22 Don’t Miss X-Ray Lesions!!!

By Stefan Tigges MD MSCR
Hi Kids, I’m Doctor Dog and I am going to introduce you to 22 imaging findings that you never want to miss, appropriately called “Don’t Miss Lesions”. The list was compiled by the Alliance of Medical School Educators in Radiology (AMSER).

**AMSER “Don’t Miss Lesions”**

1. Pneumothorax
2. Pneumomediastinum
3. Pneumoperitoneum
4. Pleural effusion
5. Pulmonary edema
6. Aortic dissection
7. Aortic rupture
8. Diaphragmatic rupture
9. Small bowel obstruction (SBO)
10. Cecal and sigmoid volvulus
11. Distal large bowel obstruction
12. Ascites
13. Misplaced lines/tubes
14. Child abuse
15. Stroke
16. Intracranial traumatic hemorrhage
17. Increased intracranial pressure
18. Intracranial space occupying lesions
19. Cervical spine injury
20. Fracture with extension into joint
21. Elbow joint effusion
22. Shoulder dislocation

**WARNING:**

This comic introduces students to the “Don’t Miss Lesions”, using drawings, photos and x-rays, it is not encyclopedic. You must supplement this comic with additional reading.

Every Doctor should know how to make these findings, we don’t want our students missing potentially catastrophic diagnoses.
1. Pneumothorax
Definition: Air in the pleural space, between the visceral and parietal pleura.

1. Pneumothorax
X-Ray finding: Sharp white pencil thin visceral pleural line outlined by black intrapleural air.

1. Pneumothorax
Etiologies: Penetrating trauma (stab, rib fx), iatrogenic (line placement, vent.) and spontaneous (bleb/cyst rupture).

1. Pneumothorax
Mechanism of Injury: Overdistended subpleural alveolus ruptures through visceral pleura in ventilated patient.
1. Pneumothorax
Complications: Large ptx may become tension pneumo and must be treated by emergent chest tube placement to prevent death.

Large right ptx, mediastinal shift to left (arrow) --> tension

1. Pneumothorax
Pitfalls: Many (!!), including dependent positioning and skinfolds.

With the patient upright, air rises to the chest apex

In a supine patient, air rises over the diaphragm

1. Pneumothorax
Pitfalls: Dependent positioning and pneumothorax results in deep sulcus.

Air in the lateral sulcus causes "deep sulcus"

CXR with "Deep sulcus"

1. Pneumothorax
Pitfalls: Skin fold mimics ptx.

Skin heaps up after cassette placement

Skin fold

X-ray cassette
1. Pneumothorax
Pitfalls: Skin fold mimics ptx.

Ptx with pleural line

Skinfold

A pneumothorax is a thin white line with no lung beyond it. A skinfold is a thick white line with lung beyond it.

2. Pneumomediastinum
Definition: Abnormal mediastinal air collection, i.e. not in the tracheobronchial tree or esophagus.

X-Ray findings: Streaky air (top 3 red arrows) outlining mediastinal structures extending to neck. Continuous diaphragm sign. Usually subtle.

Etiologies: Ruptured air containing structures (tracheobronchial tree or esophagus) or increased intraalveolar pressure with alveolar rupture.

Coronal image, trachea, left bronchus
2. Pneumomediastinum
Mechanism: Increased intraalveolar pressure with alveolar rupture is similar to ptx, except that more central alveoli do not rupture into pleural space. Air \( \uparrow \) tracks centrally along bronchovascular bundles to the mediastinum.

Parietal Pleura
Pulmonary artery
Bronchus
Visceral Pleura

2. Pneumomediastinum
Mechanism of Injury: Overinflated alveolar rupture is most common cause of both ptx and pneumomediastinum and they are often seen together, but one does not cause the other.

Pneumomediastinum
Subpleural Air
Air tracks along vessel
Ptx

2. Pneumomediastinum
Complications: Related to underlying cause. Must repair tracheobronchial or esophageal injury, but pneumomediastinum related to increased pressure usually harmless, but must exclude other causes.

