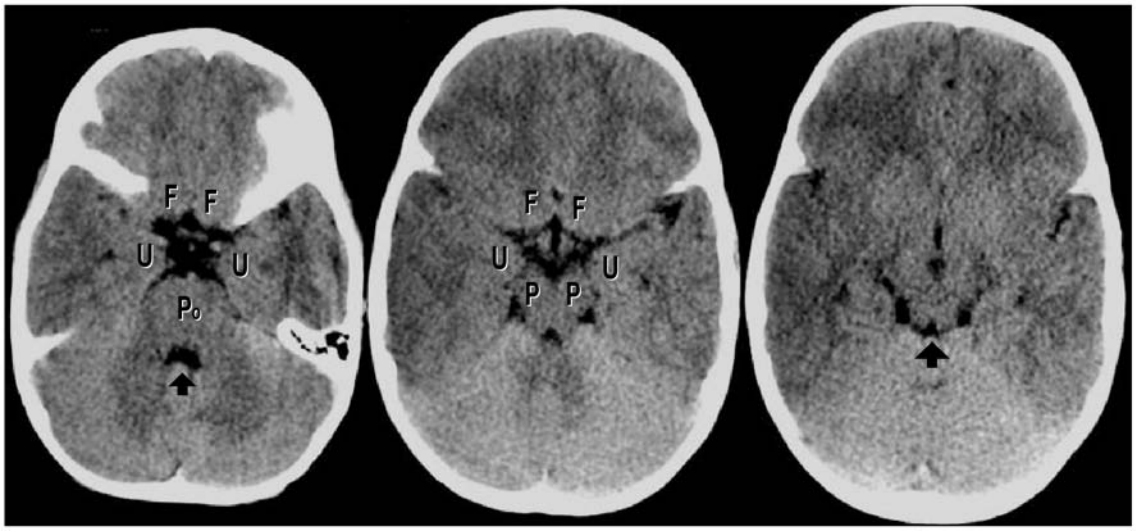
_____ Medulla

_____ Quadrigeminal plate (superior and inferior colliculi)

_____ Quadrigeminal cistern

_____ Fourth ventricle

QUESTIONS 56,57: Below are three separate cuts of a head CT displaying the suprasellar cistern and the anatomy that forms its well-known star appearance.



56. Match the anatomic structure with the correct corresponding letter as you see labeled on the above head CT:

_____ Frontal lobes

_____ Uncus of the temporal lobes

_____ Pons

_____ Cerebral peduncles

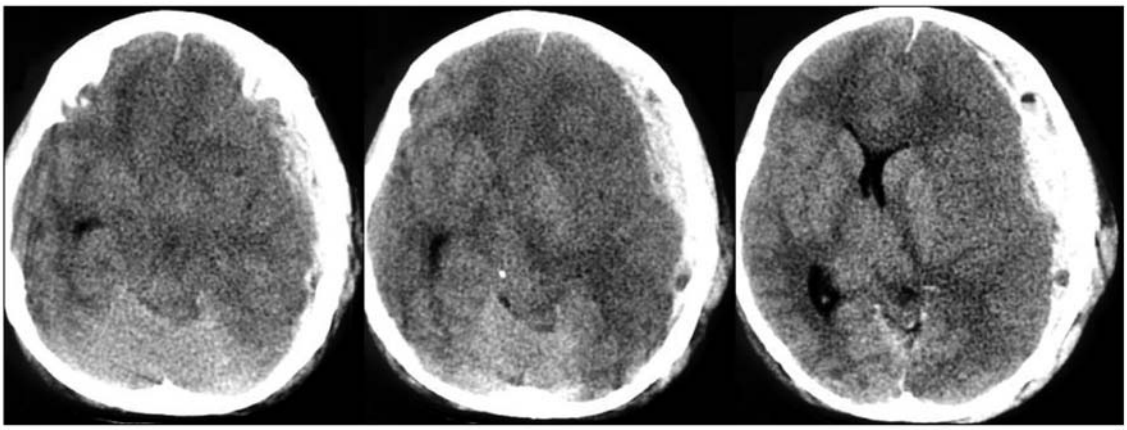
57. Match the above four structures with the appropriate anatomic border that it represents, collectively forming the suprasellar cistern:

_____ Anterior border

_____ Lateral borders

_____ Posterior border

QUESTIONS 58–62: The life flight crew arrived from an outlying facility with a 6-year-old female who was involved in a serious motor vehicle accident. As the unrestrained front-seat passenger, she was found unresponsive with multiple head lacerations secondary to being ejected from the vehicle. During the initial assessment, her heart rate was 35 and flexor posturing was noted. After initiating rapid sequence induction, you accompany the patient down to radiology for a head CT.



58. The correct impression on this child's head CT is as follows:

a. Subdural hematoma.
b. Midline shift.
c. Central transtentorial herniation.
d. Subfalcine herniation.
e. All of the above.

59. Describe what happens in transtentorial herniation:

a. Occurs with midline lesions in the parietal and temporal lobes.
b. Downward herniation; downward pressure on the cerebellar hemispheres and brainstem.
c. Upward herniation of the vermis and cerebellar hemispheres.
d. Both a and b.
e. Both c and b.

60. What clinical signs are characteristic of central transtentorial herniation?

a. Irregular respirations.
b. Bilateral Babinski's sign.
c. Increased muscle tone.
d. Late finding of decorticate posturing.
e. All of the above.

61. What is Cushing's triad?

a. Hypertension, bradycardia, and irregular respiration.
b. Hypotension, bradycardia, and irregular respiration.
c. Hypertension, tachycardia, and irregular respiration.
d. Hypotension, tachycardia, and irregular respiration.

62. Decorticate posturing corresponds with what numerical value on the Glasgow Coma Scale?

a. 1.
b. 2.
c. 3.
d. 4.
e. 5.

Answers

CHAPTER 1: CHEST RADIOGRAPHS

1–3. D, C, E

Common causes of pneoumonia in the 1-month to 2-year age group include respiratory viruses, *Streptococcus pneumoniae*, *Haemophilus influenzae* type B and nontype B, *Chlamydia trachomatis*, and *Mycoplasma pnuemoniae*. *Escherichia coli*, as well as group B strep, *Klebsiella*, *Listeria*, and *Chlamydia*, would be more likely in the neonate. Consider admission for persistent hypoxia, underlying disease, history of cyanosis or apnea, toxic appearance, age less than 3 months, presence of effusion, poor social situation of follow-up. All children discharged home should be followed up in 24 to 48 hours, and provided with strict instructions for return for worsening respiratory problems or failure to take oral fluids or antibiotics.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 20 (Case A). University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v3c20.html.

Brown K, Terndrup TE. Emergency Medicine: A Comprehensive Study Guide, 5th ed. pp. 809–813.

4–6. B, B, C

Foreign body aspirations occur most commonly in the 1-year to 3-year age group, with food and toys being the most common aspirated objects. Physical exam is very variable. Complete obstruction of airway will lead to respiratory, and eventually cardiac arrest. Partial obstruction can occur at any level in the airway. Classically, upper airway obstructions produce stridor, and obstruction below the vocal cords produces wheezing. This is extremely variable. Presentation can be late and a high index of suspicion is required. Unilateral aspiration is more common, and right-sided foreign bodies are more common than left-sided ones. Aspiration should always be considered in a unilateral wheeze. X-ray findings can be normal; subtle findings to look for include hyperexpansion, atelectasis, and air trapping. Although food matter can lead to a pneumonitis, antibiotic coverage is not recommended prophylactically. All foreign bodies must be removed, either immediately, during resuscitation, or by bronchoscopy. Clinically suspected cases should be ruled out by bronchoscopy.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 20 (Case B). University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/ pemxray/v3c20.html; Cordle R, Relich NC. Emergency Medicine: A Comprehensive Study Guide, 5th ed. pp. 886–888.

7,8. D, C

A right upper lobe infiltrate is visible; although this age group most commonly will present with viral causes, the absence of bilateral infiltrates, the lobar presentation, and sudden onset make bacterial etiologies more likely. Antibiotic coverage should consider *Streptococcus pneumococcus*, *Streptococcus pyogenes*, *Staphylococcus aureus*, and *H. influenzae*.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 20 (Case C). University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v3c20.html.

Brown K, Terndrup TE. Emergency Medicine: A Comprehensive Study Guide, 5th ed. pp. 809–813.

9,10. C, C

Hypocalcemia, VSD, and absence of the thymic shadow are consistent with the diagnosis of DiGeorge's syndrome. This child was probably experiencing hypocalcemic tetany, not seizure activity.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol, 3 Case 20 (Case E). University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/ v3c20.html.

Pollack Jr CV, Pollack ES. Emergency Medicine: Concepts and Clinical Practice, 4th ed. pp. 2152–2153.

11–13. E, E, B

Pneumomediastinum is a rare complication in asthma and may accompany a history of vague chest pain. It can be seen on chest X-ray but may be subtle. With good follow-up and small amounts of mediastinal air, patients may be managed as outpatients. Large amounts of mediastinal air, complete lobar atelectasis, pneumothorax, poor home resources, underlying cardiopulmonary disease, respiratory failure, return visits in less than 24 hours, persistent oxygen requirement, or persistent symptoms requiring treatment are all reasons for admission. Steroid burst as an outpatient should be considered in all but the mildest of asthma exacerbations. Pneumomediastinum is also the result of trauma and should lead to diligent search for underlying or concurrent pulmonary and chest injury in the absence of asthma exacerbation or any history of trauma.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine. Vol. 3, Case 20 (Case F). University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemx ray/v3c20.html.

Kou M, Mayer T. Emergency Medicine: A Comprehensive Study Guide, 5th ed., p. 821; Bowling WM, et al. Emergency Medicine: A Comprehensive Study Guide, 5th ed. p. 1685.

14–16. D, A, A

This X-ray reveals a left-sided atelectasis, the result of complete obstruction of the airway distal to the obstruction. On close inspection you may be able to make out the faint outline of a 1.5-cm cylindrical foreign body in the left main stem bronchus. Shift of the mediastinal structures will be toward an atelectasis or away from a tension pneumothorax. However, the vital signs are not consistent with an unstable clinical condition, nd lung markings are present throughout the right side of the film. Hemothorax is not consistent with this history. On X-ray, a hemothorax will demonstrate a more typical fluid layer.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 3 Case 20 (Case G). University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v3c20. html.

Cordle R, Relich NC. Emergency Medicine: A Comprehensive Study Guide, 5th ed. pp. 886–888.

17–19. B, B, C

The X-ray reveals small bilateral, central pulmonary infiltrates leading to a diagnosis of viral pneumonia. Viruses are the most common pathogens in the first 2 years of life. Outpatient therapy is warranted if the child is having no respiratory difficulty and continues feeding well. Bronchodilator therapy should be considered as well, especially in any child with bronchiolitis-like symptoms.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 20 (Case H). University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v3c20.html.

Brown K, Terndrup TE. Emergency Medicine: A Comprehensive Study Guide, 5th ed. pp. 809–813.

20,21. C, B

A right upper lobe infiltrate separate from the thymus and scapula shadows is present. The clinical scenario and radiographic findings are consistent with a pneumonic process.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine. Vol. 3, Case 20 (Case I). University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/ pemxray/v3c20.html.

Brown K, Terndrup TE. Emergency Medicine: A Comprehensive Study Guide, 5th ed. pp. 809–813.

22–24. C, B, D

The stat chest X-ray reveals air in the pericardium; in conjunction with the deteriorating clinical condition, this yields a diagnosis of tension pneumopericardium. Treatment requires prompt evacuation of the pericardial space. An evaluation of a patient in respiratory distress or failure on a ventilator requires evaluation of the circuit; however, in this case the diagnosis is evident (and time-critical) with the chest X-ray. A pericardiocentesis would relieve the air but it may be expected to reaccumulate; a more definitive treatment may require that a catheter with a stopcock be left in place or a pericardial window by a thoracic surgeon be created. The condition is somewhat rare. The mechanism is a high alveolar pressure leading to rupture and air dissecting into the hilum and mediastinum with entrance to the pericardial space via the membrane reflection on the pulmonary vessels. Pacing wires are also visible. This would be consistent with a post-op cardiac patient.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 20 (Case K). University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pem xray/v3c20.html.

Jouriles NJ. Emergency Medicine: Concepts and Clinical Practice, 4th ed. pp. 1725–1726.

25–29. C, D, B, E, D

A left lower lobe and right lower lobe infiltrate are visible. Blood cultures are appropriate in infants and the toxic-appearing child. Antibiotic coverage with a presumption of a possible bacterial etiology is not unwarranted. M. pneumoniae is the most common pathogen in school age children. Viruses predominate from 3 months through 5 years. Group B and Listeria are concerns for neonatal infection. Follow-up care is of utmost importance in the ambulatory setting.

Classic teaching has focused on the typical versus atypical pattern, but a great amount of overlap exists in presentation. It must be emphasized that a bilateral infiltrate pattern on X-ray does not automatically qualify the infiltrate as typical or atypical. A typical pneumonia includes a high spiking fever, abrupt onset, productive cough, toxic appearance, and localized lung findings. Atypical pneumonias are associated with a gradual onset, low-grade fever, nonproductive cough, general malaise, and headache.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 20 (Case M). University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu /medicine/pediatrics/pemxray/v3c20.html.

Brown K, Terndrup TE. Emergency Medicine: A Comprehensive Study Guide, 5th ed. pp. 809–813.

30–34. C, D, B, B, C

What initially looks like a right-sided mass on this X-ray is more likely to represent an infectious process, given the clinical picture. Pseudotumor represents a fluid collection in the fissure and is a not-uncommon finding. Absence of known metastatic disease does not rule out a mass; however, lung cancerous processes in children are relatively rare. Typical infiltrates lag behind the clinical picture on X-ray and infiltrates may be seen 4 to 6 weeks after an acute pneumonia. Although tuberculosis is an unlikely diagnosis, it must remain in the differential of any upper-lobe infiltrate. Children are not immunized in the United States for tuberculosis; however, immigrants from many high-incidence countries will be. The immunization will give a positive purified protein derivative skin test. On X-ray, tuberculosis can take many forms, including hilar adenopathy, mediastinal lymphadenopathy, consolidation, cavitary and noncavitary lesions in the upper lobe or superior segments of the lower lobe, small nodules throughout the lung fields, and pleural effusions, typically unilateral.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 20 Case N. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v3c20.html.

Poponick JM, Moll J. Emergency Medicine: A Comprehensive Study Guide, 5th ed. pp. 466–470; Johnson GA. Atlas of Emergency Radiology, p. 41.

35,36. E, D

This X-ray reveals pneumomediastinum. Mechanism of injury is rupture of alveoli and dissection of air to the mediastinum. It is thought to occur as a complication of forced exhalation against a closed glottis. Classically this occurs in severe coughing episodes, including asthma. In smoking crack cocaine, many users will forcibly exhale against a closed glottis to increase the effects (absorption) of the cocaine. Cardiac disease is not associated with pneumomediastinum.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 20 (Case O). University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine /pediatrics/pemxray/v3c20.html.

Colucciello SA, Tomaszewski C. Emergency Medicine: Concepts and Clinical Practice, 4th ed. pp. 2891–2895.

37–40 B, A, C, D

This X-ray reveals bilateral patchy infiltrates. Near-drowning is defined as survival beyond 24 hours of submersion. The primary problems in the near-drowning victim include hypoxia, hypothermia, and aspiration. Hypoxia is the most critical, as irreversible brain damage can begin in as little as 4 to 5 minutes of anoxia. Although all drowning victims will suffer hypothermia to some degree, there appears to be some protective effect to submersion in icy waters, with documented extended survival times. For this reason, all drowning victims should have resuscitation efforts initiated immediately. Drowning rates are highest in children under age 4 years and in teenage males. Drowning is associated with lapses in supervision, alcohol consumption, increased risk-taking, and occult trauma. All victims should have C-spine protection, with immediate attention to airway control and ventilation management. Survival rates range from 100% for those who arrive awake and alert, to less than 45% of those who arrive comatose.

References: Morisada M. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 15. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v5c15.html.

Feldhaus KM, Knopp RK. Emergency Medicine: Concepts and Clinical Practice, 4th ed. pp. 1061–1066.

41–44. A, B, C, A

The initial abdominal series reveals a pleural effusion obvious on the right side. A much more subtle finding includes an irregularity in the left diaphragm contour. The lateral decubitus films reveal a layering out of pleural fluid on both sides. The diagnosis of a pleural effusion is not an end-point, but should trigger an investigation into underlying pathology. The first step is determining whether the effusion is an exudate or a transudate. An exudate will have an lactate dehydrogenase level greater than 200 U; the fluid-to-blood ratio will be greater than 0.6 for lactate dehydrogenase and 0.5 for protein. Glucose is not a useful parameter in the evaluation of pleural effusions. Many disease processes and pathology can lead to pleural effusion. Some of the more common include congestive heart failure (CHF), bacterial pneumonia, tuberculosis, malignant disease, cirrhosis, glomerulonephritis, pulmonary embolism, esophageal rupture, pancreatitis, subphrenic abscess, or even postsurgical effusions for both thoracic and abdominal surgery.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 2, Case 4. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v2c04.html.

McEwen JI. Emergency Medicine: Concepts and Clincal Practice, 4th ed. pp. 1521–1525.

45–49. C, D, B, C, D

Swallowed foreign bodies are common, and some 80% of all cases involve pediatrics. It is a potentially serious problem, with an estimated 1500 deaths per year. Pediatric foreign bodies typically include coins, crayons, ballpoint pen caps, and toys; adults typically have greater problems with meat or bones. Most spontaneously pass; about 10–20% require some intervention. Sharp irregular objects pose a problem throughout the gastrointestinal tract; however, most objects become less of a concern once they are past the pylorus. In pediatrics the greatest areas of narrowing involve the esophagus and include the level of the cricoid, thoracic inlet, aortic arch, tracheal bifurcation, and hiatal narrowing. Objects that are lodged for more than 24 hours will require specialty intervention, with endoscopy being the "gold standard." Initial management involves airway support and identification of the foreign body within the body. Button batteries must always be removed immediately. Chest X-ray will typically show coins in the esophagus in a straight-on plane, whereas coins in the trachea will be seen on edge. Vomiting should not be induced. This child's ongoing history of wheezing may represent an extended lodging of the foreign body. The history of hemoptysis is extremely alarming and suggestive of erosion in vessels and represents an immediate life threat.

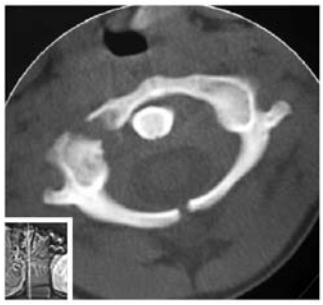
References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 2, Case 1. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v2c01.html.

Gaasch WR, Barish RA. Emergency Medicine: A Comprehensive Study Guide, 5th ed. pp. 529–531.

