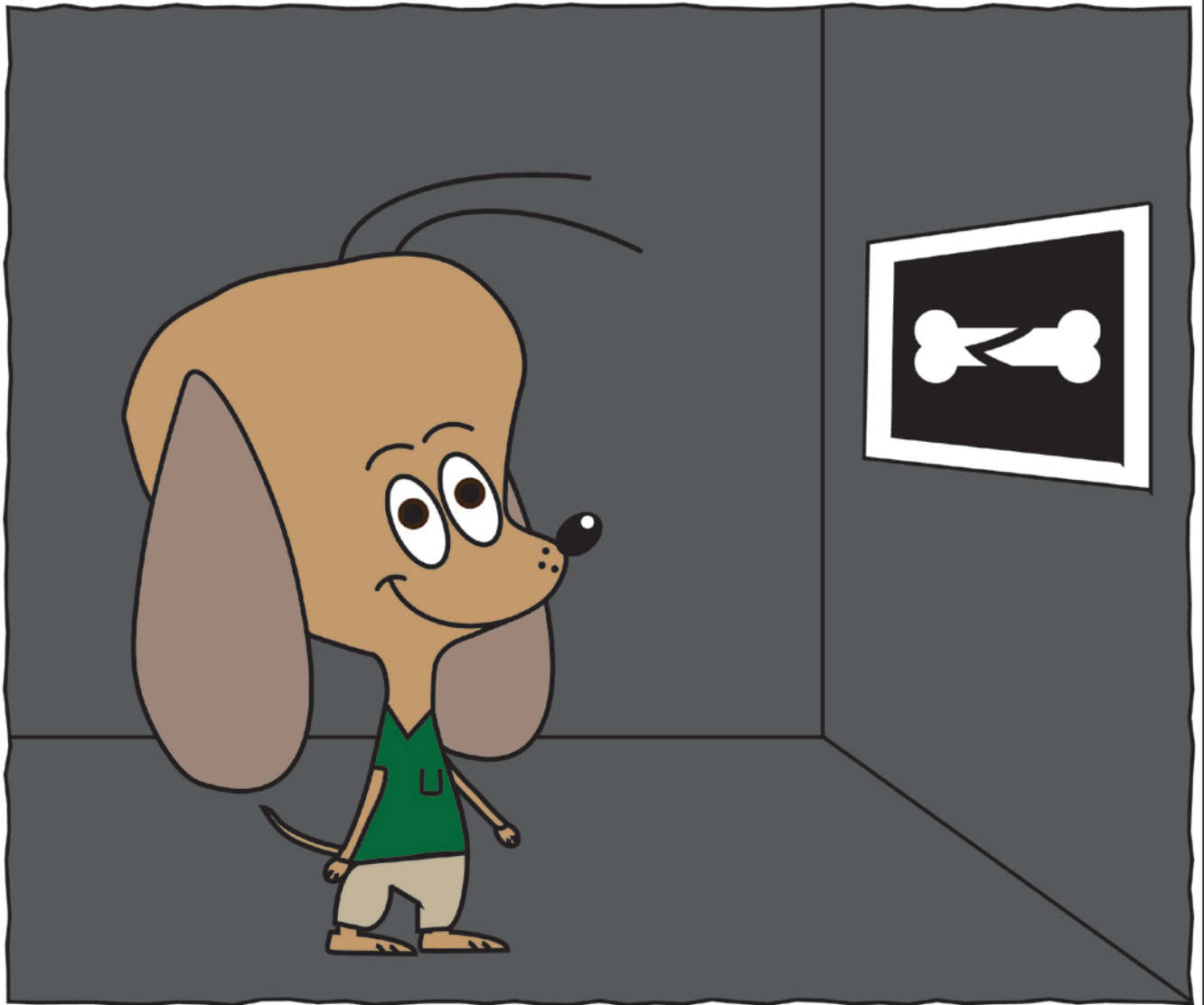


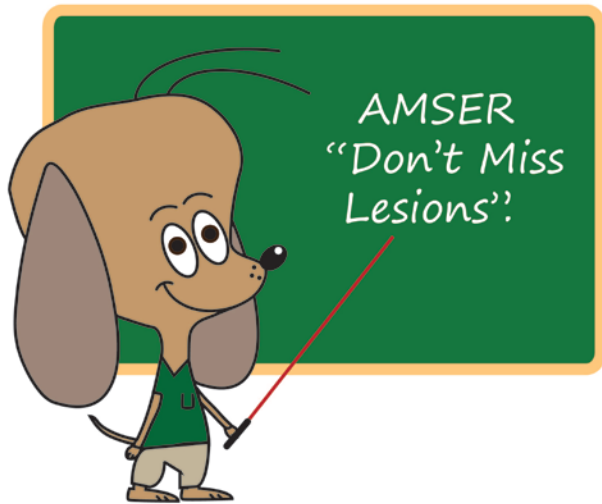
Doctor Dog Comix, Episode One

# 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).



The 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



Every Doctor should know how to make these findings, we don't want our