Chicken bone w/ esophageal tear

2. Pneumomediastinum
Pifalls: Subtle cases, medially located ptx, pneumopericardium. All 3 air collections may occur together!

Air around heart only
Pericardium

Courtesy Gautham Reddy MD
3. Pneumoperitoneum
Definition: Air outside bowel within the abdomen.

3. Pneumoperitoneum
X-Ray Findings: Lucent air below diaphragm.

Free air between liver and diaphragm

3. Pneumoperitoneum
Etiologies: Perforated bowel and iatrogenic (post-abdominal surgery).

From Kim S et al. Radiographics 2007;27:129-143

3. Pneumoperitoneum
Mechanism of Injury: Multiple potential causes, like peptic ulcer, cancer, blunt and penetrating trauma, necrotizing enterocolitis and ruptured diverticulum.

Free air around liver
Perforated diverticulum
3. Pneumoperitoneum
Complications: Due to underlying etiology. Patient below was in an MVA. CT shows ruptured bowel (straight arrow), free air (curved arrow) and devascularized kidney (star).

From Brofman N et al. *Radiographics* 2006;26:1119-1131

3. Pneumoperitoneum
Pitfalls: Many, including colonic interposition and supine patient position. If amount of free air is low, findings may be subtle.

Colon Interposition. Note bowel markings.

3. Pneumoperitoneum
Pitfalls: In supine patient finding free air on x-ray is difficult. Look for air on both sides (inside and outside) of bowel wall.

Air inside bowel

Air outside bowel

3. Pneumoperitoneum
Pitfalls: If you can see both inner and outer bowel walls in a supine patient, free air is present.

Air inside bowel

Inner and outer bowel walls visible

Air outside bowel
4. Pleural Effusion
Definition: Fluid in the pleural space, between visceral and parietal pleura.

4. Pleural Effusion
X-ray Findings: Soft tissue density “meniscus sign” in the lateral costophrenic angle if effusion is small.

4. Pleural Effusion
Etiology: Transudative (CHF, cirrhosis) vs exudative (infection, cancer). Malignant effusions are often so large that they opacify an entire hemithorax.

4. Pleural Effusion
Mechanism of Injury: Transudative effusions occur when fluid leaks into the pleural space because of increased capillary pressure or low vascular oncotic pressure. This fluid has low protein and cell count and is usually due to CHF. Other causes: liver and renal failure.

Massive right pleural effusion with left shift of the mediastinum
4. Pleural Effusion
Mechanism of Injury: Leaky capillaries cause exudative effusions. The fluid has high protein and cell count and is often due to infection or cancer.

Pitfalls: Many, including subpulmonic effusion, loculated effusion and supine patient positioning.

Upright:
Discrete fluid collection lateral costophrenic angle.

Supine patient:
Fluid layers behind lung with diffuse haziness.

Complications: Depends on cause. Infected effusion (empyema) requires drainage. Large effusions can cause dyspnea and may require chest tube placement. For transudates, treat underlying cause.

5. Pulmonary Edema
Definition: Increased lung fluid, initially interstitial but with progression, alveolar as well.

Alveolar fluid
Thick, edematous interstitium

From: http://research.vet.upenn.edu
5. Pulmonary Edema

X-ray findings: Increased peripheral linear opacities (Kerley B lines) reflect interstitial edema while fluffy central consolidation represents alveolar fluid.

5. Pulmonary Edema

Etiology: Increased hydrostatic pressure from left heart failure (cardiogenic edema) is most common. Multiple non-cardiac causes include neurogenic, ARDS etc.

Cardiogenic edema with enlarged heart

5. Pulmonary Edema

Mechanism of Injury: Secondary pulmonary lobule (smallest part of lung surrounded by connective tissue, below) is key to x-ray findings. Kerley B lines form when excess lymphatic fluid accumulates. If more fluid forms, alveoli fill.

Alveolar sacs (fluffy!)

Venule

Arteriole

Bronchiole

Lymphatics (linear!)

Connective tissue (septum)

5. Pulmonary Edema

Complications: Edema fluid may impair gas exchange and cause respiratory failure. Treat underlying cause, may need ventilator support.