CHAPTER 2: LATERAL NECK RADIOGRAPHS

1–5. C, B, C, B, C

This is a Jefferson fracture, which is a compression and/or burst fracture of C1. A direct blow to the top of the head (e.g., a fall or dive) can inflict this injury. On the lateral neck film, there is a soft tissue swelling noted in the preverterbral space. In the odontoid view, the lateral masses are widened (*see* drawing below). A CT scan further emphasizes the burst fracture present (below). Approximately one-third of Jefferson fractures are associated with other cervical fractures, with C2 being the most common. When spinal cord damage is suspected, intravenous steroids may help minimize further damage and neurosurgical consultation for possible surgery is necessary.



References: Yee LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 4. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v5c04.html.

Cornelius R, Leah J. Neuroimag Clin N Am 1995;5(3),451–463; Fesmire F, Luten R. J Emerg Med 1989;7:133–142; Roberge R. Emerg Med Clin N Am 1991;9(4):733–742; Daffner R. Semin Roentgenol 1992;27(4); 239–253; Gerlock A, et al. The Cervical Spine in Trauma.

6–9. B, B, D, B

This child has an epiglottitis. The epiglottis is swollen, as are the aryepiglottic folds. Controlled intubation for airway management is recommended, preferably in the operating room, by a pediatric anesthesiologist. Dysphagia, tripid positioning, and stridor are all consistent with epiglottitis. Despite the advent of *H. influenzae* type B polysaccharide protein conjugate vaccines and an overall decrease in cases of epiglottitis, it is the most likely causative organism (of the choices listed).

References: Boychuk RB. Radiology Cases in Pediatric Emergency Medicine, Vol. 1, Case 10. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/ v1c10.html; Fleisher GR. Textbook of Pediatric Emergency Medicine, 3rd ed., pp. 613–621.

Santamaria J, Abramo TJ. Pediatric Emergency Medicine Concepts and Clinical Practice, pp. 680–682.

10–13. B, A, A, C

Laryngotracheobronchitis (croup) is a disease most commonly caused by viruses (e.g., parainfluenzae, influenza, respiratory syncytial virus, etc.). Therefore, intravenous antibiotics do not benefit these children. Intubation and/or ventilation are otherwise not necessary in an alert child with a good oxygenation status (while on room air). Corticosteroids are clearly beneficial. They can be given intravenously, intramuscularly, or orally. Single-dose dexamethasone 0.6 mg/kg (max 10 mg) is commonly utilized.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 20. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v5c20.html.

Feigin RD, Strechenberg BW, Strandgaard BH. Textbook of Pediatric Infectious Diseases, 3rd ed., pp. 1110–1116, Fleisher GR. Textbook of Pediatric Emergencies, 3rd ed., p. 621.

14–18. C, B, A, C, B

This is an unstable fracture of the C2 pedicles with displacement of C1 and the bodies of C2 and C3, aka hangman's fracture. It is the direct result of rapid hyperextension or acceleration/deceleration injury, and most commonly caused in an automobile accident. Overall, trauma is less severe with pseudosubluxation than with a hangman's fracture. The absence of a visible fracture does not rule out hangman's fracture. A CT scan would further identify cervical structures and fractures present (if any).

References: Yee LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 3. University of Hawaii John A. Burns School of Medicine,http://www.hawaii.edu/medicine/pediatrics/pemxray/v5c03.html.

Cornelius R, Leah J. Neuroimag Clin N Am 1995;5(3):451–463; Fesmire F, Luten R. J Emerg Med 1989;7:133–142; Roberge R. Emerg Med Clin N Am 1991;9(4):733–742; Daffner R. Sem Roentgenol 1992;27(4):239–253; Gerlock A, et al. The Cervical Spine in Trauma.

19.

BA: Normal, but unable to see C7.
VB: Normal sizes, but unable to see C7.
C: Normal.
P: Extension.
PS: Slightly full, but less than the width of a vertebral body.
E: Thumb-like in appearance (white arrow). It should normally appear thin or triangular.
SG: Normal. The pre-epiglottic space (black arrow) is narrow and nearly obliterated.
Dx: Epiglottitis.

20.

BA: Normal, but unable to see C7.
VB: Normal sizes, but unable to see C7.
C: Normal.
P: Extension.
PS: Widened (black arrow). It is slightly thicker than the width of a vertebral body.
E: Thin; the pre-epiglottic space is normal.
SG: Satisfactory (white arrow).
Dx: Retropharyngeal abscess.

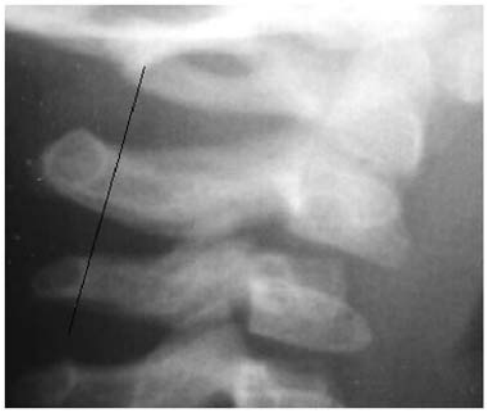
21.

BA: Normal, but unable to see C7.
VB: Normal sizes, but unable to see C7.
C: Normal.
P: Extension.
PS: Not widened.
E: Thin; the pre-epiglottic space is normal.
SG: Narrowed.
Dx: Subglottic edema (croup).

22.

BA: Abnormal. Misalignment of the posterior borders of the vertebral bodies. C2 is anterior relative to C3.
VB: Normal sizes.
C: Normal.
P: Flexion.
PS: Not widened.
SG: Not included in this view; not able to fully see the airway in this view.
Dx: Pseudosubluxation C2 on C3. Recall that films taken in flexion are likely to show this C2/C3 pseudosubluxation. This is distinguished from a hangman's fracture by the Swischuk line drawn between the anterior margin of the vertebral arches of C1 and C3. This line should touch the anterior margin of the vertebral arch of C2 or come within 1 mm of it.

Comment: The two most common causes of C2–C3 malalignment are pseudosubluxation and a hangman's fracture. To distinguish between these two, Swischuk defined a posterior cervical line drawn from the cortex of the posterior arch of C1 to the cortex of the posterior arch of C3. This line should pass through or be less than 1 mm anterior to the posterior arch of C2. If this distance is greater than 1 mm (possibly up to 1.5 or 2 mm may be normal), this indicates a fracture of the arch of C2 (the vertebral body moves anteriorly, while the arch and the spinous process move posteriorly). Additionally, pseudosubluxations are most pronounced with the neck flexed. C2–C3 malalignment should not persist if the neck is placed in a more neutral or extended position. Persistence of the subluxation in extension is felt to be due to injury (nonphysiological).



The Swischuk line is drawn on our patient's radiograph. The posterior arch of C2 is pointed out; this Swischuk line intersects the posterior arch of C2. It indicates good alignment of this region despite the apparent malalignment of the vertebral bodies.

23.

BA: C2 is slightly anterior with respect to C3. However, Swischuk line is OK. Not able to see C7.
VB: Not able to fully see C6 and C7. The heights of C4 and C5 are compressed (anteriorly). C6 may also be compressed.
C: Normal.
P: Flexion.
PS: Not widened.
E: Not able to see it on this view.
SG: Not able to fully assess it on this view.
Dx: Cervical spine compression fractures.

References (for questions 19–23): Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 2, Case 20. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pem xray/v2c20.html.

24. **A**

Despite the satisfactory alignment of the Swischuk line, the anterior vertebral body line, the posterior vertebral body (anterior spinal canal) line, and the spinolaminal (posterior spinal canal) line are out of alignment. Also, this cannot be a pseudosubluxation because the neck should be in a neutral or flexion position for an actual diagnosis of pseudosubluxation.

25. **C**

The lateral view shows separation of the skull from the cervical spine (atlanto-occipital dislocation). There is a visible lucency at the base of the odontoid. This is the subdental synchondrosis, a normal finding in young children. This synchondrosis generally fuses by age 3–6 years.

26. **F, G**

There is a distinct fracture of the odontoid on the lateral film: avulsion fracture of the anterior inferior line of C2 and slight displacement of C2. This fracture is emphasized by the angulation of the odontoid.

27. **H**

This has the appearance of a typical "clay shoveler's" fracture, which generally occurs when the neck is forced forward (flexed) while it is held in extension (lordosis). In this case, this teenager was swimming when someone diving from the rocks above fell onto his back.

28. **I**

C2 appears to be slightly displaced anteriorly with respect to C3. This is caused by kyphosis secondary to the fractures. Unable to visualize C7.

29. **J**

The anterior vertebral body line, the posterior vertebral body (anterior spinal canal) line, and the spinolaminal (posterior spinal canal) line are out of alignment.

30. **E**

C2 is out of alignment anteriorly with respect to C3. A lucency is present through the base of the odontoid. There is widening of the prevertebral soft tissue, although the Swischuk line is in satisfactory alignment. When this film was repeated with a better lordotic extension of the neck, both the C2–C3 pseudosubluxation and the prevertebral soft tissue widening resolved.

References (for questions 24–30): Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 5. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v5c05.html.

31–35. D, E, B, D, A The initial X-ray is significant for a large increase in the prevertebral soft tissue. Rules of thumb for normal are 6 mm at C2 and 22 mm at C6 in adults, but in children, the preverterbral space should not be greater than half of a cervical vertebra. This X-ray and clinical picture are consistent with a retropharyngeal abscess. Prior to age 6 months most cases of stridor will be from congenital causes. After age 6 months the most common causes have included epiglottitis, retropharyngeal abscess, viral croup, bacterial tracheitis, and foreign body aspiration; however, any process affecting the diameter of the upper airways may produce stridor. Epiglottitis and bacterial tracheitis both involve very ill toxic-appearing children. Epiglottitis will usually involve dysphagia and drooling, whereas bacterial tracheitis does not; it is associated with a preceding illness and thick secretions. The final X-ray represents epiglottis and the "thumbprint" sign.

References: Boychuk RB. Radiology Cases in Pediatric Emergency Medicine, Vol. 1, Case 10. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v1c10.html; Cordle R, Relich NC. Emergency Medicine: A Comprehensive Study Guide, 5th ed., pp. 879–890.

CHAPTER 3: ABDOMINAL RADIOGRAPHS

1–5. C, B, A, D, D An infant with episodic pain and associated vomiting should be suspected of having intussusception. The patient may not have grossly bloody stool (the cause of currant jelly-colored stool) all the time but will almost always have heme-positive stool. Initial evaluation with plain abdominal X-rays can be helpful to detect absence of liver edge, which is suggestive of intussusception, but plain films usually are not definitive. The gold standard is contrast enema, which can be curative in many cases.

References: Young LL, Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 1, Case 2. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/vl1c02.html.

Tintinalli JE. Emergency Medicine: A Comprehensive Study Guide, 5th ed., p. 849; McMillian JA, et al. Oski's Pediatrics, 3rd ed., pp. 1652–1654.

6–10. D, A, D, C, A Pyloric stenosis is commonly found in males in the first 2–8 weeks of life. Projectile vomiting is a common presentation and is almost always nonbilious. A palpable mass or "olive" can sometimes be felt but does not have to be present to make the diagnosis. Infants are at high risk for weight loss and metabolic abnormalities related to the gastric fluid losses. They can develop hypochloremia, hyponatremia, and hypokalemia. Ultrasound will confirm the diagnosis and surgery is the treatment.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 17. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v5c17.html; Tintinalli JE. Emergency Medicine: A Comprehensive Study Guide, 5th ed., pp. 848–849; McMillian JA, et al. Oski's Pediatrics, 3rd ed., p. 311.

11–14. B, B, A, B In ileus, there is a dilation of the bowel that is proportional and nonpreferential. There is generally good gas distribution over most of the abdomen and increased gas in both the large and small bowel.

References: Chan-Nishina CC, Tim-Sing PML. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 18. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pem xray/v3c18.html.

McMillian JA, et al. Oski's Pediatrics, 3rd ed., p. 321.

15–20. A, D, A, A, C, E

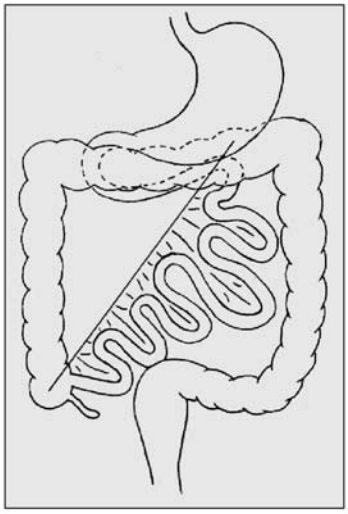
Foreign bodies in the esophagus and stomach pose some interesting problems. First is the appearance of the foreign body on X-ray. Coins in the esophagus appear in the frontal plane. If a coin appears in the sagittal plane it is likely in the trachea because of the opening in the tracheal rings. The patient will most likely have associated dyspnea, respiratory distress, and hemoptysis. Coins in the esophagus usually become lodged at one of three places—at the level of the cricoid, the level of the tracheal bifurcation or at the gastroesophageal junction. Coins lodged in the esophagus for a period of time have the potential for causing serious damage. They can cause ulceration, perforation, and extension of injury into the trachea, mediastinum, and great vessels. Coins have the potential to cause vascular injury, although sharper objects are a more common cause of this.

Battery ingestion can be commonly mistaken for a simple coin ingestion. Close-up examination of the X-ray can reveal some clues to differentiate a disk or button battery from a coin. Some batteries have an internal ring that may be visible on X-ray. Others have irregular shapes or sizes that differ from coins. Batteries can leak caustic substances, which can be corrosive and toxic. Most of the substances found in batteries are neutralized or converted to nonabsorbable forms by gastric acids. If the battery is in the esophagus, it needs to be removed. If it has passed into the stomach or beyond, the patient can be discharged with warnings for potential toxicity. The stool needs to be screened to see if the battery has passed. Follow up X-rays may be necessary for batteries that have not passed to determine need for endoscopic retrieval.

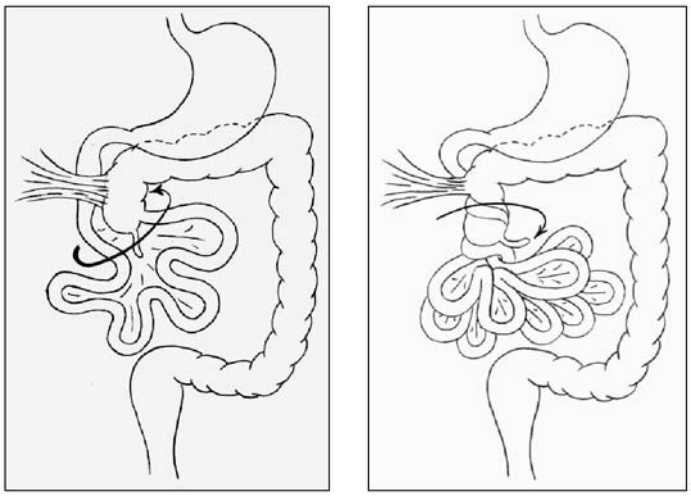
References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 2, Case 1. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v2c01.html.

21–28. E, B, C, A, C, C, E, A

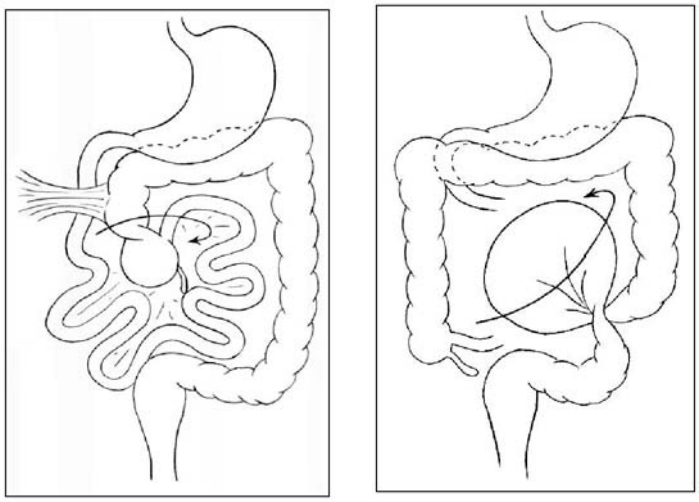
Malrotation is a congenital anomaly in which the bowel rotates incorrectly during development and predisposes the bowel to twisting or volvulus with subsequent ischemia. During development the cecum should enter the mid-abdomen at 12 o'clock and rotate toward the right lower quadrant. The mesentery, which has the small bowel fixed to it, will fix the cecal end in the right lower quadrant and the opposite end at the upper mid-abdomen behind the duodenum. The superior mesenteric artery is contained in the mesentery. The following diagram illustrates the normal position of small and large bowel with relation to the mesentery.



When this rotation does not occur properly, the terminal ileum and cecum are fixed at different position and become prone to twisting or volvulus. Ladd's bands are attachments that fix the terminal ileum and may cross over the duodenum, causing obstruction. The following diagrams show how malrotation can lead to midgut volvulus.



A midgut volvulus should not be confused with a cecal volvulus or sigmoid volvulus, both of which are common in adults. Cecal volvulus can also occur without malrotation. The following are illustrations of cecal and sigmoid volvulus, respectively:



Malrotation is best diagnosed with an upper gastrointestinal or barium enema. Most cases present around the first month of life, although less than half occur in the neonatal period. Midgut volvulus can occur rapidly and cause widespread infarction in a matter of hours. Early surgical evaluation is crucial in preventing this catastrophic complication.

References: Rosen LM, Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 2, Case 8. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/ v2c08.html.

Tintinalli JE. Emergency Medicine: A Comprehensive Study Guide, 5th ed., p. 847; McMillian JA, et al. Oski's Pediatrics, 3rd ed., pp. 311–312.

29–33. A, B, A, B, A

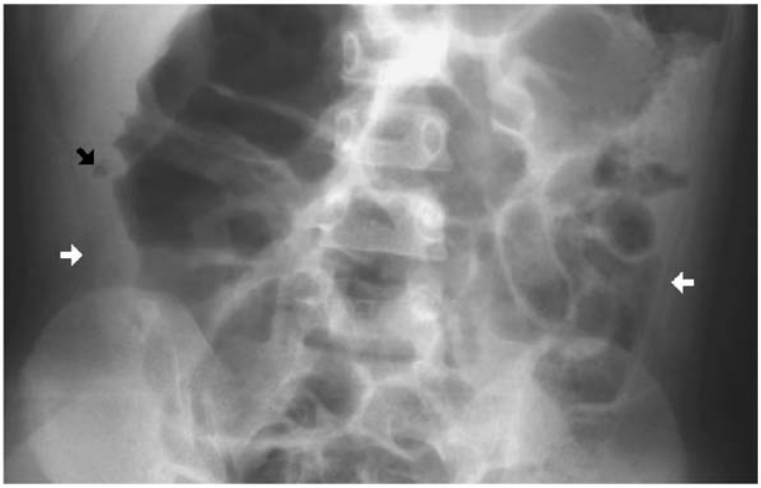
Inguinal hernias are more common in males than in females. They are due to a weakness in the processus vaginalis, which leads to herniation of the bowel. The bowel can become trapped or incarcerated. If it becomes incarcerated it may twist or strangulate which can cause ischemia and infarction. A Richter hernia is a type of hernia in which only part of the bowel wall becomes trapped. The bowel lumen remains open preventing an obstruction but the entrapped bowel wall can become ischemic. Treatment for all hernias is surgery.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 16. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v3c16.html.