students missing potentially catastrophic diagnoses.

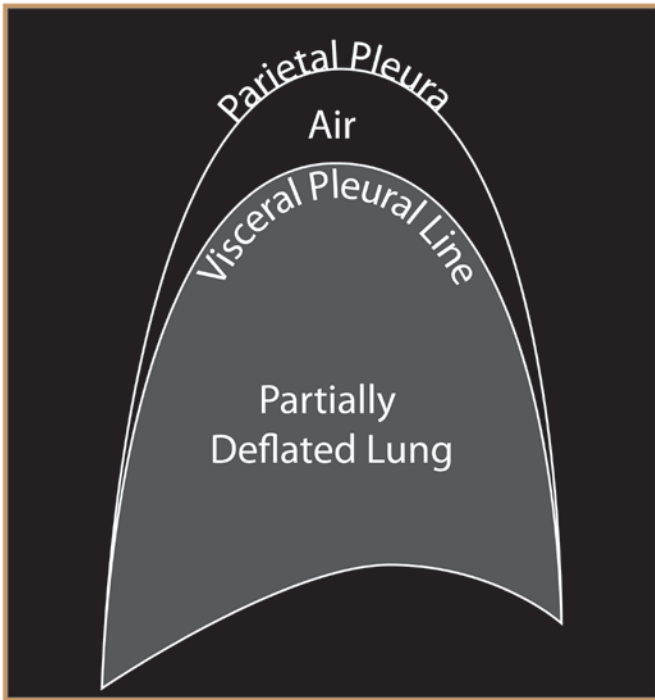
**WARNING:**

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.



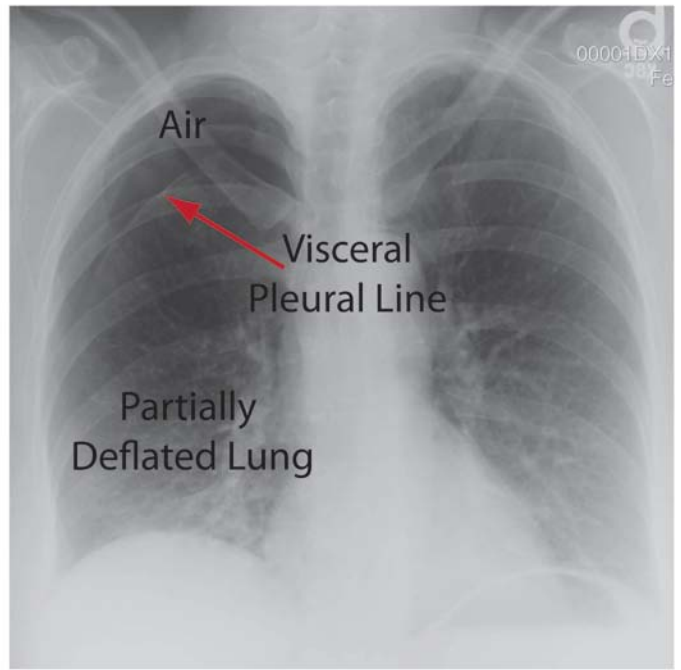
### 1. Pneumothorax

Definition: Air in the pleural space, between the visceral and parietal pleura.