ET tube
5. Pulmonary Edema
Pitfalls: Alveolar edema fluid may be indistinguishable from other processes that fill the alveoli like hemorrhage, infection and certain cancers. Edema is often symmetrical and clears rapidly.

6. Aortic Dissection
Definition: Intimal tear with entry of blood into the media.

6. Aortic Dissection
X-Ray Findings: Enlarged aorta.

Etiology and mechanism of injury: Intimal tear most often due to hypertension. Cystic medial necrosis (Marfan syndrome, Ehlers-Danlos) another possible cause.

From: http://library.med.utah.edu/WebPath
6. Aortic Dissection
Complications: Related to location. We will keep it simple: Type A involves the ascending aorta +/- the descending aorta while type B involves only the descending aorta.

![Aortic Dissection Diagram]

From: http://library.med.utah.edu/WebPath

6. Aortic Dissection
Complications: Type A dissections more likely to propagate. Proximal propagation into the pericardium may result in cardiac tamponade and death.

![Pericardium Image]

From: http://library.med.utah.edu/WebPath

6. Aortic Dissection
Complications: Propagation to coronary or carotid arteries may result in vessel narrowing or occlusion.

Dissection propagation to carotid artery with narrowing

![Carotid Artery Image]

From: http://library.med.utah.edu/WebPath

6. Aortic Dissection
Complications: Propagation to aortic valve leads to aortic insufficiency. Aorta may rupture (below). Type A dissections require surgery, type B usually managed medically (lower BP).

![Type B Dissection with Stent Image]

From: http://library.med.utah.edu/WebPath

Subsequent aortic rupture with left hemothorax
6. Aortic Dissection
Pitfalls: Dissection may not enlarge aortic contour. In older people, the aorta may be tortuous and look big but is normal. If dissection suspected and plain film is normal, order cross sectional imaging (CT or MRI).

Near normal aorta
Type A dissection

7. Aortic Rupture
Definition: Better termed traumatic aortic injury (TAI), a contained rupture of the aorta following trauma.

7. Aortic Rupture
X-ray Findings: Many, most commonly wide, indistinct mediastinum caused by bleeding veins. Most patients with wide mediastinum do not have TAI, but finding is marker for severe trauma and must be evaluated with CT to R/O TAI.

Etiology: Contained rupture, intima and media tear with intact adventitia.

Adventitia
Contained rupture
Aortic lumen
7. Aortic Rupture
Mechanism of Injury: Rapid deceleration in MVA or fall causes shearing at transition between fixed and mobile parts of aorta.

2. Distal to left subclavian art.

3. Diaphragmatic hiatus

7. Aortic Rupture
Complications: Aortic root injury is most common, almost uniformly fatal with bleeding into pericardium and tamponade. Tear distal to left subclavian art. most commonly seen in practice, needs repair to prevent complete rupture.

7. Aortic Rupture
Pitfalls: Other causes wide mediastinum like aortic dissection or aneurysm. CT is used to establish correct diagnosis.

Mediastinal hematoma

Torn aorta

Pleural effusion (hemothorax)

8. Diaphragmatic Rupture
Definition: Post traumatic tear of diaphragm.
8. Diaphragmatic Rupture

X-ray Findings: Don’t see rupture itself, but displacement of abdominal contents into chest.

Stomach herniated into chest.

Mechanism of Injury: Negative intrathoracic pressure causes abdominal contents to herniate into the chest.

Complications: Herniated structures at risk for vascular compromise and occlusion. Compression of lungs may cause respiratory insufficiency. High likelihood serious other injuries (i.e.TAI).

Etiology: Either penetrating or blunt. If blunt, rupture may be due to shearing or avulsion. Alternatively, blow to the abdomen may result in abrupt rise in abdominal pressure transmitted to the diaphragm which ruptures.

Torn diaphragm
8. Diaphragmatic Rupture Pitfalls: Findings may be subtle, especially on the right or if abdominal contents have not yet herniated or if patient on positive pressure ventilation.