McMillian JA, et al. Oski's Pediatrics, 3rd ed., pp. 1640–1642.

34–37. A, B, B, B

The abdominal films show a positive peritoneal fat stripe. This is the fat surrounding the bowel wall. With appendicitis, it can be displaced. Review the following X-ray close-up.



Notice the difference in the fat stripes on the left compared with those on the right. The patient's right side has a much thicker fat stripe, suggesting inflammation. This is suggestive of appendicitis. The patient's left side has a normal thin peritoneal fat stripe. Otherwise the abdominal X-ray shows dilated bowel without any air–fluid levels, suggesting possible ileus or early bowel obstruction. Remember, with appendicitis the temperature and white blood cell count may be normal. Loss of appetite doesn't always occur either. The presence of vomiting or diarrhea doesn't rule out appendicitis. Children under 2 years old are unlikely to have appendicitis. The preferred treatment is surgery. This case revealed a perforated appendix.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 19. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v3c19.html.

Tintinalli JE. Emergency Medicine: A Comprehensive Study Guide, 5th ed, pp. 535–537, 850; McMillian JA, et al. Oski's Pediatrics, 3rd ed., pp. 1702–1704.

38–42. B, A, A, A, B

This case represents an ileus. The X-rays show gas in all quadrants, as well as bowel dilation. There are no air–fluid levels. There is also a disorderly arrangement of the dilated bowel. This resembles a bag of popcorn. An obstruction will more likely resemble a bag of sausage. Ileus will also give rise to sentinel loops secondary to an underlying inflammatory process.

References: Chan-Nishina CC, Tim-Sing PML. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 18. University of Hawaii John A. Burns School of Medicine, http://www. hawaii.edu/medicine/pediatrics/pemxray/v3c18.html.

McMillian JA, et al. Oski's Pediatrics, 3rd ed., p. 321.

43–47. E, D, D, C, E

This apparent "calcification" is really not from calcium, but from bismuth. Ingestion of Pepto-Bismol® will leave this radiopaque finding on X-ray. What is important is making sure this finding is not due to other things that are radiopaque. Heavy metal ingestion, such as an iron overdose, can be potentially life-threatening. With iron, you may see actual pill fragments in the bowel. Iron studies, bowel irrigation, and deferoxamine are appropriate treatments. Pepto-Bismol® is a common over-the-counter medication that can lead to abnormal abdominal X-rays, which can be misleading, but harmless.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 10. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v3c10.html.

48–52. C, D, C, B, E

This is a case of appendicitis with evidence of a fecalith. This is not always common but when present, it can solidify the diagnosis. The majority of all appendices are not retrocecal or pelvic. Having pyuria or evidence of gastroenteritis does not rule out appendicitis.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 4, Case 10. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v4c10.html.

Tintinalli JE. Emergency Medicine: A Comprehensive Study Guide, 5th ed., pp. 535–537, 850; McMillian JA, et al. Oski's Pediatrics, 3rd ed., pp. 1702–1704.

53–57. E, C, A, B, B

This is a case of necrotizing enterocolitis. This is a serious condition with high complication and mortality rates. It occurs most frequently in low-birthweight (<750 g) premature infants. These infants are at great risk for sepsis, bowel necrosis, perforation, and DIC. Aggressive therapy early on, including intravenous fluids, nasogastric tube decompression, intravenous antibiotics, cultures, and possible operative repair, is crucial to improve the chances of recovery without complications. The classic finding on X-ray is pneumatosis intestinalis. This is seen as a double-density layering of the intestinal wall. This is sometimes referred to as "railroad tracks." This is most commonly seen in the neonatal intensive care units but can occur in the first few months of life. The prevalence is around 4%. There is no genetic disposition. Males are afflicted more often than females.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 6, Case 14. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v6c14.html.

Tintinalli JE. Emergency Medicine: A Comprehensive Study Guide, 5th ed., pp. 55, 765; McMillian JA, et al. Oski's Pediatrics, 3rd ed., pp. 325–332.

58–64. D, C, D, B, D, B, C

Meckel's diverticulum is a pouch of tissue in the bowel that usually contains ectopic tissue. This may be gastric (most common), pancreatic, or ileal. The gastric tissue produces acid and may ulcerate and eventually bleed. The diverticulum may also cause obstruction and may become inflamed, giving the picture of appendicitis. If it perforates, it will lead to peritonitis. The "rule of 2s" is as follows: 2% of population, 2% of people with Meckel's will have symptoms, located 2 feet proximal to terminal ileum, usual length is 2 inches, and symptoms usually manifest at age 2. A

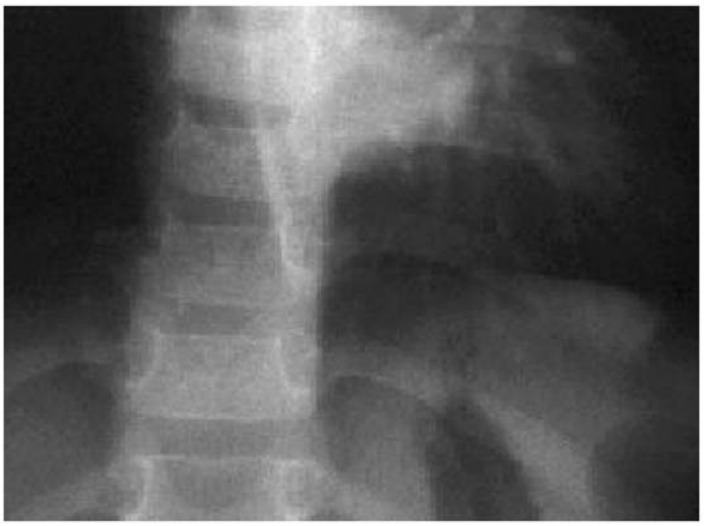
Meckel's scan is the best way to diagnosis the condition but it is most often found at laparotomy.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 4, Case 9. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v4c09.html.

Tintinalli JE. Emergency Medicine: A Comprehensive Study Guide, 5th ed., p. 851; McMillian JA, et al. Oski's Pediatrics, 3rd ed., pp. 1644–1645.

65–68. D, C, D, C

Look at the following close-up of the X-ray included in this abdominal series.



This shows a triangular-shaped density superimposing over the heart. This represents a pulmonary infiltrate in the medial aspect of the left lower lobe. The patient did well on antibiotics and his abdominal pain resolved. The teaching point here is to not forget about other causes of abdominal pain that can sometimes be picked up on your abdominal series. Pneumonia is known to cause abdominal pain. Other potential causes of abdominal pain include pneumothorax, pneumomediastinum, pericarditis, herpes zoster, osteomyelitis, discitis, black widow spider envenomation, and diabetic ketoacidosis.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 1, Case 3. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v1c03.html.

69–73. A, E, A, A, A

This is a case of bowel obstruction secondary to Hirschsprung's disease. This is a failure of neural crest cell migration, resulting in the absence of Auerbach nerve plexus in the bowel wall. This causes loss of tone and peristalsis, setting the bowel up for obstruction. It is more frequently found in patients with Down syndrome. It is also more common in males than in females. Most of these patients will require operative repair.

References: Chan-Nishina CC, Tim-Sing PML. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 18. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v3c18.html.

74–78. C, B, B, F, D

This is a case of necrotizing enterocolitis (NEC). The classic findings on X-ray are pneumatosis intestinalis, or "railroad tracks." This suggests air in the bowel wall and is classic for NEC. NEC usually occurs in premature infants and rarely in full-term infants. There are many risk factors involved (i.e., respiratory distress syndrome, patent ductus arteriosus, CHF, umbilical vessel cath, hypothermia). Patients with NEC are at risk for sepsis and bowel necrosis. They need prompt medical care, surgical consultation, and admission.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 2, Case 14. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v2c14.html.

Tintinalli JE. Emergency Medicine: A Comprehensive Study Guide, 5th ed., pp. 55, 765; McMillian JA, et al. Oski's Pediatrics, 3rd ed., pp. 325–332.

79–84. A, C, E, D, A, C

This is a case of appendicitis. The X-ray shows an ileus in the right lower quadrant and the presence of a fecalith (spherical structure). With the clinical scenario this suggests acute appendicitis. It is important to remember that not just appendicitis will cause an elevated white blood cell count; gastroenteritis, ruptured ovary, and Meckel's diverticulum can as well. Perforation is more common in children. Rovsing sign is pain in the right lower quadrant while palpating the left lower quadrant.

References: Chan-Nishina CC, Tim-Sing PML. Radiology Cases in Pediatric Emergency Medicine; Vol. 3, Case 18. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/ medicine/pediatrics/pemxray/v3c18.html.

Tintinalli JE. Emergency Medicine: A Comprehensive Study Guide, 5th ed., pp. 535–537, 850; McMillian JA, et al. Oski's Pediatrics, 3rd ed., pp. 321, 1702–1704.

85–90. A, A, C, A, B, B

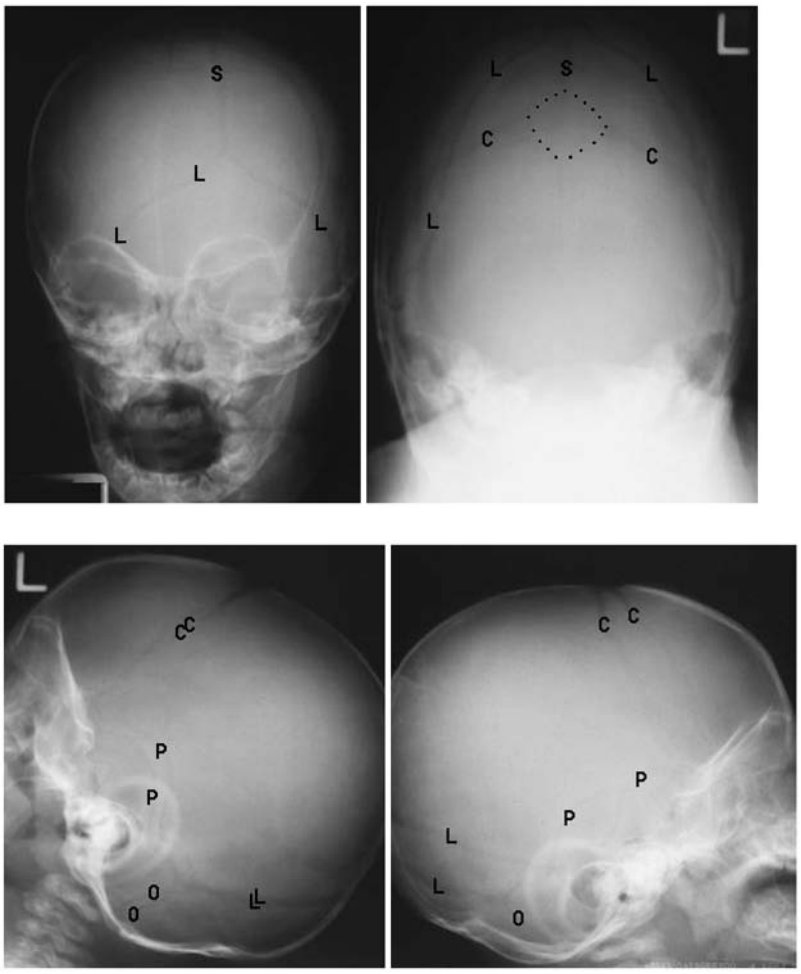
The correct interpretation of the X-ray is intussusception. First, there is a paucity of bowel gas. This should make you suspicious for an obstructive process. The "target sign" is two concentric circles of fat density. It is from the peritoneal fat layers alternating between the layers of mucosa and muscle in the intussusception. This is a very subtle finding, but very specific for intussusception. The crescent sign and absent liver edge are also other findings on X-ray that suggest intussusception. The preferred treatment is a contrast enema if a bowel perforation is not suspected. This will not only confirm your diagnosis but will also usually reduce the intussusception. Approximately 80% will be successfully reduced if done earlier and 5–10% will recur.

References: Chan-Nishina CC, Tim-Sing PML. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 18. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v3c18.html.

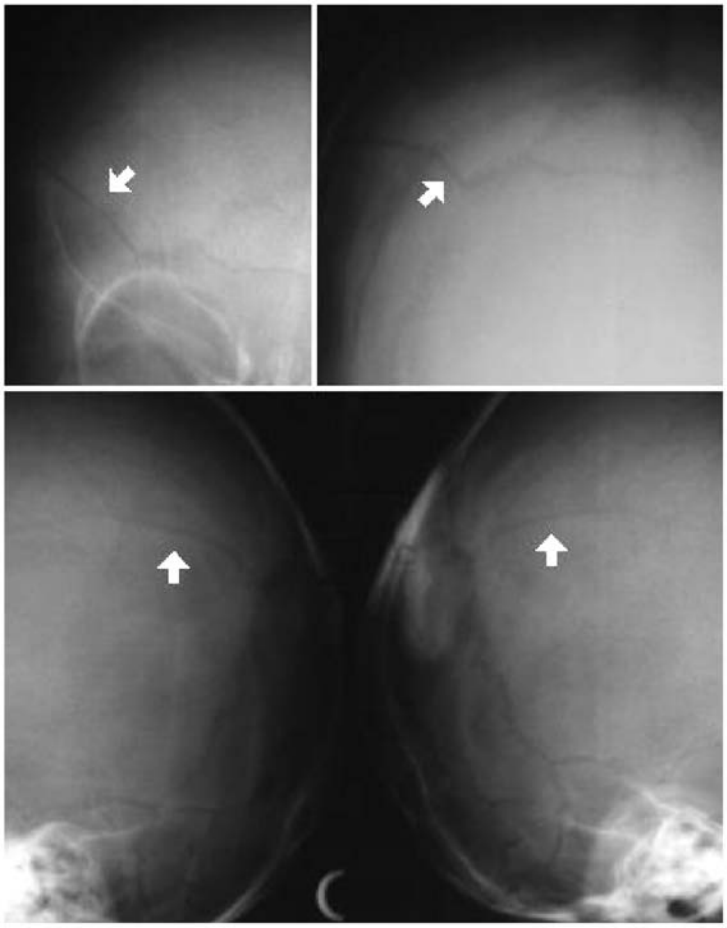
Tintinalli JE. Emergency Medicine: A Comprehensive Study Guide, 5th ed., p. 849; McMillian JA, et al. Oski's Pediatrics, 3rd ed., pp. 1652–1654.

CHAPTER 4: SKULL RADIOGRAPHS

1. The anterior fontanelle is outlined in the broken line. Note that a suture extends anteriorly into the frontal bone from the anterior tip of the anterior fontanelle.



2. Linear fracture of the posterior portion of the right parietal bone extending across the lambdoidal suture into the occipital bone.



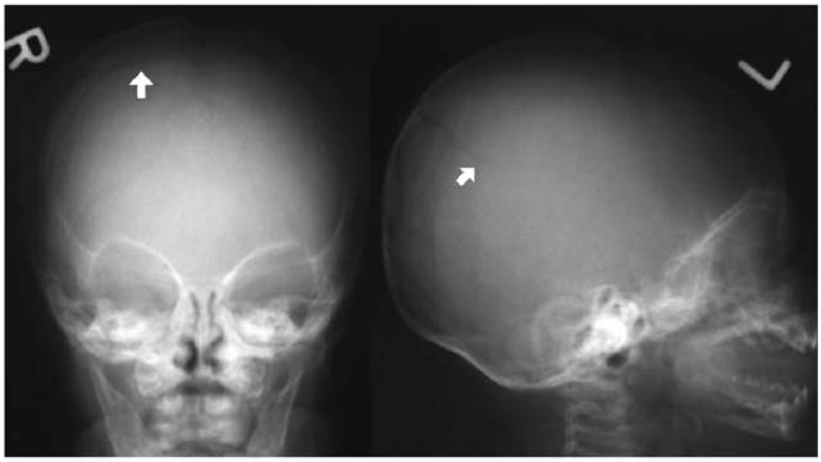
Linear skull fractures are rarely associated with the need for neurosurgical intervention. Patients with such fractures will often present to an acute care clinic or emergency department (ED) several days after the injury with a subgaleal hematoma (soft swelling on the side of the head) as a chief complaint. These are benign and should not be aspirated unless an infection is present.

Parietal skull fractures that cross the path of the middle meningeal artery or other major vessels may be associated with epidural or other types of intracranial hemorrhage. In young children, the middle meningeal artery does not groove into the bone as it does in adults; thus, laceration of the middle meningeal artery is less likely to occur (compared with adults) with a parietal skull fracture. Roughly half the epidural hematomas in children occur in the absence of skull fractures. Thus, plain-film skull radiographs should not be used as a routine screening measure to determine risk of intracranial hemorrhage. CT scanning is more effective at ruling out cerebral hemorrhages.

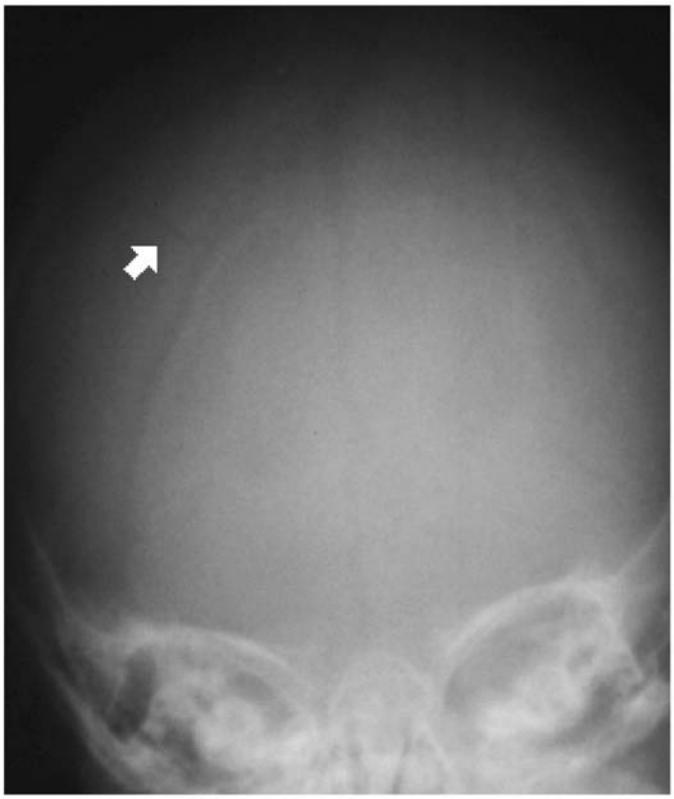
Neither CT nor plain-film skull radiographs are highly reliable in ruling out a basilar skull fracture. Such fractures are difficult to see on CT scans and plain-film skull radiographs. This diagnosis is often made clinically (nasal cerebrospinal fluid [CSF] leak, CSF otorrhea, hemotympanum, Battle's sign, etc.) and then confirmed on fine or angled CT cuts, or MRI.