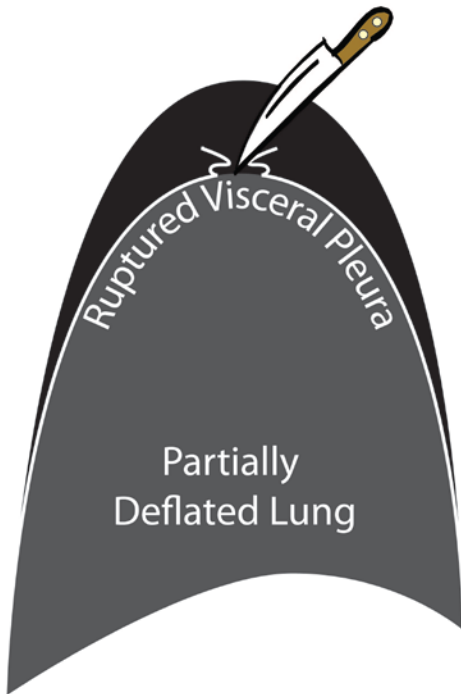
### 1. Pneumothorax

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



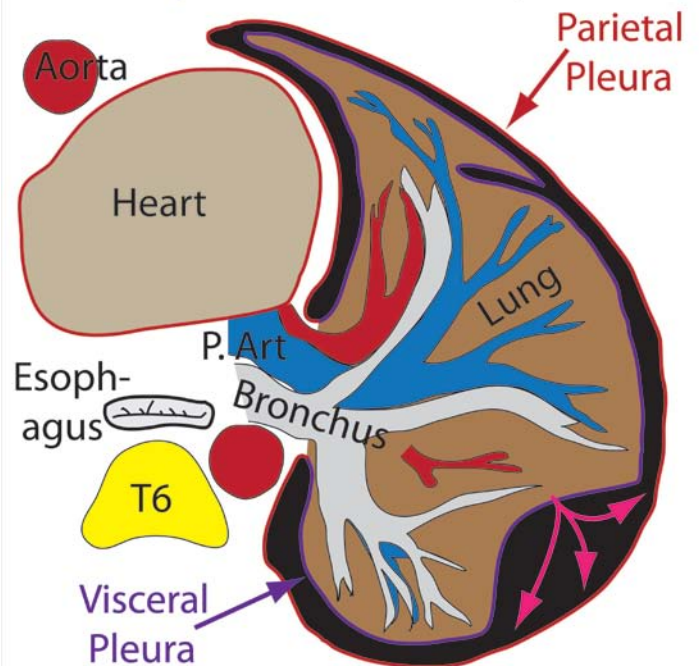
### 1. Pneumothorax

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

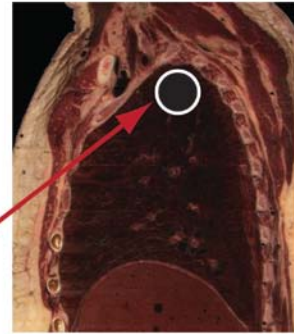
Complications: Large ptx may become tension pneumo and must be treated by emergent chest tube placement to prevent death.



1. Pneumothorax

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

With the patient up-right, air rises to the chest apex

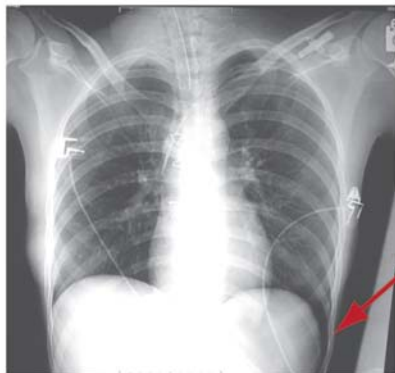
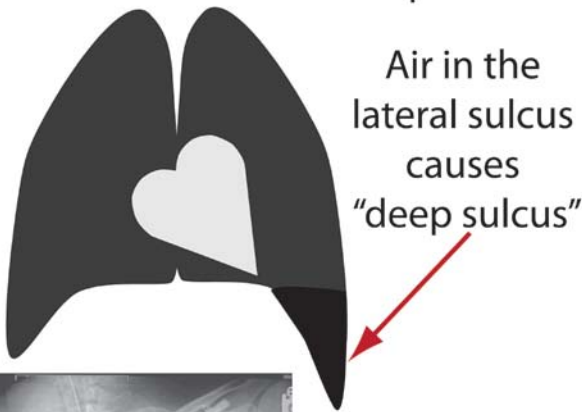


In a supine patient, air rises over the diaphragm



1. Pneumothorax

Pitfalls: Dependent positioning and pneumothorax results in deep sulcus.