Indistinct diaphragm, but no gross herniation yet (same patient as previous panel)

9. Small Bowel Obstruction (SBO) 
Definition: Obstruction of bowel lumen preventing transit of contents.

Obstruction with dilated proximal bowel

9. Small Bowel Obstruction (SBO) 
X-Ray Findings: Dilated small bowel, little or no large bowel gas, air-fluid levels on upright X-Ray.

9. Small Bowel Obstruction (SBO) 
Etiology: Hernia, adhesions from prior surgery and tumor (least common).

Hernia 
Dilated small bowel
9. Small Bowel Obstruction (SBO)
Mechanism of Injury: Hernia, adhesion or tumor narrows/occludes lumen.

9. Small Bowel Obstruction (SBO)
Complications: Dilated bowel may become ischemic and perforate. Vomiting may cause dehydration and aspiration.

9. Small Bowel Obstruction (SBO)
Pitfalls: If partial/early obstruction, findings may be subtle. Patients with ileus have dilated small and large bowel.

10. Cecal and Sigmoid Volvulus
Definition: Twisting of the sigmoid colon or cecum resulting in obstruction.
10. Cecal and Sigmoid Volvulus
X-Ray Findings: Dilated bowel RLQ and small bowel dilatation (cec volvulus).

10. Cecal and Sigmoid Volvulus
X-Ray Findings: Dilated bowel rising up from the pelvis, “coffee bean” sign (sigmoid volvulus).

10. Cecal and Sigmoid Volvulus
Etiology: Twisting of mobile bowel around a fulcrum point.

10. Cecal and Sigmoid Volvulus
Mechanism of Injury: Twisting causes closed loop obstruction, isolating a portion of bowel.

From: Moore C J et al. AJR 2001;177:95-98
From: Levsky J M et al. AJR 2010;194:136-143
From: Furukawa A et al. AJR 2009;192:408-416
10. Cecal and Sigmoid Volvulus
Complications: Bowel obstruction, ischemia, infarction and perforation.

Gas in mesenteric veins (white circle) due to bowel infarction

From: Furukawa A et al. AJR 2009;192:408-416

11. Large Bowel Obstruction (LBO)
Definition: Obstruction of large bowel lumen preventing transit of contents.

Obstruction

Dilated proximal colon

Decompressed distal colon

10. Cecal and Sigmoid Volvulus
Pitfalls: Dilated cecum may “flop” toward the LUQ in cecal volvulus.

Dilated cecum

11. Large Bowel Obstruction (LBO)
X-Ray Findings: Dilated colon with air-fluid levels on upright view.

Air-fluid level
11. Large Bowel Obstruction (LBO)
Etiology: Usually tumor, but volvulus, intussusception, diverticulitis and hernia also possible.

Dilated colon

Sigmoid mass

11. Large Bowel Obstruction (LBO)
Complications: Ischemia may result in necrosis and perforation.

Diffuse colonic necrosis

From: Rha S E et al. Radiographics 2000;20:29-42

11. Large Bowel Obstruction (LBO)
Mechanism of Injury: Colonic dilatation results in increased colonic pressure, reducing mesenteric blood flow.

Ischemic colon

Colon cancer

From: Rha S E et al. Radiographics 2000;20:29-42

11. Large Bowel Obstruction (LBO)
Pitfalls: Obstructed small bowel, ileus.

SBO, markings completely traverse small bowel

LBO, markings incompletely traverse large bowel
12. Ascites
Definition: Fluid in peritoneum, outside solid or hollow organs.

Fluid around the liver

12. Ascites
X-Ray Findings: If there is alot of fluid, it collects in the flanks, pushing bowel to the center of the abdomen.

Centrally displaced bowel

12. Ascites
X-Ray Findings: If there is alot of fluid, it collects in the flanks, pushing bowel to the center of the abdomen.

Peripheral fluid

Central bowel

12. Ascites
X-Ray Findings: If fluid < 500 cc, x-ray is often normal. CT and US can detect very small amounts of fluid.

Fluid, black on US

Nodular, cirrhotic liver
12. Ascites
Etiology: Similar to pleural effusion, transudative (CHF, cirrhosis) vs exudative (infection, cancer).