Widely separated linear skull fractures (widely diastatic) are associated with a higher risk of subdural hematoma and an increased risk of developing leptomeningeal cysts. The follow-up radiograph 1 month later may show a "growing" fracture that results from a meningeal laceration. This results in a bulging leptomeningeal sac that causes erosion of the overlying skull and an eventual skull defect if it is not repaired. Depressed skull fractures may be evident on plain radiographs; however, CT scanning is better able to determine the extent of the depression.

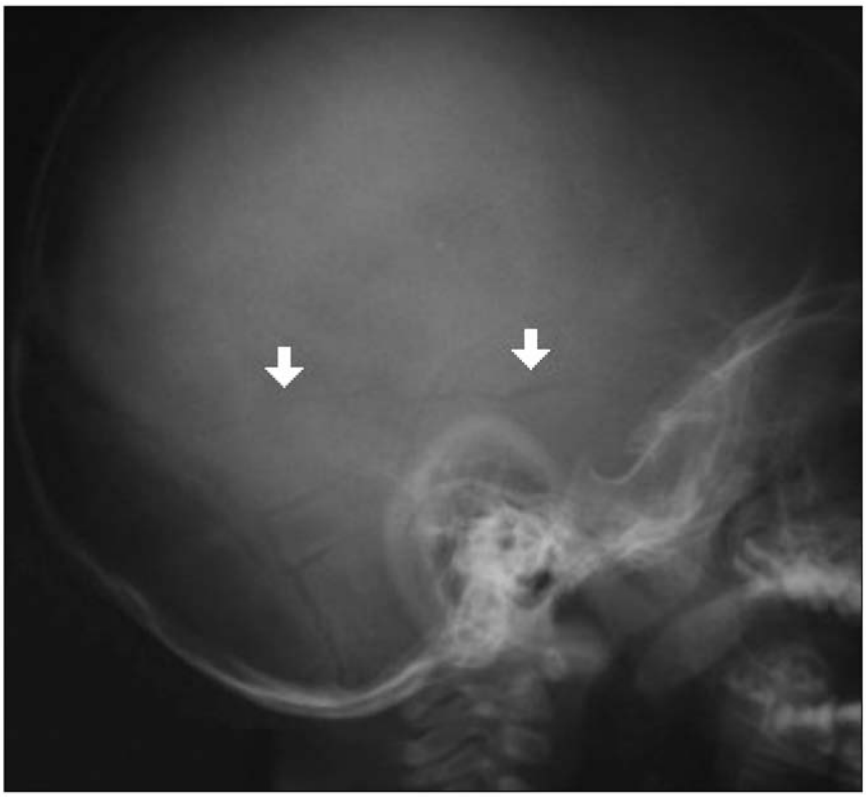
3. Right parietal skull fracture.



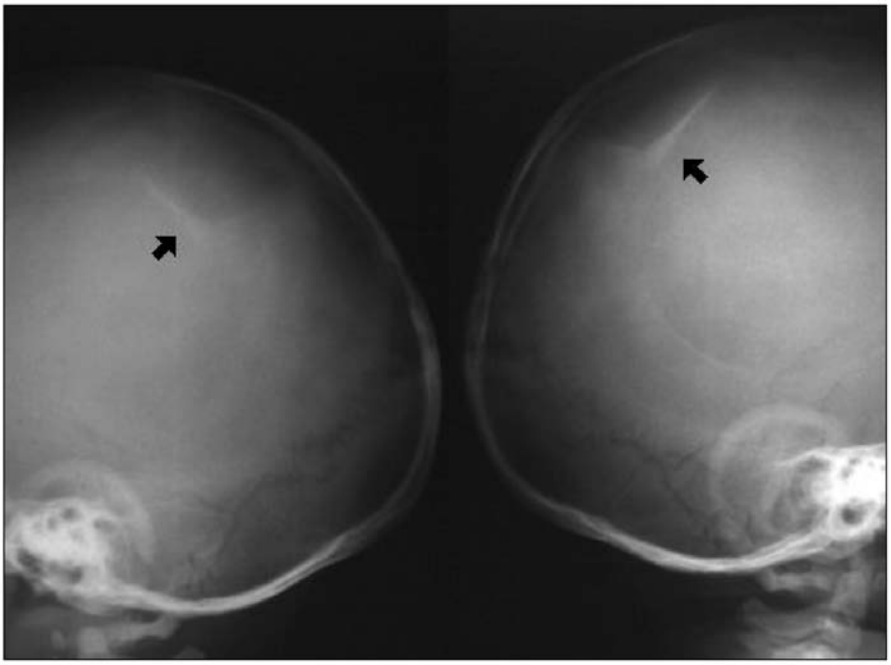
4. Linear fracture of the right occiput.



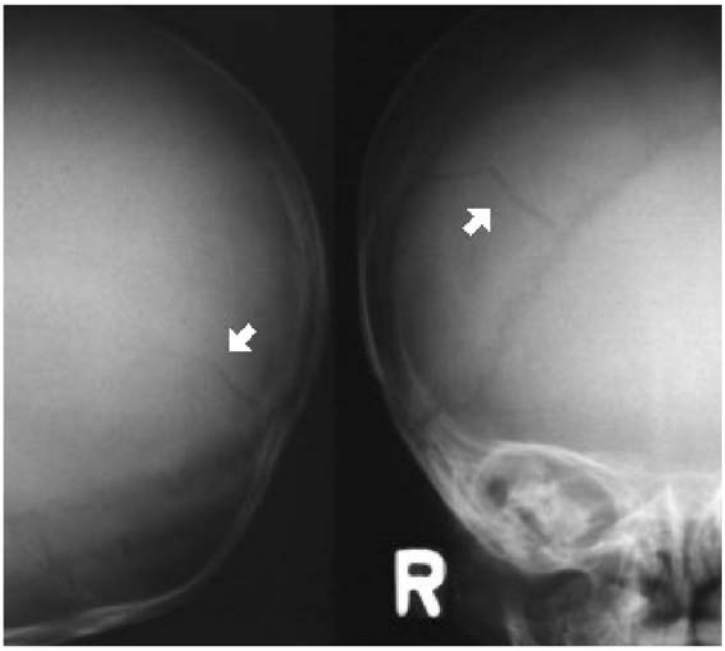
5. Horizontal hairline fracture (very subtle) running across the right temporal bone, which extends posteriorly to the level of the lambdoidal suture.



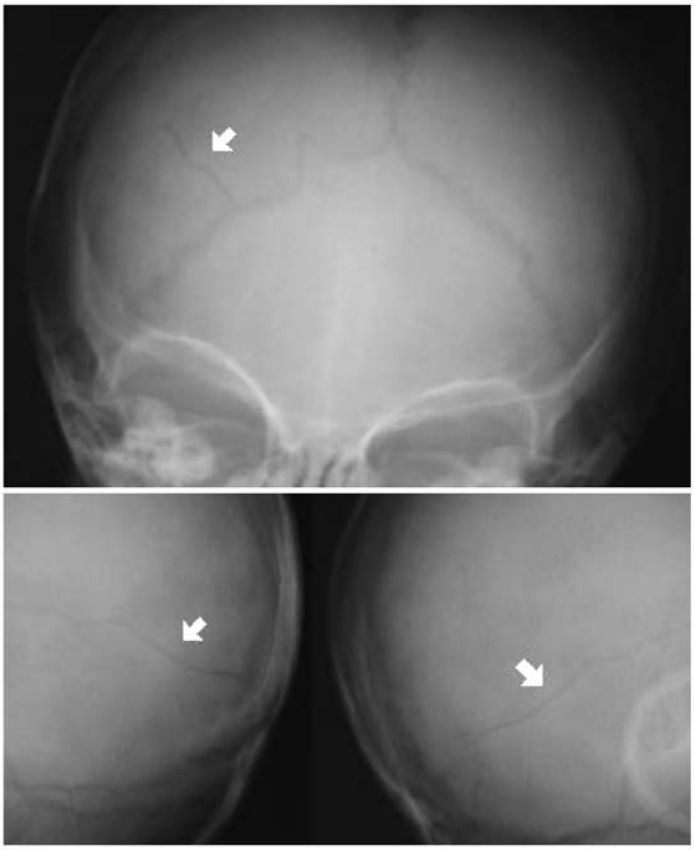
6. There is a depressed skull fracture over the posterior right parietal bone. The hyperdense (sclerotic) appearance of the skull abnormality indicates the presence of a depressed skull fracture.



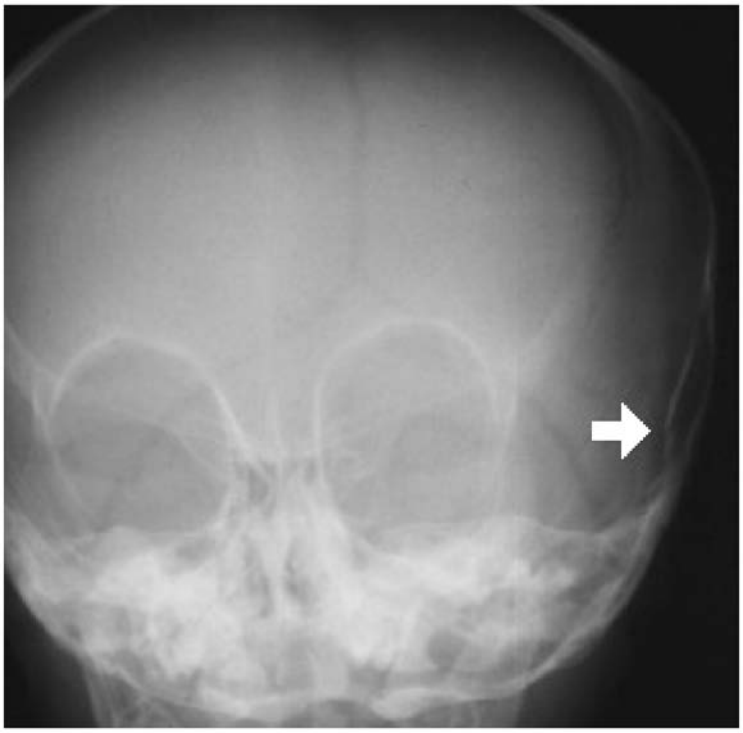
7. There is a 3-cm angled fracture in the right parietal bone, which communicates with the lambdoidal suture.



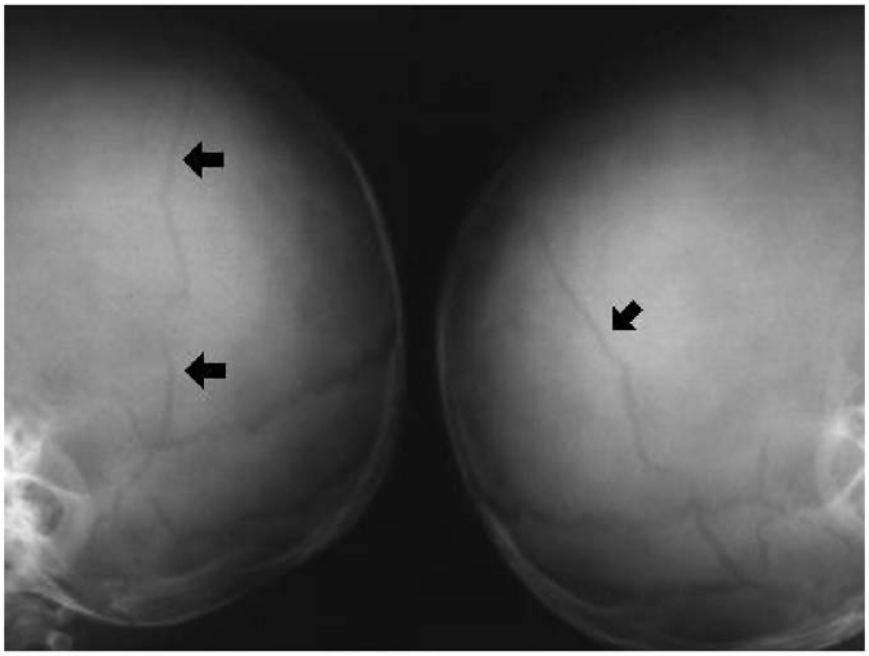
8. Linear skull fracture of the right parietal bone extending from the lambdoidal suture to the parietomastoid suture.



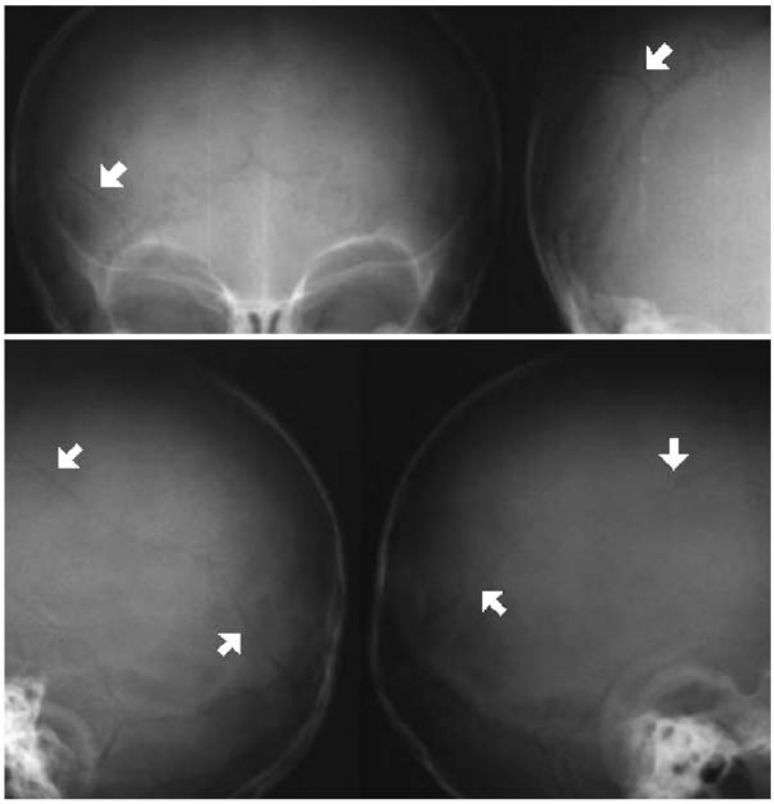
9. There is a fracture of the lower portion of the left parietal bone.



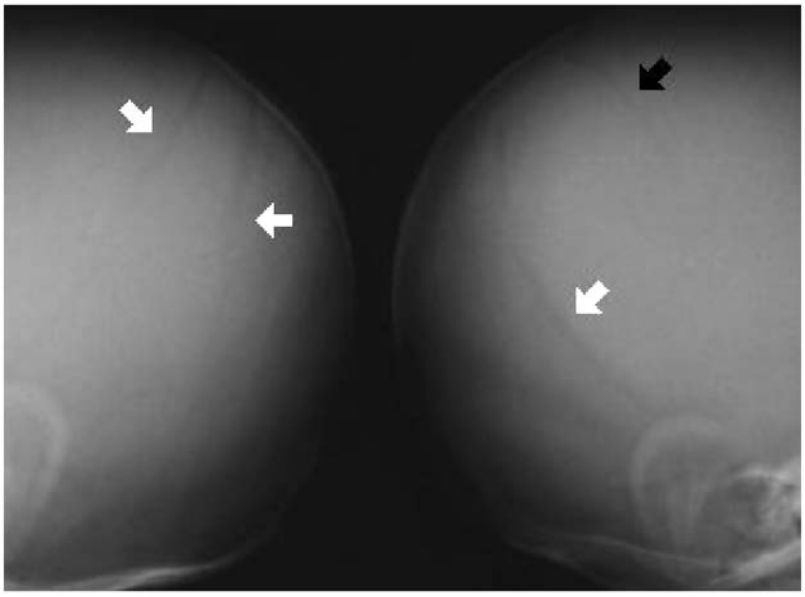
10. Long linear left parietal fracture extending from the vertex to the lambdoidal suture.



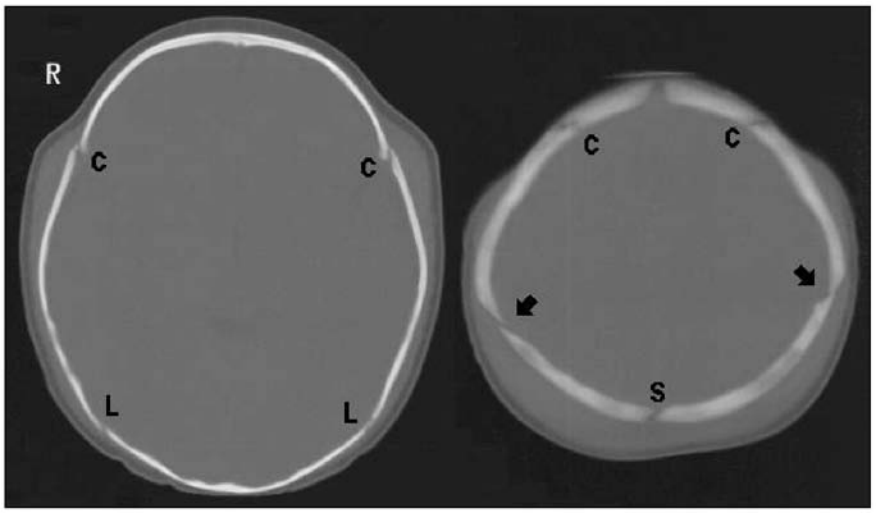
11. Linear fracture extending the length of the right parietal bone.



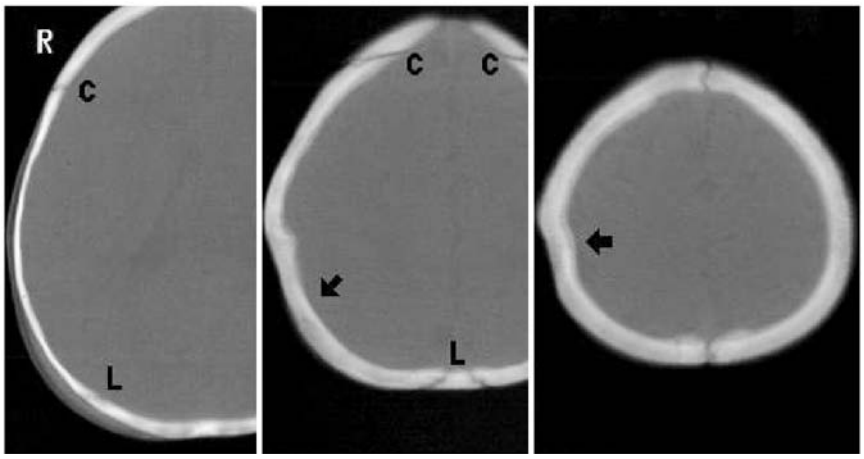
12. Biparietal skull fractures.



13. The top set of scans focuses on the brain, which appears to be normal. Extensive soft tissue swelling exterior to the skull is evident on this set of scans. The lower set of scans is contrasted to view the bones (bone windows). There are bilateral fractures of the parietal region (arrows). The lambdoidal (L), coronal (C), and sagittal (S) sutures are identified. Note that the fracture is not seen in the lower cuts.



14. The top set of scans focuses on the brain, which appears to be normal. A skull depression is visible on the right. The lower set of scans is contrasted to view the bones (bone windows). There is a depressed skull fracture of the upper portion of the right parietal bone (arrows). The lambdoidal (L) and coronal (C) sutures are identified.



References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 9. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v5c09.html.

Bruce DA. Textbook of Pediatric Emergency Medicine, 3rd ed., pp. 1105–1107; The Head. Emergency Imaging of the Acutely Ill or Injured Child, 3rd ed, pp. 577–592.

CHAPTER 5: LONG BONE AND EXTREMITY RADIOGRAPHS

1–5. B, E, A, E, B

The plain films show an angulated distal radius and ulna fracture, a fracture through the physis of the distal ulna, and a dislocation of the distal ulna (radioulnar dislocation). This is a classic Galeazzi fracture, a fracture of the distal third of the radius associated with a dislocation of the distal ulna. Another more obvious fracture of the ulna (present on this film) may or may not be present. The dislocation of the ulna may easily be overlooked, resulting in painful prominence of the distal ulna. This film reveals a dislocated ulnar epiphysis consistent with a type I Salter-Harris (S-H) fracture, although small parts of the metaphysis may still be attached, making it a type II.

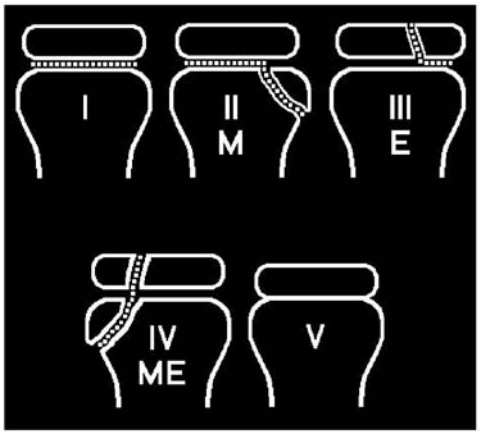
These fractures are relatively uncommon in young children, and are most common in adolescents and young adults. Simple nonangulated fractures of the distal radius still require treatment, but are rarely associated with dislocations of the distal ulna. Treatment for Galeazzi fractures consists of immediate closed reduction, usually under sedation, by an orthopedic surgeon. A careful exam under sedation and traction may reveal ulnar dislocations clinically. Occasionally open reduction is required.

References: Yamamoto LG, Chung SMK. Radiology Cases in Pediatric Emergency Medicine, Vol.1, Case 16. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/ pemxray/v1c16.html.

Letts RM. Management of Pediatric Fractures, pp. 295–321; Zitelli BJ, Davis HW. Atlas of Pediatric Physical Diagnosis, 3rd ed., pp. 663–664.

6–11. B, A, D, A, E, D

The S-H classification system is used to describe fractures in and around the growth plate (physis). The dotted line in the following diagrams corresponds to the fracture line.



S-H type I fractures go straight through the physis only. They may be visible on X-ray as a separation or dislocation of the epiphysis. More commonly, the plain films are normal and the fracture is a clinical diagnosis based on mechanism and point tenderness. They are most common at the distal radius from hyperextension of the wrist. In the following film the fracture is only visible in the lateral view as a slight posterior dislocation of the radial epiphysis.

S-H type II fractures have a fracture line extending into the metaphysis in addition to partial or completed fracture through the physis. This is shown in question 1 above.

S-H type III fractures have a fracture extending through the epiphysis in addition to a partial or complete fracture through the physis.

S-H type IV fractures are a combination of types II and III, with fractures extending into both the metaphysis and the epiphysis (above).

An easy way to keep type II through IV distinguished in your mind is to remember that they increase in severity from II to IV. A fracture into the joint capsule is generally worse than a metaphyseal fracture because the articular surface of a joint is involved. Type III is worse than type II because it involves the joint. Of course type IV is worse than a type III because it has both epiphyseal and metaphyseal involvement. Type III and IV fractures are generally more associated with long-term complications of disability and arthritis.

An S-H type V fracture is a crush injury of the physis. Like type I, type V fractures often appear normal on plain films. They may be visible as a narrowing of the physis. Comparison views of the contralateral limb may be helpful to compare the physeal space. Unfortunately, radiographic appearance is often equivocal. Diagnosis is based on mechanism (forceful axial load along the long bones), and physical exam (tenderness with or without swelling in the physeal area). Here is an example of a type V fracture of the distal tibia. The patient fell from a second story window onto her feet.

This type of fracture often leads to growth arrest in the affected bone.

References: Yamamoto LG, et al. Radiology Cases in Pediatric Emergency Medicine, Vol. 1, Case 18. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemx ray/v1c18.html.

Bachman D, Santora S. Textbook of Pediatric Emergency Medicine, 3rd ed., pp. 1237–1238.

12–17. B, C, E, D, E, A These films show a classic Monteggia's fracture: fracture of the proximal ulna and an anterior dislocation of the radial head. Monteggia first described these classic findings more than 100 years ago; however, today any fracture of the mid- or proximal ulna with radial dislocation may be referred to as a Monteggia's fracture. Radial fracture and/or joint effusion may or may not be present. In these films the anterior fat pad is prominent, but probably within normal limits. The radiocapitellar line should pass through the center axis of the radius and cross the mid-portion of the capitella in all views. In this view the line passes superior to the capitella, indicating dislocation.

The most common mechanism for a Monteggia's fracture is hyperextension of the elbow, although hyperpronation from a fall is another common cause. The most common nerve injury is to the interosseous branch of the radial nerve, which innervates the deep extensors of the forearm. The most feared complications of Monteggia's fractures include recurrent dislocation or subluxation of the radial head with limited range of motion. Any fracture should be evaluated with views of the proximal and distal joints. This rule is especially important with ulnar fractures because they are commonly accompanied by radial dislocations at the elbow. The elbow injury may be easy to miss clinically because of focus on forearm pain and swelling.

References: Young L. Radiology Cases in Pediatric Emergency Medicine, Vol. 1, Case 15. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/ pemxray/v1c15.html.

Joffe M. Pediatric Emergency Medicine Concepts and Clinical Practice, pp. 353–354; Bachman D, Santora S. Textbook of Pediatric Emergency Medicine, 3rd ed., pp. 1260–1261; Letts RM. Management of Pediatric Fractures, pp. 295–313; Lincoln TL, Mubarak SJ. J Ped Orthoped 1994;14: 454–457.

18–22. D, A, E, C, B A small fracture of the radial metaphysis can be seen laterally on the anterior–posterior (AP) view. There is also a prominent anterior fat pad, which may indicate a joint effusion. An oblique view should be considered to help examine this part of the radius. The fracture is slightly more prominent on the oblique view here. (The arrow also helps).

Even if this fracture is missed on X-ray, the child should be treated with fracture precautions, ice, immobilization, and follow-up based on clinical suspicion. It is important to relate to the patient or family that no X-ray can detect 100% of all fractures. An elbow sprain is a common diagnostic pitfall for this type of injury.

Typically, patients with radial head fractures have significant tenderness on supination/pronation, and not much tenderness on flexion/extension.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 1, Case 17. University of Hawaii John A. Burns School of Medicine, http://www. hawaii.edu/medicine/pediatrics/pemxray/v1c17.html.

23–26. C, E, D, C

On the initial X-rays, no obvious abnormality can be noticed. With the presence of swelling and a negative initial radiographic exam, further films are warranted. The oblique views clearly demonstrate a fracture of the lateral (external) condyle.

Orthopedic referral for follow-up would be recommended after confirmation of the above fracture. In fact, without any clear radiographic abnormality, but with the clinical presence of swelling and pain, an orthopedic consult is warranted, as a true radiographic fracture may not always be visible.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 1, Case 19. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v1c19.html.

27–31. A, D, B, D, C

This child suffers from calcaneal apophysitis, also known as Sever's disease. This is the most common cause of heel pain in this age group, and results from repeated microtrauma at the insertion of the Achilles' tendon into the calcaneal apophysis. An apophysis is a growth plate that does not contribute to the length of a bone. Peak age of incidence of calcaneal apophysitis is 6 to 10 for girls and 8 to 12 for boys, just as the apophyses are closing. The injury is bilateral about 60% of the time because usually both heels are experiencing the same overuse.

The radiographs are completely normal. There are some lucencies seen in the calcaneus in the oblique view, but these are normal views of the growth plate. The most practical treatment for this type of injury is to discontinue or limit the aggravating sport until pain subsides. Foam heel pads, which shorten the length of the Achilles' tendon, reducing tension, have been used successfully. Physical therapy with stretching has also been helpful, and short leg casts may be helpful in refractory cases. Long leg casting and orthopedic consultation are not needed in this case.

References: Nakano EA. Radiology Cases in Pediatric Emergency Medicine, Vol. 1, Case 20. University of Hawaii John A. Burns School of Medicine, http://www. hawaii.edu/medicine/pediatrics/pemxray/v1c20.html.

Meehan P. Lovell and Winters Pediatric Orthopedics, 3rd ed., pp. 1001–1002; Micheli LJ, Ireland ML. J Ped Orthoped 1987;7:34–38; Tolo VT, Wood B. Pediatric Orthopaedics in Primary Care, p. 229.

32–38. D, E, A and E, C, C, B, E

Although the first two films could be read as normal, this is a case of presumptive fracture of the scaphoid bone. The emergency room physician who read these films did not see a fracture but correctly placed a thumb spica with radial gutter and wrap and scheduled the patient for orthopedic follow-up. Immobilization helps prevent avascular necrosis, the most significant complication from this type of injury. Radiologists subsequently disagreed about whether a small buckle fracture is visible laterally. Films are required, including scaphoid views, but even with normal films,

snuff-box tenderness with plausible mechanism (wrist hyperextension is the most common mechanism) is indicative of scaphoid injury and should be splinted as shown here, with the addition of a volar splint.

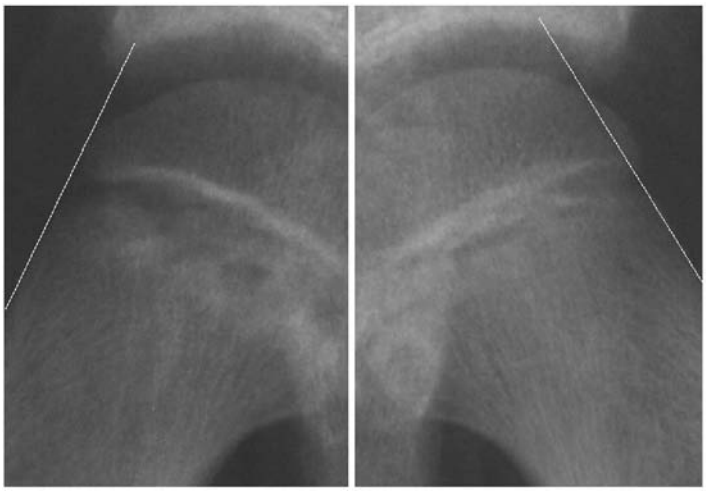
The second patient had a more visible injury to the scaphoid, along with fractures of the radius. The proximal portion of the scaphoid bone has the most tenuous blood supply and has the highest risk of developing avascular necrosis. Children tend to damage the scaphoid more distally. Here a more obvious fracture of the scaphoid bone is shown.

References: Inaba AS, Boychuk RB. Radiology Cases in Pediatric Emergency Medicine, Vol. 1, Case 14. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/V1c14.html.

Simon RR, Koenigsknecht SJ. Emergency Orthopedics: The Extremities, 2nd ed., pp. 81–84; Letts RM. Management of Pediatric Fractures, pp. 389–396; Etzwiler LS. Pediatric Emergency Medicine Concepts and Clinical Practice, p. 332.

39–44. E, C, A, B, E, D This child suffers from slipped capital femoral epiphysis. Obese and active males age 9 to 12 are most at risk because they exert heavy forces on bones that have not yet reached adult strength. Presentation varies from indolent to acute onset. Pain may be at the hip but often the child relates thigh pain and knee pain as the chief complaint. A knee sprain or thigh muscle pull is a diagnostic pitfall. Inability to fully internally rotate at the hip is common.

A line drawn along the proximal femur metaphysis should intersect the epiphysis. In the AP view, the left hip appears normal but on the right side the line barely touches the epiphysis and this gives the diagnosis.



There is also some widening of the right epiphysis but narrowing or normal spacing may also be present. Here is a more obvious case:

In this case no lines are needed; the slip is obvious on the left and is also present on the right. Children are at risk for bilateral injuries, especially if they limp for some time and put more pressure on the unaffected side. Occasionally lateral films, frog-leg, or CT may be ordered to asses subtle slips. MRI is not indicated. Treatment is bed rest and orthopedic consultation for internal fixation.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 2, Case 10. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v2c10.html.

Morrissy RT. Lovell and Winter's Pediatric Orthopedics, 3rd ed., pp. 885–902.

45–49. B, D, A, C, E This case again demonstrates the importance of clinical suspicion. Even after three normal views and normal labs, the orthopedic surgeon persevered. Delayed films or bone scan are more sensitive for hairline or stress fractures. This child had a history and physical suggestive of a fracture from the start. In spite of normal films it would have been inappropriate to offer this patient reassurance without occult fracture pre-

cautions and follow-up. The ultrasound is more sensitive than plain films for joint effusions but is not sensitive for fractures or dislocations. The final film shows a linear hairline fracture. Some small fractures are visible only from specific views and there are many different oblique angle films that can be taken when clinical suspicion is high.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 2, Case 11. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v2c11.html.

50. **A, C**

The radiograph in Fig. 1 demonstrates a pathological fracture through a bone cyst of the proximal humerus. The fracture extends distally through the humerus. The bone cyst's margins are well defined and slightly sclerotic.

51. **A, C**

The radiograph in Fig. 2 shows a large bone cyst in the proximal humerus with a pathological fracture involving the cyst. This is another case in which the history of the trauma is minor, but a fracture is present because of abnormal bone. We cannot always assume that our patients have normal bones.

52. **U, A, U, A, U, A**

Unicameral bone cysts are one of the most common types of benign bone cysts. These cysts contain serous fluid and are lined by a thin connective tissue membrane. Most of these are located in the metaphysis of the proximal humerus or femur. These usually heal spontaneously during the teen years unless a pathologic fracture occurs. Large cysts at risk for recurrent pathologic fracture require treatment, whereas smaller lesions generally regress on their own. Aneurysmal bone cysts are also benign bone cysts, but are not as common as unicameral bone cysts. Common locations include the spine and the same areas as unicameral bone cysts. These are eccentrically placed within the metaphysis. The lesion resorbs cortex and elevates the periosteum, resulting in an aneurysm-like appearance. These are more difficult to distinguish from malignant tumors; CT may be helpful in determining this. Nonossifying fibromas, nonosteogenic fibromas, and fibrous cortical defects are different terms for the same histological process. The names differ because of the different radiographic appearances. Small lesions are called fibrous cortical defects. Larger lesions, referred to as nonossifying fibromas, cause bulging of the bone and bony reaction over the lesion.

Fibrous dysplasia is a developmental anomaly of the bone that results in focal lesions of the bone where fibrous tissue replaces the medullary canal. The majority of patients have a single focal lesion and a few patients have multiple lesions.

Pathological fractures occur with minimal trauma that would not ordinarily be expected to cause a fracture. Basically, these are fractures through weak bones. Conditions causing weak bones can be divided into two types:

a. Conditions that cause focal weakness; or

b. Generalized conditions causing all the bones to be weak.

53. **D, D, D, F, D, D, F**

Focal conditions include benign tumors or tumor-like conditions, malignant bone tumors, metastatic lesions, infectious or inflammatory conditions (osteomyelitis, eosinophilic granuloma), and iatrogenically weakened areas of bone (screw holes, bone graft harvest sites, etc.). Even though an incompletely healed fracture may be weaker than normal bone, a new fracture through a healing fracture is generally not considered to be a pathological fracture.

Generalized conditions resulting in weak bones include osteogenesis imperfecta, osteopetrosis, neurofibromatosis, fibrous dysplasia, rickets, renal osteodystrophy, scurvy, hyperparathyroidism, Cushing's syndrome, cytotoxic drugs, and disuse atrophy because of neurological or other disabling conditions resulting in generalized demineralization.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 6, Case 1. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v6c01.html.

Poitras B, Rivard CH. Management of Pediatric Fractures, pp. 1027–1048.

54–56. B, A, E

The lateral radiograph view better delineates the oblique spiral nature of the fracture. This is a substantial fracture. Because this is a femur fracture, there should be a history of substantial trauma, which is lacking in this case.

The parents are confronted with the child's radiographs. They are asked if there is any other possible injury about which they have neglected to tell the physician. They cannot recall any other possible trauma. His mother now believes that the door may have hit the box she was carrying at the time and this box might have hit him in the leg. She is told that such an injury would require a force greater than this. Another possibility is that he received several immunizations in his thighs at his pediatrician's office three days earlier, but he did not seem to be in any pain until this night.

In most instances, it is advisable to inform parents whenever a report to the child protective authorities is made, because they may be very unhappy when they find out that such a report has been submitted. If they are upset enough, they will be able to find out who made the report and they may possibly retaliate in some way. An easy way to inform parents that a report is about to be made is to inform them in a very nonjudgmental and nonpersonal way. Put the radiograph with the femur fracture on the view box and, while pointing to the fracture, inform them, "There is a government law that requires us to report this type of injury to the child protective authorities. I, as a physician, have no choice in the matter. Whenever this type of injury occurs, it must be reported. The child protective authorities will be contacting you. Just tell them what happened." This approach is nonjudgmental because it does not accuse anyone of causing the injury. Parents perceive that it is the radiograph that is being reported, and not them personally.

No other fractures were identified on the complete skeletal survey. However, the radiologist noted the possibility of Wormian bones on the views of the skull. The radiologist also felt that the long bones were slightly demineralized. This raises the possibility of osteogenesis imperfecta (OI). A geneticist was consulted.

By this time, child protective authorities had investigated the home and the parents. They concluded that the likelihood of child abuse was low if there could be a medical explanation for the injury. A detailed family history done by the geneticist revealed a family history of multiple fractures, malformations, scoliosis, and "bow legs." The geneticist felt that the infant had OI type I or type IV. Genetic studies were sent to a specialized reference lab for confirmation.