12. Ascites
Mechanism of Injury: Again, like pleural effusion, transudative (elevated portal vein or decreased oncotic pressure) vs exudative (leaky capillaries).

12. Ascites
Complications: Uncommon, treat underlying cause. Occasional infection.

Peritoneal nodularity
Ascites with TB infection

From: Levy A D et al.
Radiographics 2009;29:347-373

12. Ascites
Pitfalls: Unless fluid amount is large, CT or US needed.
13. Misplaced Lines and Tubes

This is a huge topic and we will briefly consider only 3 devices (below). If you want to read more (and you should!), try “Medical Devices of the Chest” Hunter T B et al. Radiographics 2004;24:1725-1746

Devices:
1) ET tube
2) Feeding tube
3) Central line

13. Misplaced Lines and Tubes

X-Ray Findings: ET tube tip should be 5 cm above carina. On CXR use aortic arch as landmark: ETT tip should be just above top of the aorta.

13. Misplaced Lines and Tubes

Definition: Improper support device position that compromises device function or leads to complications.

ET tube tip in right bronchus
Collapsed left lung

13. Misplaced Lines and Tubes

X-Ray Findings: Feeding tube tip should be in the GI tract, not the lungs!

Feeding tube enters right lung, with tip in the pleural space
13. Misplaced Lines and Tubes

X-Ray Findings: Central line tip should be in the SVC.

13. Misplaced Lines and Tubes

Etiology: Device placement is usually done without imaging guidance. Devices may shift after placement.

Correct position
ET tube tip

13. Misplaced Lines and Tubes

Mechanism of Injury: Devices may not work properly if in the wrong place.

13. Misplaced Lines and Tubes

Complications: Depends on device. Central line in right atrium may cause arrhythmias. ET tubes and central lines even if correctly positioned may cause ptx. Lung placement of feeding tube may cause ptx.

Tube feeding the lung is poor form! Check pCXR before starting.
13. Misplaced Lines and Tubes
Pitfalls: Most frequent pitfall is what Dr. Dog calls the spaghetti sign: so many lines and tubes on an x-ray that they become difficult to sort out.

14. Child Abuse
Definition: Acts of commission/omission by caregivers that results in harm to a child (paraphrased from CDC). We will limit ourselves to injuries visible on images. Typical sites of injury below.

14. Child Abuse
X-Ray Findings: Skull fractures, intracranial bleeding (see #16 to follow) common. Posterior rib fractures of varying ages characteristic.

14. Child Abuse
X-Ray Findings: Midline blow to upper abdomen injures liver, pancreas and duodenum.

Multiple rib fractures
14. Child Abuse

X-Ray Findings: Characteristic long bone fractures, old and new fractures.

- Acute fracture
- Bowing deformity
- Periosteal reaction
- Old fracture

X-Ray Findings: Bucket handle fractures.

Metaphyseal bucket handle fractures.

X-Ray Findings: Corner fractures.

Metaphyseal corner fractures.

Epiphysis (cartilage, not visible on x-ray)

Distal metaphysis (ossified, visible on x-ray)

14. Child Abuse
Etiology: Complex blend of social and economic factors. Abusers were often abused as children.

Loner gan G J et al. Radiographics
2003;23:811-845

Pancreatic laceration

14. Child Abuse
Mechanism of Injury: Shaking accounts for most CNS injuries and metaphyseal fractures. Rib fractures due to shaking and squeezing.

Loner gan G J et al. Radiographics
2003;23:811-845

14. Child Abuse
Pitfalls: Corner/bucket fractures almost pathognomonic. If clinical picture not consistent with abuse, consider other conditions.

Osteogenesis imperfecta with bowing

Cheema J J et al. Radiographics
2003;23:871-880

15. Stroke
Another huge topic. We will restrict ourselves to ischemic strokes due to arterial occlusion, you will have to read about other causes of stroke like venous thrombosis and systemic hypoperfusion elsewhere.

MCA stroke

http://library.med.utah.edu/WebPath
15. Stroke
Definition: According to the World Health Organization, a "neurological deficit of cerebrovascular cause that persists beyond 24 hours or is interrupted by death within 24 hours."

15. Stroke
X-Ray Findings: No plain film findings. CT findings may be subtle or absent, look for low density corresponding to a vascular territory. MRI most sensitive.

15. Stroke
X-Ray Findings: Vascular territories.

15. Stroke
X-Ray Findings: Vascular territories.
15. Stroke
Etiology: Acute vessel thrombosis or embolism from more proximal source.

Big left atrium, patient with atrial fibrillation

15. Stroke
Mechanism of Injury: Brain ischemia rapidly results in cell death.

Cyst cavity after infarct

http://library.med.utah.edu/WebPath

Carotid artery thrombus

15. Stroke
Complications: Hemorrhage, edema.

Blood

Swollen, edematous brain

15. Stroke
Pitfalls: CT relatively insensitive, MRI very sensitive and specific.

CT

MCA infarct

MRI

Normal brain
16. Intracranial Traumatic Hemorrhage
Another huge topic: we will only discuss 2 types, subdural and epidural hematomas.

16. Intracranial Traumatic Hemorrhage
Definition: Abnormal post-traumatic intracranial blood collections.

16. Intracranial Traumatic Hemorrhage
X-Ray Findings: Hemorrhage invisible on plain x-ray, CT is preferred modality. Iron containing blood is dense on CT.

16. Intracranial Traumatic Hemorrhage
X-Ray Findings: Subdural hematoma is crescentic and crosses sutures.
16. Intracranial Traumatic Hemorrhage

X-Ray Findings: Epidural hematoma is lentiform and does not cross sutures.

- Dense lentiform epidural hematoma
- Displaced gray-white junction

Mechanism of Injury: Epidural bleeds most often due to a direct blow and are associated with skull fractures. Subdural blood usually due to shaking.

Etiology: Subdural hematoma occurs if subdural bridging veins tear. Middle meningeal artery tear causes epidural bleeding.

Reflected dura
Subdural bridging veins
Middle meningeal artery branches

Complications: Cerebral edema, injury of adjacent brain parenchyma. SDH has higher likelihood of parenchymal injury.

Extensive parenchymal hemorrhage inferior gyri after a fall
16. Intracranial Traumatic Hemorrhage Pitfalls: Small bleeds, anemic patients may have blood isodense to brain.

17. Increased Intracranial Pressure Definition: Pressure in the skull/brain may increase in certain conditions. High pressure is bad! The skull is a completely filled rigid box, if pressure increases, the brain may squirt out!

17. Increased Intracranial Pressure X-Ray Findings: No plain film findings, CT and MRI show displaced and compressed structures.

Artist: Eric Jablonowski
17. Increased Intracranial Pressure

X-Ray Findings: No plain film findings, CT and MRI show displaced and compressed structures.

Etiology: Any cause of brain edema, like ischemia, trauma, tumor etc.

Solitary lung cancer metastasis with edema, compare to opposite side

Mechanism of Injury and Complications:
Increased pressure may compromise blood flow. Stretched vessels may tear and bleed, causing death.

“Duret” hemorrhage due to midbrain compression

http://library.med.utah.edu/WebPath

http://library.med.utah.edu/WebPath
17. Increased Intracranial Pressure Pitfalls: Alas, Dr. Dog is not a neuroradiologist, so many of the findings appear subtle to him, BUT, even he can recognize midline shift and obliteration of the lateral ventricle.

18. Intracranial Space Occupying Lesions Definition: Any mass lesion within the skull, i.e. primary/metastatic tumors, hematomas etc. Localization (below) limits differential diagnosis.

Extradural

Dura

Intradural extraaxial

Intraaxial

18. Intracranial Space Occupying Lesions X-Ray Findings: Plain x-rays generally normal, CT or MRI required. Intraaxial lesions arise in the brain parenchyma. Differential includes primary/metastatic tumors, abscess, clot etc.

Glioblastoma multiforme

Altman D A et al. Radiographics 2007;27:883-888

18. Intracranial Space Occupying Lesions X-Ray Findings: Intradural extraaxial lesions arise outside the brain, but inside the dura.