There are four types of OI. Type I is characterized by osteoporosis and excessive bone fragility, blue sclerae, and hearing loss in adolescents and young adults. This is the most common form of OI, with an incidence of about 1 in 30,000 live births. Inheritance is autosomal-dominant. Minimal trauma may result in fractures. About

10% of infants have fractures at birth. Bow legs, flat feet, kyphosis, and scoliosis are commonly seen with OI. A variant of OI type I is associated with dentinogenesis imperfecta (yellow or blue-gray translucent teeth, which frequently erode or break prematurely). Radiographs show generalized osteopenia and healing fractures. Skin fibroblasts from patients show a reduction of type I procollagen synthesis.

Type II OI is a lethal form characterized by low birthweight, severe osteopenia, crumpled long bones, and multiple rib deformities (beaded ribs). Most cases are new mutations, but some are autosomal-recessive, occurring in 1 in 60,000 live births. Fifty percent are stillborn and the remainder eventually succumb to respiratory failure owing to the skeletal defects of the chest. The skull is soft and the limbs are short. The skin is fragile as well. Type I collagen (the main collagen of bone) synthesis is defective.

Type III OI manifests in the newborn or infant with multiple fractures caused by severe bony fragility. The sclerae may be blue at birth and become less blue with age. Inheritance is autosomal recessive, with clinical variability in severity. Very few patients reach adulthood. Children sustain multiple fractures and progressive kyphoscoliosis. The skull is soft and deformed. Most patients succumb to cardiorespiratory complications in infancy or childhood.

Type IV OI is characterized by osteoporosis leading to bone fragility of variable severity. Inheritance is autosomal dominant. The sclerae may be bluish at birth, but this becomes less prominent as the patient ages. Because of variable severity, some patients sustain their first fractures in infancy, whereas others sustain their first fractures as adults. There are variable degrees of bow legs, scoliosis, and short stature. Many patients show spontaneous improvement with age. This form of OI may be occult. Radiographs may demonstrate osteopenia, but this is not as severe as in other forms of OI.

It appears that our patient fits best with OI type IV.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 6, Case 2. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v6c02.html.

Nelson Textbook of Pediatrics, 15th ed., pp. 1978–1980. Poitras B, Rivard CH. Management of Pediatric Fractures, pp. 1027–1048.

57–61. C, E, D, C, C

Interpretation: The L2 vertebra shows some loss of height of the anterior vertebral body. The posterior vertebral line is intact. A compression deformity of L2 is suspected.

Thoracolumbar fractures are a major cause of disability. Ninety percent of all spinal fractures are in the thoracolumbar region. Fractures at the thoracolumbar junction have a significant incidence of neurological deficit of up to 40% in one series. Several factors contribute to thoracolumbar vulnerability: (a) in the lumbar spine there are no ribs to provide additional stability as in the thoracic region; (b) the alignment of the spine changes from a kyphotic curvature in the thorax to a lordotic alignment in the lumbar spine; (c) lumbar spinal segments are more mobile than thoracic segments. The mobility is caused in part by changing orientation of the facet joints. The coronal orientation of the facets in thoracic region is more stable then the oblique orientation of the lumbar region.

The three-column concept: The management and outcome of lumbosacral spine injuries largely depend on the stability of the spinal column. There are different models to describe the stability following an injury. The three-column concept described by Denis in 1983 is the most accepted (*see* Fig. 1).

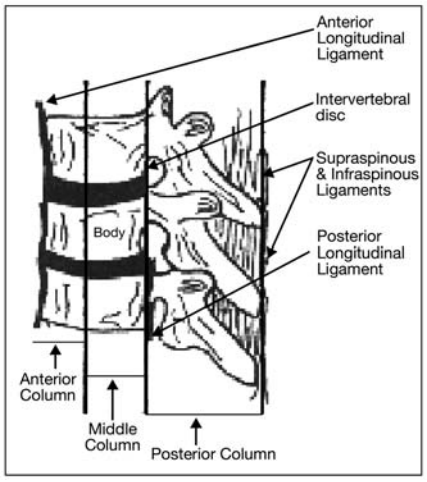


Fig. 1. Denis' three-column concept of spinal stability post-injury.

The anterior column consists of the anterior longitudinal ligament and the anterior part of the vertebral body.

The middle column extends from the middle portion of the vertebral body to the posterior aspect of the vertebral body and includes the posterior longitudinal ligament.

The posterior column includes all bony and ligamentous structures posterior to the posterior longitudinal ligament and includes the pedicles, facets, spinous processes, and all associated ligaments.

Fractures involving only the anterior columns are considered stable, whereas fractures that involve the middle or all three columns are considered unstable.

Types of thoracolumbar fractures: Thoracolumbar fractures and dislocations have been classified by different investigators. However, no one classification system is inclusive of all injury patterns. Currently, the classification described by McAfee et al. is the most widely recognized. Their thoracolumbar spine (TLS) injury scheme consists of five distinctive injury patterns: wedge compression fractures, burst fractures, Chance fractures, flexion–distraction injuries, and translational injuries (*see* Fig. 2). In recent years, the increased use of MRI and helical CT scanning have led to improvements in classifying TLS injuries.

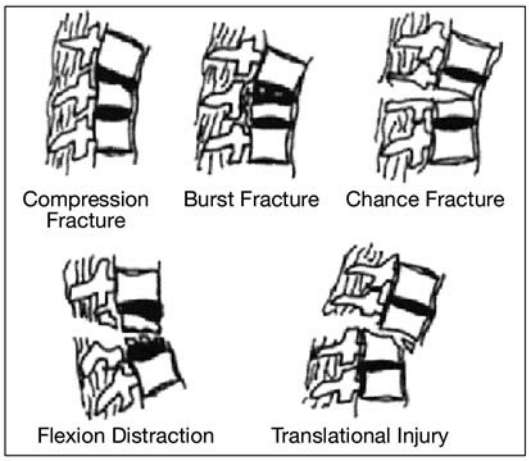


Fig. 2. McAfee et al.'s five-injury scheme.

Wedge compression fractures are the most common type of lumbar fracture. They occur during hyperflexion and axial loading (as was likely in our case). The vertebral body fails under a compressive load and its anterior portion becomes compressed, whereas the middle column remains intact. This fracture is rarely associated with neural injury unless multiple adjacent vertebral bodies are compressed. Radiographically, the wedge deformity is best appreciated on the lateral view. A CT scan is used to confirm that the posterior vertebral body, pedicles, and lamina are intact.

A burst fracture of the spine is a fracture of the anterior and middle columns of the spine with or without an associated posterior column fracture. Both a compression fracture and burst fracture occur during hyperflexion and axial loading of a vertebra. With a burst fracture, however, there is compression of the vertebra and intervertebral disk in such a fashion that the compressed disk adjacent to the affected vertebra herniates into the vertebral body. As a result, the vertebra fractures outward with retropulsion of bone fragment into the spinal canal and an increase in interpeduncular distance (distance between the pedicles). All burst fractures have the potential for severe neurological sequelae and be considered unstable during the initial ED evaluation. Unstable burst fractures are treated with surgical stabilization to improve long-term alignment. For stable fractures, the neurological outcome may be similar for surgically and nonsurgically treated patients.

A Chance fracture is commonly associated with lap seat belt use in high-speed motor vehicle crashes. A Chance fracture is a horizontal vertebral injury that results from flexion about an axis that is anterior to the anterior spinal longitudinal ligament. This vector of force results in the horizontal disruption of the spinous process, lamina, transverse processes, pedicles, and the vertebral body. A lateral radiograph best illustrates the split in the posterior arch and vertebral body. More subtle signs include an increase in adjacent spinous process distance above and below the injury and an increase in the height of the posterior vertebral body. An AP radiograph may demonstrate the split in the transverse processes. Because the fracture runs in an axial plane, a routine axial CT scan may miss a Chance fracture. It is important to perform the reconstruction in the sagittal plane to detect the fracture and any malalignment caused by ligamentous injury.

A flexion distraction injury is one in which the axis of flexion is posterior to the anterior spinal longitudinal ligament. There is compressive failure of the anterior column, and destructive forces placed on the middle and posterior columns lead to a tear of the posterior longitudinal ligament. Typically, these injuries involve both ligamentous and bony structures and can extend over more than one vertebral level. These injuries are considered unstable because the middle column and often the posterior column are disrupted. Radiographic findings include anterior impaction with compression fracture of the vertebral body and posterior distraction with fanning of the spinous processes.

Translational injuries are associated with shearing forces that disrupt all three columns. Because the ligament of the spinal canal is affected, these injuries are always unstable and are associated with a very high incidence of neurological deficit. On the AP radiograph, the interspinous distance at the affected level is widened and there may or may not be a rotational malalignment of the vertebra. CT scan may show "naked facets" or a double vertebra, if the dislocation is severe.

TLS injuries are common and often result in serious morbidity. Forty-seven percent of patients with spine trauma and 64% with spinal cord injuries have concomitant injuries elsewhere. In the setting of multiple trauma, in which most TLS injuries occur, strict spinal cord injury precautions must be observed until injury has been ruled out. Application of Denis's three-column model to assess spinal stability and McAfee's classification of fracture/dislocation facilitate management decisions.

References: Khan A. Radiology Cases in Pediatric Emergency Medicine; Vol. 6, Case 13. Maimonides Medical Center. Dayan PS. Columbia College of Physicians and Surgeons; http://www.hawaii.edu/medicine/pediatrics/pemxray/v6c13.html.

Kraemer WJ, et al. J Orthoped Trauma 1996;10(8):541–544; Frankel HL, et al. J Trauma 1994;37:673–676; Kaye JJ, Nance EP. Radiol Clin North Am 1990;28:361–377; Brandser EA, Ei-Khoury GY. Radiol Clin North Am 1997;35:533–557; Denis F. Clin Orthop 1984;189:65–76; Denis F. Spine 1983;8:817–831; McAfee PC, et al. J Bone Joint Surg 1983;65-A:461–473; Holdsworth FW. J Bone Joint Surg 1963;45-B:6–20; Savitsky E, Votey S. J Emerg Med 1997; 15(1):49–60; Saboe LA, et al. J Trauma 1991;31:43–48.

62–66. B, A–D–E, E, B, B

Upon questioning one of the patient's friends, it was revealed that the patient had taken 20 or 30 shots of liquor the previous night. After falling off the barstool, his friends carried him into the back of a pickup truck, where he slept until he awoke the next day. His compartment syndrome (CS) was the result of his sleeping on his arm in an intoxicated state and compressing it for an extended period of time. Because of his ethanol intoxication, normal body protective reflexes that stimulate the body to move and roll while sleeping were blunted. In retrospect, it was believed that the necrotic lesion on his back was probably caused by pressure necrosis resulting from something (in the back of the pickup truck) pressing on his flank while he was unconscious.

Key points about CS:

1. CS can occur without any trauma. Prolonged external compression of an extremity can occur in the setting of drug/alcohol overdose and lead to CS.
2. Prognosis depends on the speed of diagnosis and treatment.
3. Severe pain (especially with passive stretching of the muscles) followed by increasing neuromuscular deficits are the key clinical manifestations of CS.

4. The traditional sign of pulselessness is not a definitive criterion of CS. Pulses may still be palpable in CS because of arteriole–arteriolar shunts. Do not be fooled by palpable pulses. Learn the three important P's of pain, paresthesia, and paresis.
5. CS is mainly a clinical diagnosis, but can be confirmed by measuring intracompartmental pressures.
6. Critically ill patients may present with a myriad of complicating factors:
   a. Shock: Hence, a lower intracompartmental pressure is needed to overcome a lower perfusion pressure. Additionally, patients who require large volume resuscitation are at risk for developing interstitial edema and subsequent CS *(7)*.
   b. Altered mental/neurological status: Thus, the patient may not complain of pain and/or paresthesia. Examples include patients with central nervous system injury or patients on narcotics *(5)*.
   c. Hypoxia and/or anemia: In this case ischemia will occur more quickly following smaller compromises in capillary perfusion pressure.
7. Treatment of rhabdomyolysis involves aggressive intravenous hydration to prevent acute renal failure.
8. Fasciotomy is the definitive treatment for compartment syndrome.

References: 1. Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 7, Case 7. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v7c07.html.

2. Vollmar B, et al. J Trauma 1999;46(1):91–96; 3. Carriere SR, Elsworth T. J Emerg Nursing 1998;24(3):214–217; 4. McQueen MM, et al. J Bone Joint Surg (Br) 2000;82-B(2):200–203; 5. Cohen RI, Rao R. Chest 1997;111(3):810–812; 6. Freedman SH, King BR. Textbook of Pediatric Emergency Procedures, pp. 1113–1114; 7. Jacobs DG, et al. J Trauma 1999;46(2):343–345; 8. Arbabi S, et al. J Trauma 1999;47(5):829; 9. Heppenstall RB. Univ Pennsylvania Orthopaedic Journal (online at http://health.upen.edu/ortho/oj/oj10sp97p49.html), 1997; 10. The Leg Emergency Orthopedics: The Extremities, 3rd ed., pp. 471–478; 11. Uppal GS, et al. J Orthoped Trauma 1992;6(1):87–89.

67. **B**

68. **D** Plantar flexion and inversion

69.

Bones:
- b1—Fibula
- b2—Tibia
- b3—Talus
- b4—Calcaneus

Ligaments:
- A—anterior talofibular ligament (ATFL)
- B—calcaneofibular ligament
- C—posterior tibiofibular ligament
- D—intraosseous membrane
- E—anterior tibiofibular ligament

70. **A** Ankle injuries are one of the most common sports-related orthopedic injuries seen in the ED. These types of injuries are most commonly sustained in patients between 15 and 35 years of age. The majority of ankle sprains (up to 85%) are caused by inversion injuries, whereas only 15% are caused by eversion-related injuries.

Although ankle sprains are common in older adolescent patients and young adults, isolated ankle sprains are not very common in younger children and in preadolescent patients. The physis (growth plate) in these younger children is much weaker than the surrounding ligaments, and is thus more susceptible to injury. Therefore in the pediatric population, injuries involving the growth plates (Salter-Harris injuries) must also be considered in addition to ligament sprains. The ATFL is the weakest of the three lateral ligaments and is the most commonly injured of the lateral ankle ligaments. Sixty-five percent of lateral ligament sprains are confined to the ATFL alone, while 20% have concomitant CFL tears.

The white arrow in Fig. 4 points to the region of the ATFL. Because the patient in this case has point tenderness in an area other than that over the ATFL, he has therefore not sustained a typical ankle sprain. In comparison with these lateral ligaments, the medial deltoid ligament has a fair degree of elasticity and is much more resistant to tears. Most injuries also occur while the ankle joint is in plantar flexion rather than in dorsiflexion. Anatomically, the talar dome is wedge-shaped, with the anterior aspect of the talus being wider than the posterior aspect. During dorsiflexion, this wider, anterior aspect of the talus is engaged within the mortise (formed by the distal tibia and fibula), and the joint is very stable. However during plantar flexion, the narrower, posterior aspect of the talus becomes engaged in the ankle mortise (Fig. 3).

Fig. 3. Visual of Mortise.

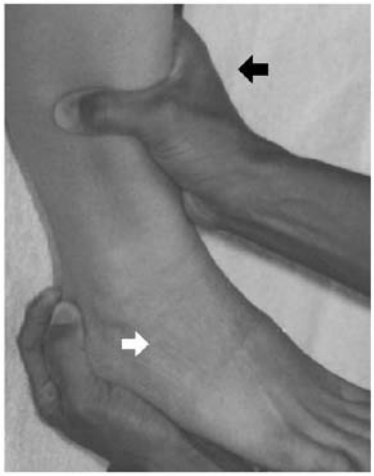


Fig. 4. Anterior drawer test.

71. A

The last part of the clinical examination of an injured ankle involves assessing the stability of the ankle joint. The two maneuvers that can be performed to assess the stability of the ankle joint are the anterior drawer and talar tilt maneuvers. Do not attempt to perform either of these tests if there is an obvious deformity of the ankle suggestive of a possible ankle fracture.

The ATFL ligament normally prevents the anterior subluxation of the talus from the mortise. The anterior drawer maneuver assesses the integrity of the ATFL. Because the ATFL is usually the first ligament to be injured in a typical inversion injury, some physicians feel that if this anterior drawer test is negative, it is then unnecessary to perform the talar tilt maneuver, as the talar tilt stress test is positive only if both the ATFL and the CFL are injured. To perform the anterior drawer maneuver, the patient can be either supine or sitting down, with the ankle in neutral position. One hand of

the examiner cups the heel of the affected ankle (and attempts to pull the foot anteriorly), while the other hand braces along the anterior aspect of the lower leg (Fig. 4).

If the foot of the affected ankle can be pulled forward by more than 3 to 5 mm (or if the affected ankle can be subluxed more forward than the nonaffected side), suspect a rupture of the ATFL.

72. B

The talar tilt test assesses the integrity of the CFL. To perform this maneuver the patient can again be either sitting down or supine, with the ankle in neutral position. While one hand of the examiner holds the lower leg stationary, the other hand gently attempts to invert the ankle.

Review the talar tilt maneuver.

Greater than 10° of difference in the talar tilt when compared to the nonaffected side is suggestive of an injury to the CFL.

73.

Proximal to the lateral and medial ankle ligaments, the distal tibia and distal fibula are connected to each other by a series of tough fibrous structures collectively referred to as the tibiofibular syndesmosis. The three individual components that make up this syndesmosis include (a) anterior tibiofibular ligament, (b) posterior tibiofibular ligament, and (c) intraosseous membrane.

One can check for injuries of the tibiofibular syndesmosis by the squeeze test. To perform this test, the examiner firmly grasps the patient's lower leg (around the lower aspect of the calf), and gently squeezes the tibia and fibula together. Provided that there are no fractures of the tibial or fibular shafts, if ankle pain can be elicited by this squeeze maneuver, one should suspect an injury to one or more of the components of the tibiofibular syndesmosis.

74. A, B, D

75.

AP, lateral, and mortise views.

AP view: There are several findings that can be observed on the AP view. The tip of the lateral malleolus normally extends more distally than the tip of the medial malleolus. The syndesmosis of the ankle joint normally causes an overlap of the medial aspect of the distal fibula and the lateral aspect of the distal tibia on this AP view. Therefore, subtle fractures involving either the lateral aspect of the distal tibia or the medial aspect of the distal fibula (i.e., between the tibia and fibula) may be difficult to visualize on this AP view alone because of the overlap. It is a common pitfall to

miss a S-H type III fracture of the distal lateral tibia because it is obscured by the overlapping fibula.

Lateral view: The lateral view provides a better view of the posterior aspect of the distal tibia and fibula, the talus, calcaneus, and the base of the fifth metatarsal.

Mortise view: This mortise view represents a true AP projection of the ankle mortise and also provides a good visualization of the talar dome (to rule out osteochondral talar dome fractures). The clear joint space (formed by the talofibular joint, the superior space between the dome of the talus and the tibial plafond [the inferior articulating surface of the tibia], and the tibiotalar joint) should all uniformly measure 3 to 4 mm. A difference of greater than 2 mm (i.e., the joint space width varies by more than 2 mm—e.g., the joint space measures 2 mm at the lateral part of the joint and 5 mm at the medial side of the joint) is suggestive of mortise instability.