Meningioma with adjacent edema
18. Intracranial Space Occupying Lesions

**X-Ray Findings:** Extraaxial lesions will displace the gray-white junction.

- Normal gray-white junction
- Meningioma
- Edema
- Displaced gray-white junction

*From: http://anocf.org/atlas/images/n/nPl17a2.jpeg*

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**Etiology:** Many possible etiologies given wide variety of causes. For example, metastases reach the brain hematogenously in embolic showers and tend to be multiple.

- Pigmented melanoma metastases

*Smirniotopoulos J G et al. *Radiographics* 2007;27:525-551*

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**Mechanism of Injury:** Increase intracranial pressure, damage to adjacent normal structures and diffuse spread.

- Contralateral spread
- Mass effect

*Glioblastoma*

*http://library.med.utah.edu/WebPath/*
18. Intracranial Space Occupying Lesions
Complications: Lesions may bleed with catastrophic rise in intracranial pressure.

Aspergillus infection with abrupt hemorrhage

Smith A B et al. Radiographics 2008;28:2033-2058

18. Intracranial Space Occupying Lesions
Pitfalls: Small or isodense lesions may be hard to see on CT, MRI more sensitive.

Bilateral isodense SDH

19. Cervical Spine Injury
Wow, another huge topic. Entire books have been written on these injuries. We will have a limited exploration of this subject and introduce some key concepts, but you will need to do more reading on your own.

19. Cervical Spine Injury
Definition: Post traumatic disruption of cervical spine ligaments and/or bones.

Ligament disruption
19. Cervical Spine Injury
X-Ray Findings: Malalignment, vertebral body height loss, fracture lines.

19. Cervical Spine Injury
X-Ray Findings: Mentally draw 3 lines, along the front and back of the vertebral bodies and along the spinolaminal junction. Normally, these lines should be smooth.

19. Cervical Spine Injury
X-Ray Findings (alignment): If the lines are not smooth, ligaments that correspond to these lines are torn.

19. Cervical Spine Injury
X-Ray Findings (alignment): Cannot see ligaments directly on x-ray, we infer that they are torn if structures normally held together by a ligament are distracted.

Torn ant. long. ligament

Torn post. long. ligament

Torn ant. long. ligament with wide anterior C4-C5 disc space
19. Cervical Spine Injury

X-Ray Findings (height loss): Axial load or hyperflexion compresses vertebral body with fracture and loss of height.

L1 compression
(Yes, I know this is not the C-spine)

19. Cervical Spine Injury
Etiology: Excessive force in MVA or fall damages bones/ligaments.

19. Cervical Spine Injury
Mechanism of Injury: Many, we will cover only hyperflexion & hyperextension.

C7 spinous process fracture

Lee P et al. Radiographics
2004;24:1009-1027
19. Cervical Spine Injury
Mechanism of Injury: Hyperflexion results in crush injuries (fractures) of the anterior spine and tension injuries (torn ligaments) of the posterior spine.

Torn posterior ligaments

Fracture

19. Cervical Spine Injury
Mechanism of Injury: “Hangman’s” fracture of C2 due to hyperextension.

Fracture

Ant. long. lig. tear

19. Cervical Spine Injury
Complications: Potential neurologic damage, especially if bone fragments are displaced into spinal canal.

Bone fragment in spinal canal
19. Cervical Spine Injury Pitfalls: Plain film findings may be subtle or underestimate extent of fracture, CT more sensitive. If one fracture is present do not stop looking. Patients subjected to enough force to produce a fracture often have multiple fractures!

L1 and L5 fractures

20. Fracture with Extension into Joint
Definition: Fracture at the end of a bone that extends through the articular surface and into the adjacent joint.

20. Fracture with Extension into Joint
X-Ray Findings: Fracture line can be followed into joint.

Fracture

Wrist joint

20. Fracture with Extension into Joint
Etiology: Often due to impaction of one bone on another, sometimes associated with abnormal bending.

Fracture

Joint

Impaction points
20. Fracture with Extension into Joint Etiology: The lateral tibial plateau is commonly fractured due to a blow to the lateral knee resulting in a valgus force with impaction of the lateral tibia and the lateral femoral condyle.

20. Fracture with Extension into Joint Complications: Articular cartilage damage results in premature osteoarthritis (OA).

20. Fracture with Extension into Joint Mechanism of Injury: When fractures extend into the joint space, the articular cartilage is damaged.

20. Fracture with Extension into Joint Pitfalls: Fractures may be subtle, if clinical suspicion persists CT should be obtained.
21. Elbow Joint Effusion
Definition: Abnormal elbow joint fluid collection.

Normal elbow  Elbow effusion

21. Elbow Joint Effusion
X-Ray Findings: Distended fat pads.
Distended anterior fat pad
Distended posterior fat pad

21. Elbow Joint Effusion
X-Ray Findings: Normal fat pads are hidden within the coronoid and olecranon fossae.

Transverse  Normal anterior fat pad
Normal posterior fat pad

Sagittal

21. Elbow Joint Effusion
Etiology: Any cause of a joint effusion i.e. hemarthrosis from trauma, septic joint or other arthritis. Effusion pushes fat pads out of their fossae so that they become visible.
21. Elbow Joint Effusion
Mechanism of Injury: Most common cause of joint effusion is hemaarthrosis due to radial head fracture (adult) or humeral supracondylar fracture (child). History is typically “FOOSH”, fall on outstretched hand.

Radial head fracture

Supracondylar fracture in a child

Distended posterior fat pad

21. Elbow Joint Effusion
Pitfalls: A sliver of the anterior fat pad is normally visible, but the posterior fat pad is always invisible in the absence of an abnormality. The actual fracture line may be subtle, if suspicion for fracture is high, treat as fracture even if fracture line is not present.

Subtle fracture line

22. Shoulder Dislocation
Definition: We will discuss only 2 types of glenohumeral joint dislocation.

Normal

Anterior dislocation

Posterior dislocation
22. Shoulder Dislocation

X-Ray Findings: Anterior dislocations are easy to see, the humeral head ends up below the base of the coracoid process.

Coracoid

Humeral head

Posterior dislocation

Normal

22. Shoulder Dislocation

X-Ray Findings: Posterior dislocations are difficult to see, the x-ray is almost normal.

22. Shoulder Dislocation

X-Ray Findings: Scapular Y view is obtained so that posterior dislocations are not missed.

AP ("frontal") shoulder positioning

Scapular Y view is a 45 degree oblique view that “looks” at the glenoid (red arrow) en face

22. Shoulder Dislocation

X-Ray Findings: Normal scapular Y view anatomy, bone specimen and x-ray.

Acromion

Coracoid

Glenoid is where 3 arms of the Y come together
22. Shoulder Dislocation

X-Ray Findings: Dislocations on scapular Y view.

Posterior dislocation is in direction of acromion
Anterior dislocation is in direction of coracoid

X-Ray Findings: Posterior dislocation on scapular Y view.

Acromion
Glenoid
Humeral head

X-Ray Findings: Anterior dislocation on scapular Y view.

Glenoid
Coracoid
Humeral head

Etiology: Shoulder extremely mobile, therefore unstable.

Small glenoid
Big humeral head
22. Shoulder Dislocation
Mechanism of Injury: Most (95%) are anterior caused by combined abduction, extension and external rotation. Posterior dislocations are less common (4%), associated with seizures.

Bilateral ant. shoulder dislocations

NEJM 367;8
August 23, 2012

22. Shoulder Dislocation
Complications: Axillary nerve injury, fractures/cartilage damage.

Impaction fx humeral head after post. dx

Case courtesy Walter Carpenter PhD., M.D.

References, Acknowledgements etc.
Most illustrations in this comic are original. Credit is given for all illustrations taken from other sources except modified Microsoft clip art. Dr. Dog is based on a drawing by Chris Hart. Illustrations were prepared in Adobe Photoshop and Illustrator. Dr. Dog is now very tired and needs a beer followed by a cat nap.

Sugimoto H et al.
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