76. This patient has sustained a nondisplaced S-H type I fracture of the distal fibula (lateral malleolus) that would warrant an outpatient orthopedic follow-up.

For our patient, the AP and lateral views do not reveal any obvious fractures. However, there is a subtle widening of the medial aspect of the distal fibular growth plate (physis) on the mortise view. Comparative views and/or stress views would confirm that this is a fracture versus a normal growth plate closure. This patient has sustained a nondisplaced S-H type I fracture of the distal fibula (lateral malleolus).

Clinical and or radiographic criteria that would warrant immediate orthopedic intervention include:

- An open fracture.
- Any type of injury with neurovascular compromise.
- Any unstable fracture (which would be difficult to adequately immobilize in a splint).
- Any dislocation (which tends to carry a high risk of neurovascular compromise).

77. This patient may be immobilized in an appropriate splint and sent home with an orthopedic referral for definitive casting. A posterior ankle splint would probably not be adequate immobilization by itself for an ankle fracture.

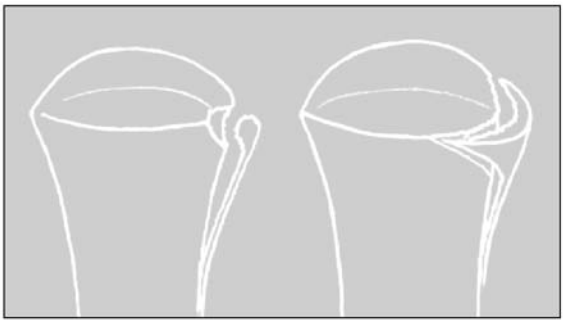
References: Inaba AS. Radiology Cases in Pediatric Emergency Medicine, Vol. 3, Case 3. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v3c03.htm.

Anderson AC. Textbook of Pediatric Emergency Medicine, 3rd ed., pp. 259–267; Harris JH, et al. The Radiology of Emergency Medicine, pp. 966–1009; Jackson JL, Linakis JG. Pediatric Emergency Medicine: Concepts and Clinical Practice, pp. 366–375; Pigman EC, et al. Ann Emerg Med 1994;24;41–45; Reisdorff EJ, Cowling KM. Emerg Med Reports 1995;16;39–48; Simon RR, Koenigs SJ. Emergency Orthopedics, The Extremities, 3rd ed., pp. 477–489; Stiell IG, et al. Can Med Assoc J 1992;147:1671–1678; Stiell IG, et al. JAMA 1993;269:1127–1132; Swischuk LE. Emergency Imaging of the Acutely Ill or Injured Child, 3rd ed., pp. 528–548.

78,79. Corner fractures on both sides of the distal femur are barely visible at the top, after 2 days the two corner fractures are more clear, and after 9 days the fracture sites show some periosteal reaction. The pattern of healing shows a bucket-handle appearance at the inferior border of the metaphysis.

The upper extremity radiograph shows a transverse fracture of the mid-portion of the shaft of the left humerus.

Significance of epiphyseal–metaphyseal fractures: Injuries at the epiphyseal–metaphyseal junction are highly suggestive of abuse. The periosteum surrounding the growing long bones is thick and tightly anchored at both ends by heavy extensions into the epiphyseal cartilages. In contrast, the highly vascularized, loosely attached young periosteum of the diaphysis is easily torn from its underlying cortex. The resultant subperiosteal bleeding lifts the periosteum, forming layers of periosteal new bone away from the cortex to form an external shell of new bone. This extremely strong periosteum that is tightly anchored by heavy extensions into the epiphyseal cartilages can easily explain the dynamics of epiphyseal–metaphyseal fractures. Axial ligament and periosteal traction or torsion forces are generated by sudden traction on the extremity, such as that which occurs when the arms or legs are pulled or swung violently upward or forward. This results in the typical traction "corner" fracture pathognomonic of child abuse (shown here).



80.

Multiple views of the right elbow demonstrate a distal humeral bucket-handle type fragment. The thin fragment represents a section of the distal metaphysis. Although the physis (growth plate) cannot be seen radiographically, it is evident that the fracture must go through the physis to splinter off a section of the distal metaphysis, as seen. The radius should be pointing at the capitellum in all views. In the oblique lateral view, the radius is not pointing straight at the capitellum, indicating that the epiphysis of the humerus (capitellum) is displaced. The AP view shows that the capitellum is displaced medially. This type of fracture is known in the orthopedic literature as a "transepiphyseal" (transphyseal) fracture. This is not a true bucket-handle fracture, although it resembles a bucket handle.

Types of fractures suggestive of child abuse are as follows:

Epiphyseal–metaphyseal fractures: "Corner" fractures are pathognomonic of child abuse. These are well-visualized in the cases described above.

Metaphyseal fractures: These fractures were first described by Caffey in 1972, who felt they represented an indirect avulsion injury to the metaphysis by the pull of the periosteum when the child was severely shaken. In 1983, Kleinman and Zito showed these to be transverse fractures through the metaphysis and appeared to be avulsion injuries only because of the radiographic projection views. If the metaphysis is tipped or simply projected obliquely to the X-ray beam, the margin of the resultant fragment is projected with a bucket-handle appearance. If the peripheral fragment is substantially thicker than the central fragment, and the plane of injury is viewed tangentially, a corner fracture appearance results. Note the potential radiographic

appearance of the injuries diagrammed earlier. Some authors believed that metaphyseal fractures were most suggestive of abuse. Reed has pointed out that these metaphyseal fractures can be seen in other orthopedic conditions, including rickets, scurvy, multiple congenital contractures, and kinky-hair syndrome.

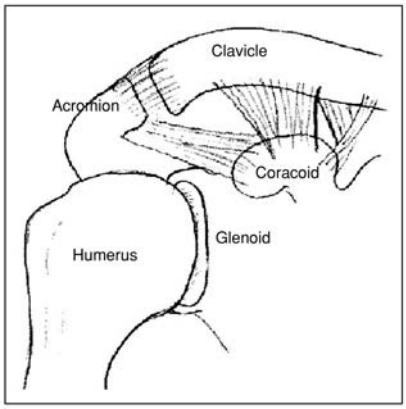
Diaphyseal fractures: These are grouped into three broad categories: (a) transverse, spiral, and oblique shaft fractures; (b) multiple fractures in various stages of healing; (c) bony deformity. A spiral or oblique fracture is produced by a twisting mechanism, whereas a transverse fracture is caused by a direct blow.

In summary, radiographic findings indicating child abuse include epiphyseal–metaphyseal fractures, such as "corner" or "bucket-handle" fractures, and subperiosteal hematoma bone formation, as described above. Consultation with an experienced radiologist will often be helpful in determining the etiology of the injury. Technetium 99 bone scanning has been shown to be highly sensitive when used to assess skeletal injury, particularly in occult areas not easily accessible to clinical examination.

References: Boychuk RB. Radiology Cases in Pediatric Emergency Medicine, Vol. 4, Case 2. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v4c02.html.

Black GV. Management of Pediatric Fractures, pp. 931–944; Caffey J. Am J Dis Child 1972:124:161; Kleinman PK, Zito JL. Presentation to the 26th Annual Meeting of the Society for Pediatric Radiology, April 1983; Reed MH. Pediatric Skeletal Radiology.

81. Acromioclavicular (AC) ligaments and coracoclavicular (CC) ligaments; see diagram below.



82. Direct trauma to the point of the shoulder (i.e., a direct blow to the AC joint region, as in the case of our patient) or secondary to falling and landing on the deltoid region with the arm in the adducted position.

83–84. B, B Explanation to both can be found in **question 89**'s summary answer.

85. The most likely diagnosis would be an AC separation.

86. An AP view of the affected shoulder (specifically looking at the AC and CC joints) upright, never supine.

87. AC separation.

88. Likely type II.

89. Immobilization with orthopedic referral.

The function of the AC joint is to elevate and abduct the arm. Although the term "AC separation" refers solely to the AC ligament, stability of the shoulder joint is actually dependent on two ligaments: the AC ligament and the CC ligament. The AC ligament anchors the distal tip of the clavicle to the acromion process of the scapula. The CC ligament consists of two separate ligaments that anchor the distal clavicle to the coracoid process of the scapula. The degree of injury to this CC ligament largely determines the classification of AC separation injuries.

The majority of patients with AC separations will have some degree of tenderness directly over the AC joint. However, with severe AC separations (type III), the normal AC joint prominence may be exaggerated. This exaggeration of the AC joint prominence is secondary to the upward displacement of the distal tip of the clavicle and the downward pull of the shoulder (caused by the weight of the arm) and the loss of the integrity of the suspending CC ligament.

Although the term "AC injuries" refers to the AC ligament, the classification and treatment of "AC injuries" are dependent on the degree of injury of both the AC and CC ligaments.

Type I (first-degree) AC separation: referred to as an AC "sprain," involves an incomplete tear of the AC ligament. The radiographs are normal even with stress views.

Type II (second-degree) AC separation: partial or complete tear of the AC ligament. As with type I injuries, the CC ligament also remains intact with type II AC separations. The subluxation of the AC joint may not be evident on the routine shoulder radiographs (AP upright view). Therefore, when a type II AC separation is clinically suspected and the routine radiographs are within normal limits, stress views can be obtained. These AP stress views are obtained upright with weights (5–15 lb or 2–7 kg) suspended by the patient's wrist (do not have the patient hold the weights). Subluxation of the AC joint is radiologically confirmed if the AC joint appears wider on the stress view and/or if the inferior border of the distal tip of the clavicle is not in alignment with the inferior border of the acromion process. With type II separations, this malalignment of the inferior borders of the distal clavicle and acromion process should not be more than half the diameter of the clavicle. Separation of the distal clavicle by more than one-half of its diameter from the acromion process indicates a type III AC injury.

Type III (third-degree) AC separation: This type of injury involves a complete tear of both the AC and CC ligaments, which then results in a complete dislocation of the AC joint (*see* **question 83**). Clinically, type III injuries will present with an exaggeration of the normal AC prominence secondary to the upward displacement of the distal tip of the clavicle and the downward pull of the shoulder. If a type III injury is clinically suspected, the AP view of the shoulder should be obtained in the upright position to allow the weight of the suspended arm to bring out the classic radiographic findings of a type III separation. Radiographically, type III injuries reveal a widening of both the AC and CC joint spaces on the routine erect AP views, and the inferior border of the distal clavicle is clearly malaligned (i.e., separated by more than one-half the diameter of the clavicle) with the inferior border of the acromion process. Stress views with weights are not necessary (*see* **question 84**).

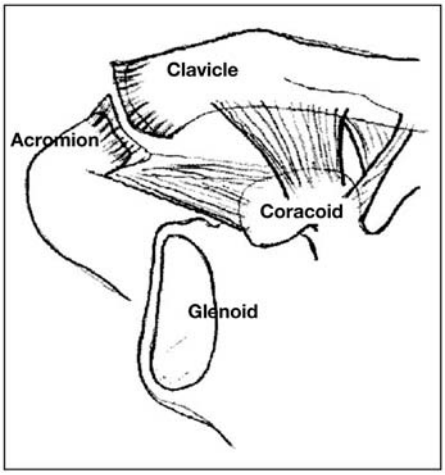


Fig. 5. Type II AC separation.

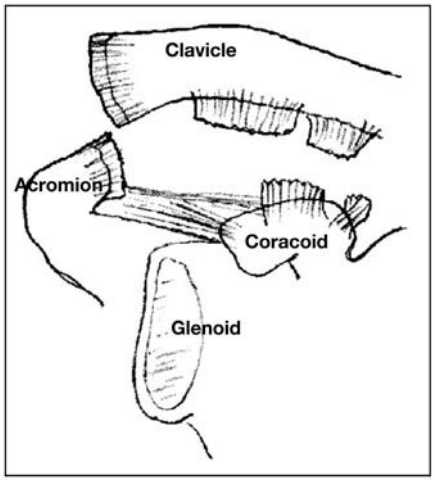


Fig. 6. Type III AC separation.

Treatment and prognosis of AC separations: The initial ED treatment of all three types of AC injuries involves placing the patient in a shoulder immobilizer with the arm adducted against the chest. Type II and type III injuries should be referred to an orthopedic surgeon for further evaluation and rehabilitation. Although internal fixation used to be advocated for the majority of type III injuries, some authorities are now attempting to treat these types of injuries with three weeks of immobilization in a Kenney-Howard sling or other similar shoulder immobilizers.

References: Inaba AS. Radiology Cases in Pediatric Emergency Medicine, Vol. 4, Case 13. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v4c13.html.

Shoulder, including clavicle and scapula. The Radiology of Emergency Medicine, 3rd ed., pp. 283–290; The shoulder and upper arm. Emergency Orthopedics: The Extremities, 3rd ed., pp. 387–389.

90. The white outlined arrow points to the lucency within the femoral neck. The gray outlined arrow points to the thickened cortex along the calcar. The vertical white lines measure the width of the hip joint space. The "teardrop" distance measures the medial margin of the inferior aspect of the acetabulum to the adjacent femoral head. This distance is wider in the left hip compared with the right hip. The Radiologist suspects osteoid osteoma. Note that intra-articular osteoid osteomas may result in joint effusions, as shown in image.

91–96. B, B, A, B, B, A This CT study is through the lucency noted in the femoral neck on the plain radiographs. The arrow points to the osteoid osteoma. Both X-ray views show this classic appearance of an osteoid osteoma in the proximal left femur (central lucency with surrounding sclerosis). Other common radiographic appearances of osteoid osteoma include dense bone alone or a lucency alone.

Osteoid osteoma is a benign bone tumor most commonly found in the 5- to 25-year age group. The male to female ratio is 3 to 1. The femur and tibia account for 50% of cases. Other common sites include the hands, feet, and spine. Patients with spinal osteoid osteoma are difficult to diagnose, as it does not usually reveal itself on plain radiographs. These patients usually present with painful scoliosis. Osteoid osteoma of the spine should be considered in young patients with painful scoliosis. The pain of osteoid osteoma is described as unrelenting and sharp, worse at night. Classical-

ly, the pain is relieved by aspirin. The source of the pain is unclear. Prostaglandins are suspected; however, nonsteroidal anti-inflammatory agents such as ibuprofen do not always relieve the pain as well as aspirin. The classic radiographic features of osteoid osteoma are a well-defined, round (or oval) radiolucent lesion with a surrounding radiodense zone (reactive sclerosis).

It is suspected that osteoid osteoma (and its pain) may resolve spontaneously. This is thought to be due to spontaneous involution of the painful lesion. Aspirin can be used to control the pain until spontaneous involution occurs. However, in most instances, the pain intensity worsens and surgical resection is chosen.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 4, Case 15. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v4c15.html.

Springfield DS. Lovell and Winter's Pediatric Orthopaedics, 3rd ed., pp. 323–363; Bisset GS. Pediatric Disease (Fourth Series) Test and Syllabus, pp. 691–719.

97. Transient synovitis, osteomyelitis, acute rheumatic fever.

Transient ("toxic") synovitis can present with intense pain, refusal to walk, and limited and/or painful range of motion. If septic arthritis is suspected, the hip should be tapped and the patient should be given IV antibiotics. A brief period of observation can also be helpful. If there is dramatic improvement in 24 hours, the diagnosis is most likely to be transient synovitis.

Osteomyelitis can cause a sympathetic effusion of the joint, without an actual infection of the joint itself.

Acute rheumatic fever can also present with acute arthritis of the hip. However, there is usually a migrating pattern to the arthritis. Other findings consistent with rheumatic fever may be present, such as a heart murmur suggestive of acute carditis, subcutaneous nodules, erythema marginatum, or chorea. The Jones criteria may be helpful in making this diagnosis.

Hemophilia with bleeding into the joint space may be difficult to distinguish from septic arthritis. However, the patient is usually a known hemophiliac. This condition requires urgent decompression of the joint space.

Other causes of refusal to walk associated with fever include diskitis, new-onset leukemia, perirectal abscess, and osteomyelitis.

98. Causes of septic arthritis include *Staphylococcus aureus*, *H. influenzae* (more common in younger patients), *Streptococcus pyogenes*. More common in young adults are *Pneumococcus*, and *Salmonella*.

99,100 B, A Her hip radiographs show a widened joint space in her right hip. Compare the joint space to the left hip, and it is rather obvious here. This finding is seen in the minority of patients with septic arthritis; thus, the absence of joint space widening cannot be relied on to rule out septic arthritis. Ultrasound is the most effective study in demonstrating the presence of a joint effusion acutely.

101. Hematogenous spread is more common in children than in adults.

Early diagnosis and treatment of septic arthritis of the hip cannot be overemphasized. Permanent damage will occur in only a few days if the diagnosis and treatment are delayed.

The diagnosis is particularly difficult to make in infants, who cannot voice their complaints, and especially in neonates who may not have the typical findings of fever, chills, and leukocytosis. Do not be fooled by a history of trauma. Parents of toddlers will almost always recall a recent "injury" prior to the onset of symptoms.

The affected extremity will typically be held in a position of slight flexion, abduction, and external rotation. This maximizes the intraarticular space, thus decreasing the tension of the joint exudate.

Laboratory findings include an elevated erythrocyte sedimentation rate and/or C-reactive protein, as well as a leukocytosis, often with a "left shift." A left shift may be present but is not reliable and is noticeably absent in our patient. Blood cultures may be positive in up to 50% of cases.

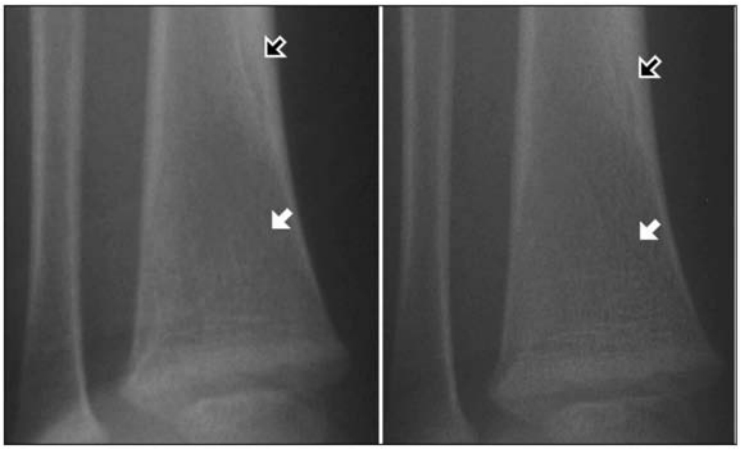
Do not expect plain radiographs to establish the early diagnosis of septic arthritis. Ultrasound is the most effective study in demonstrating the presence of a joint effusion acutely. The definitive diagnostic tool remains isolation and identification of the organism by aspiration.

The treatment for septic arthritis of the hip includes intravenous antibiotics and immediate surgical incision and drainage of the hip, followed by a period of immobilization. Antibiotics should be continued for at least 4 to 6 weeks.

References: Rosen MH. Radiology Cases In Pediatric Emergency Medicine, Vol. 4, Case 17. University of Texas Southwestern School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v4c17.html.

Salvati E. Surgery of the Hip Joint, pp. 387–403; Simon RR, Koenigsknecht SJ, eds. Emergency Orthopedics, 3rd ed., pp. 421–423; Sponseller PD. Principles and Practice of Pediatrics, pp.1042–1043; Paterson D. Orthoped Clin N Am 1978;9(1):135.

102. Fracture; *see* image below:



This view shows two radiographs of the patient's distal tibia. The image on the left was taken on the initial ED visit. The image on the right was taken on the follow-up ED visit. By enlarging the image, the oblique distal tibia fracture can be seen on both views, but it is much harder to see on the initial ED visit radiograph (left image).

The radiograph shows a definite nondisplaced oblique fracture of the distal third of the right tibia. It is a thin lucency and difficult to see except on the highly magnified view.

The white arrows point to the oblique distal tibia fracture. The black arrows with the white outline point to vascular grooves (not a fracture). Re-examine the original radiographs to see if you can see the fracture on the original views.

103. B

One can see that in the case of an isolated spiral fracture of the tibia in a child, the characteristics of the fracture are not sufficient enough to confirm or dismiss the possibility of child maltreatment.

104.

Medical conditions that cause fractures that are mistaken for child abuse:

- OI is a group of heritable conditions in which there is abnormal collagen formation. OI types II and III (the most severe forms) are diagnosed at delivery; milder involvement is seen in children with OI types I and IV; the greatest difficulty in diagnosing OI is in OI type IV. Osteopenia may not be apparent in a child presenting with a fracture, as the child may not have blue sclerae or abnormal teeth.
- Cerebral palsy and severe neuromuscular disease cause demineralization from disuse and can lead to cortical thinning, making these patients vulnerable to fractures, thus mistaken for abuse.
- Bone cysts may occur near the metaphyseal ends of long bones, causing cortical thinning.
- Similar pathologic fractures may occur at sites of osteomyelitis or in portions of bone replaced by tumor.
- Congenital syphilis.
- Vitamin D deficiency rickets.
- Copper deficiency.
- Menke's kinky hair syndrome.
- Scurvy (vitamin C deficiency).
- Hypervitaminosis A.
- Leukemia.

Fractures specific for abuse include:

- Metaphyseal–epiphyseal fractures, known as bucket-handle or chip fractures.
- Fractures of the thoracic cage (rib fractures, sternum), scapula, and spine (spinous process, vertebral body) are also specific for abuse.
- Highly suggestive fractures are multiple fractures, those of the hands and feet, and complex skull fractures. Especially important in addition to history is the association of nonskeletal injury (intracranial, visceral).
- Fractures in a preambulatory child should raise the suspicion of nonaccidental trauma.

105. A, B, E

106. B

The diagnosis of child abuse can bring about serious consequences for the suspected perpetrator, the family, and the child. Thus, clinicians must be very careful when

evaluating cases of possible child abuse and not arrive at a conclusion too quickly. We must be aware of the various conditions that can be mistaken for abuse and obtain an accurate history and do a thorough physical examination, as well as do the necessary studies to arrive at the correct conclusion.

Implication of spiral fractures and abuse:

- One study found that spiral fractures of the mid- and lower tibia have no such implication of abuse.
- Another study described cases in which patients who presented with midshaft tibial fractures (rather than distal tibial fractures) were later found to be cases of child maltreatment.
- Fractures of the midshaft of the tibia may indicate abuse, whereas distal tibial fractures may be less suspicious. Spiral or oblique fractures of the tibia are particularly common in young children because of the susceptibility, during their rapid linear growth, to bony injury from minimal trauma. Twisting or rotational force through the tibia, while the ankle and foot are fixed, is the mechanism that would produce this typical injury.
- Mellick and Reesor reviewed cases of tibial fractures; they state that isolated spiral tibial fractures of children are much more commonly accidental. The approximate age range is described as 2 to 6 years.

References: Santhany MD. Radiology Cases in Pediatric Emergency Medicine, Vol. 4, Case 18. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v4c18.html.

Alexander JE, et al. Curr Probl Diagn Radiol 1987;16:231–270; Bays J. Child Abuse: Medical Diagnosis and Management, pp. 23–53; Davis HW, Carrasco M. Atlas of Pediatric Physical Diagnosis, 2nd ed., pp. 6.1–6.30; Davis HW, Zitelli BJ. Contemporary Pediatrics 1995;12 (1):94; Dunbar JS, et al. J Canad Assoc Radiol 1964;15:136–144; Gahagan S, Rimsza ME. Pediatrics 1991;88(5):987; Mellick LB, Reesor K. Am J Emerg Med 1990;8:234–237; Merten DF, et al. Child Abuse: Medical Diagnosis and Management, pp. 23–53; Tenenbein M, et al. Am J Emerg Med 1990;8:208–211.

107. Avulsion fracture

His history indicates that his injury was not caused by an impact. A prolonged stress history is present, which may have been exacerbated by an acute stress preceding the injury. Such a history may be seen with slipped capital femoral epiphysis, small avulsion fractures, or a pathological fracture, among other things. This hip radiograph shows a bony fragment superior and lateral to the left hip joint. This is an avulsion fracture of the left superior iliac spine. Such avulsion fractures of the pelvis commonly occur during athletic competition, and occur at the sites of muscle insertion into the pelvis. Extreme muscle contraction forces pull at the insertion site. This may cause microfractures, resulting in pain and weakening, such as in Osgood-Schlatter's disease of the tibial tuberosity. Our patient exhibited symptoms of this type of preceding injury with his hip strain for 1 week preceding the avulsion fracture.

108. ASIS

The three common sites of avulsion fractures of the pelvis are the anterior inferior iliac spine (insertion of rectus femoris), anterior superior iliac spine (insertion of sartorius), and the ischial tuberosity (insertion of multiple hamstrings).

109. A

Of the common types of pelvic fractures (pelvic ring fractures, acetabular fractures, iliac wing fractures, etc.), avulsion fractures are the most benign. These can usually be treated on an outpatient basis with crutches, analgesics, and modified activity.

Spontaneous recovery usually occurs within 4 to 6 weeks. Occasionally, surgical intervention is required to remove painful fragments or to regain anatomic fixation.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 4, Case 20. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pemxray/v4c20.html.

Bachman D, Santora S. Textbook of Pediatric Emergency Medicine, 3rd ed., pp. 1266–1267; McCarthy RE. Management of Pediatric Fractures, pp. 453–482.

CHAPTER 6: CT SCAN REVIEW

1–5. C, B, E, C, C

The case illustrates an example of an epidural hematoma. An epidural hematoma is a collection of blood in one of three common, potential spaces within the skull. Also referred to as an extraaxial collection, the hematoma is located outside of the brain parenchyma. The two other classic locations for blood accumulation are within the subdural and subarachnoid spaces. An epidural hematoma is located between the outer dural layer and the inner layer of the skull and may overlie any of the regional cortices of the brain. A distinguishing feature from subdural hematoma is its ability to cross the midline. An epidural hematoma is an uncommon injury that has been described from major as well as from minor head trauma in children less than 5 years of age. This classic pathophysiologic etiology is rupture of the middle meningeal artery. An epidural hematoma in the face of altered mental status or midline shift should be treated as a neurosurgical emergency, as delays in consultation can lead to significant mortality.

References: Young LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 7. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/ pediatrics/pedtext/s18c13.html.

Castillo M, Harris JH. The Radiology of Emergency Medicine, pp. 1–35; Swischuk LE. Emergency Imaging of the Acutely Ill or Injured Child, 3rd ed., pp. 592–598; Dolan M. Pediatric Emergency Medicine Concepts and Clinical Practice, pp. 195–197; Packer RJ, Berman PH. Textbook of Pediatric Emergency Medicine, 3rd ed., pp. 122–134; Schutzman SA. Textbook of Pediatric Emergency Medicine, pp. 268–275; Bruce DA. Textbook of Pediatric Emergency Medicine, 3rd ed., pp. 1102–1119; Pons PT. Pediatric Emergency Medicine Concepts and Clinical Practice, pp. 338–354; Schutzman SA, et al. Ann Emerg Med 1993;22(3):535–541; Ota FS. Case Based Pediatrics for Medical Students and Residents, Chapter XVIII.13. University of Hawaii John A. Burns School of Medicine. http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

6–10. A, F, D, D, B

Head injuries are the most common cause of traumatic death in children. An epidural hematoma can develop if blood collects between the outer dural layer and the skull. Most often, this blood is arterial, originating from the middle meningeal artery. This is often associated with a skull fracture. Most children present with few or no symptoms in the ED. It is difficult to examine a child for mental status changes, as compared with the adult. Thus it is essential to complete a neurological exam documenting pupillary findings and fontanelle fullness.

References: Young LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 7. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/ pedtext/s18c13.html.

Tintinalli JE, et al. Emergency Medicine: A Comprehensive Study Guide, 5th ed., pp. 1614–1620; Ota FS. Case Based Pediatrics for Medical Students and Residents, Chapter XVIII.13. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

11–15. B, A, E, C, D The above CT scan shows an acute subdural hematoma, as an unfortunate result of child abuse. It is essential to include nonaccidental injury in your differential diagnosis when the history includes unexplained lethargy, vomiting, and other possible injuries that may be as a result of child abuse. In this case, the child's additional injuries included a left clavicular and radial/ulnar fracture. Subdural hematoma results from shearing of the bridging veins; thus the blood that accumulates in the subdural space is venous in origin. The damage occurs from the traumatic insult and not the bleeding, so hematoma evacuation improves the prognosis only minimally. This is in contrast to the subacute subdural hematoma sustained by elderly adults, who have a good prognosis following hematoma evacuation because the brain is largely uninjured. Acute subdural hemorrhages have a poor prognosis given the high incidence of irreversible brain damage.

References: Young LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 7. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/ pedtext/s18c13.html.

Ota FS. Case Based Pediatrics for Medical Students and Residents, Chapter XVIII.13. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

16–20. A, C, E, E, D The case illustrates shaken baby syndrome. Vigorous shaking may result in epidural, subdural, and subarachnoid hemorrhages. The presentation varies in severity, ranging from poor feeding and vomiting to respiratory or cardiac arrest. The outcome of these injuries is very serious, and may be life-threatening. It is very difficult to diagnose shaken baby syndrome because of the paucity of external trauma associated with their intracranial injuries. Therefore, it is the practioners' duty to have a high degree of suspicion to include possible child abuse in the differential. Also, anterior subdural effusions may be indicative of previous episodes of this infant being shaken.

References: Young LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 7. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

Tintinalli JE, et al. Emergency Medicine: A Comprehensive Study Guide, 5th ed., p. 759; Schwartz DT, Reisdorff EJ. Emergency Radiology, pp.622–625; Tinsley CH. Case Based Pediatrics for Medical Students and Residents, Chapter XIV.13. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

21–25. B, A, D, B, C A child with minor closed head injury is one of the most frequent reasons for seeking medical attention. The most important aspect of the evaluation is conducting a thorough history and performing a complete physical examination. Previously healthy children with closed head injury with normal mental status on presentation and without pertinent findings on the physical exam do not require any neuroimaging as part of the initial evaluation. However, observation in the clinic, office, ED, or home by a competent guardian is recommended for these children. A child with closed head injury and a history of brief loss of consciousness, however, may need a cranial CT scanning along with observation for the initial evaluation and management.

References: Young LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 7. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/ pedtext/s18c13.html.

American Academy of Pediatrics. Pediatrics 1999;104(6):1407–1415.

26–30. A, B, D, B, E

Traumatic subarachnoid hemorrhage (TSAH) results from the disruption of subarachnoid vessels because of blunt trauma or a shearing force. SAH results from tearing of small vessels of the pia matter. Patients with TSAH can present with mild to severe traumatic brain injury, thus having a wide range of symptoms. Isolated TSAH, however, usually presents with complaints of headache and photophobia, accompanied with mild meningeal signs. The findings on noncontrast CT include a collection of hyperdense fluid in the CSF spaces. It can be distinguished from subdural blood in that the subarachnoid blood may flow into the brain sulci, fissures, and cisterns, whereas subdural blood does not. All patients who present with a TSAH require admission with a neurosurgery consult. Patients with small subarachnoid hemorrhage do well, whereas those with associated intracranial injuries and larger SAH have a worse outcome.

References: Young LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 7. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

Tintinalli JE, et al. Emergency Medicine: A Comprehensive Study Guide, 5th ed., p. 1641; Schwartz DT, Reisdorff EJ. Emergency Radiology, pp. 622–625; Fleisher GR, Ludwig S. Synopsis of Pediatric Emergency Medicine, pp. 469–487.

31–35. D, E, B, E, E

Diagnosing intracranial hemorrhages in neonates includes taking a thorough prenatal and birth history, in addition to assessing risk factors including family history of bleeding diathesis. Testing includes transfontanelle cranial ultrasonography and noncontrast head CT. Ultrasonography is used primarily for preterm infants for detecting germinal matrix and ventricular hemorrhage, whereas CT is more reliable for detecting hemorrhage for full-term infants. The primary clinical manifestation that was detected in this case was the infant's opisthotonic posturing. Opisthotonos is defined as extreme hyperextension of the body in which the head and heels are bent backward and the body bowed forward. Several etiologies of opisthotonos in a neonate have been recognized in addition to intracerebral or intraventricular hemorrhage. These include bleeding diathesis, arteriovenous malformations, kernicterus, tuberous sclerosis, hydrocephalus, neonatal tetanus, and Dandy-Walker syndrome. In this particular case, the infant developed a subarachnoid hemorrhage from birth trauma.

References: Young LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 7. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

Mandeville M. Pediatr Rev 2001;22(5):169–173. From NIH/NLM MEDLINE.

36–40. E, D, C, A, B

Childhood stroke is uncommon and very difficult to identify at time of presentation. Therefore, it is important to obtain a thorough history, including past medical and family history, in addition to performing a complete physical examination. It is essential to stabilize the patient's airway immediately and to rule out possible reversible causes such as hypoglycemia.

Rare forms of cerebrovascular disease do exist that predispose children to intraventricular hemorrhage; however, laboratory studies should be considered if the etiology is unclear.

References: Young LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 7. University of Hawaii John A. Burns School of Medicine. http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

Yamamoto LG. Am J Emerg Med 1999;17(2):163–171, from NIH/NLM MEDLINE.

41–45. C, D, E, B, A

Head injury in children prompts the need for rapid and sequential intervention, including early neurosurgical consultation. Intraventricular hemorrhage not only is a result of head injury, but may also be a consequence of an underlying disorder, such as cardiac disease (septal defect or dysrhythmia), sickle cell disease, inflammatory disease, or congenital coagulation disorders. Rotational forces are usually the mechanism for which intraventricular hemorrhage happens, resulting in the rupture of subependymal veins. When treating children with head injury, it is important to remember to implement ways to prevent secondary brain injury. This includes rapid definitive airway, intracranial pressure control, seizure treatment, and maintenance of optimal systemic blood pressures.

References: Young LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 7. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

Yamamoto LG. Am J Emerg Med 1999;17(2):163–171, from NIH/NLM MEDLINE; Strange GR, et al. Pediatric Emergency Medicine: A Comprehensive Study Guide.

46–50. E, D, A, D, B

The volume that the cranium encompasses is constant, consisting of the brain volume, cerebrospinal and interstitial fluid, and blood. Therefore, if one of these components increases in volume, the others must compensate, or an increase in intracranial pressure results. In head-injured children, the cerebral blood volume may increase as a result of brain injury, contributing to the development of diffuse brain swelling, as is the case in this 14-month-old child.

References: Young LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 7. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

Fleisher GR, Ludwig S. Synopsis of Pediatric Emergency Medicine, pp. 462–486.

51–54. A, D, B, B

This CT shows a subdural hematoma over the left parietal and occipital lobes, causing a moderate mass affect and slight deviation of the midline. The patient's vital signs should be monitored closely, especially for systemic hypertension, which can result from severe drops in cerebral perfusion pressure or from increases in intracranial pressure (ICP). Serious head injuries are commonly associated with increases in ICP, resulting in deviations in brain anatomy. Thus, it is vital to identify increases in ICP in order to intervene early to prevent cerebral hypoperfusion and herniation.

References: Young LL. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 7. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

Fleisher GR, Ludwig S. Synopsis of Pediatric Emergency Medicine, pp. 462–486.

55. S, P_o, P, M, C, Q, V

It is important to understand the anatomy when viewing neuroimaging of the brain when assessing the presence and severity of intracranial hypertension. These anatomic properties include the prominence of sulci and gyri, the size of the lateral ventricles, the gray–white matter distinction, and the preservation of the suprasellar and the quadrigeminal cisterns. The suprasellar cistern is an important space, housing the circle of Willis and the optic chiasm. It is a fluid-filled space above the sella turcica, identified on most head CTs as star-shaped. The quadrigeminal cistern is also a fluid-filled space, which is located cephalad to the fourth ventricle.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 6. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

56. **F, U, Po, P**

57. **Frontal lobes, Uncus of the temporal lobes, Pons and cerebral peduncles**

When an intracranial mass or hematoma exists, it occupies the already fixed intracranial space, thus compressing the normal brain tissue. The brain anatomy becomes distorted and the known fluid-filled spaces become obliterated (e.g. the suprasellar cistern). In addition, fluid accumulates within the damaged brain tissue and glial cells, and as a consequence, interstitial cerebral edema results from the decreased absorption of fluid. This devastating cycle continues until the ventricular spaces become compressed and redistribution is no longer an option.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 6. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

Fleisher GR, Ludwig S. Synopsis of Pediatric Emergency Medicin, pp. 469–487, 55–185.

58–62. **E, D, E, A, C**

Central transtentorial herniation occurs when the diffuse mass effect in the supratentorial compartment forces a downward pressure on the cerebral hemispheres and the brainstem, also referred to as downward herniation. It occurs with midline lesions in the frontal or occipital lobes, or in the vertex. Early signs include pinpoint pupils, increased muscle tone, and bilateral Babinski's sign. Late findings include fixed midpoint pupils, prolonged hyperventilation, and decorticate posturing. The important point to remember in children with head injury is that recovery is promising if intervention is sought early. It is known that children tolerate brainstem herniation better as compared with adults. Cushing's triad is a reflex of hypertension, bradycardia, and irregular breathing patterns as a result of increasing ICP. Children may not have all three signs consecutively, but they are more likely to be present in children than in adults.

References: Yamamoto LG. Radiology Cases in Pediatric Emergency Medicine, Vol. 5, Case 6. University of Hawaii John A. Burns School of Medicine, http://www.hawaii.edu/medicine/pediatrics/pedtext/s18c13.html.

Tintinalli JE, et al. Emergency Medicine: A Comprehensive Study Guide, 5th ed., pp. 1415–1422; Schwartz DT, Reisdorff EJ. Emergency Radiology, pp. 385–425.