1. Pneumothorax

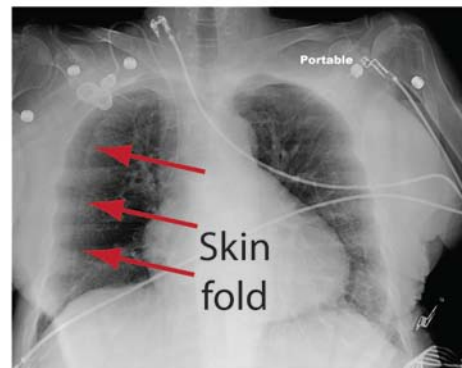
Pitfalls: Skin fold mimics ptx.

Skin heaps up after cassette placement



Skin fold

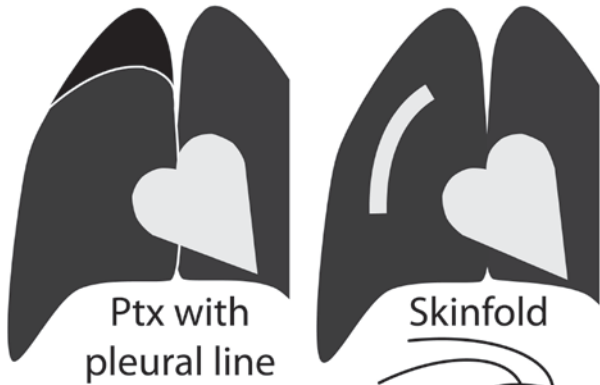
X-ray cassette





## 1. Pneumothorax

Pitfalls: Skin fold mimics ptx.

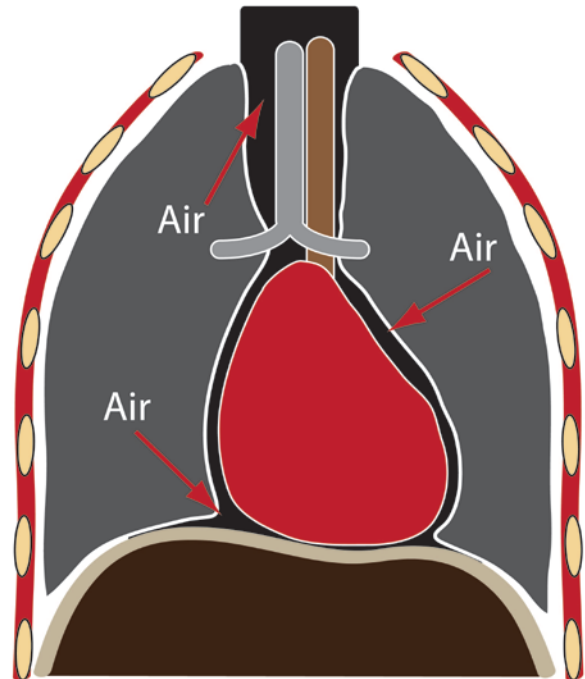


A pneumothorax is a thin white line with no lung beyond it. A skinfold is a thick white line with lung beyond it.



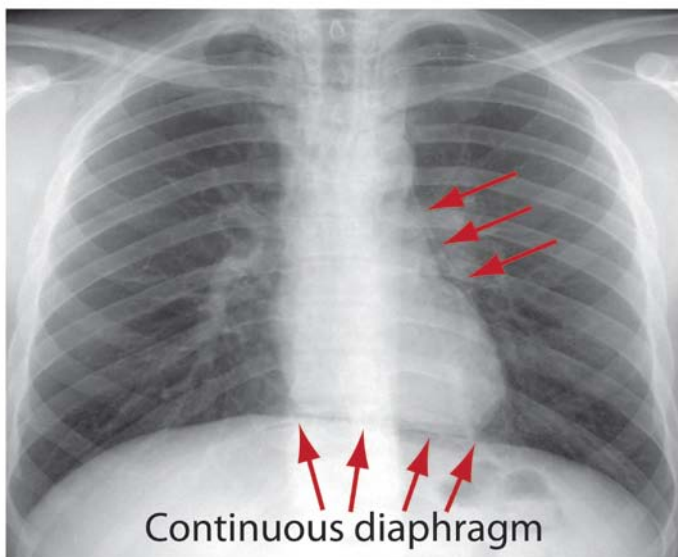
## 2. Pneumomediastinum

Definition: Abnormal mediastinal air collection, i.e. not in the tracheo-bronchial tree or esophagus.



## 2. Pneumomediastinum

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



## 2. Pneumomediastinum

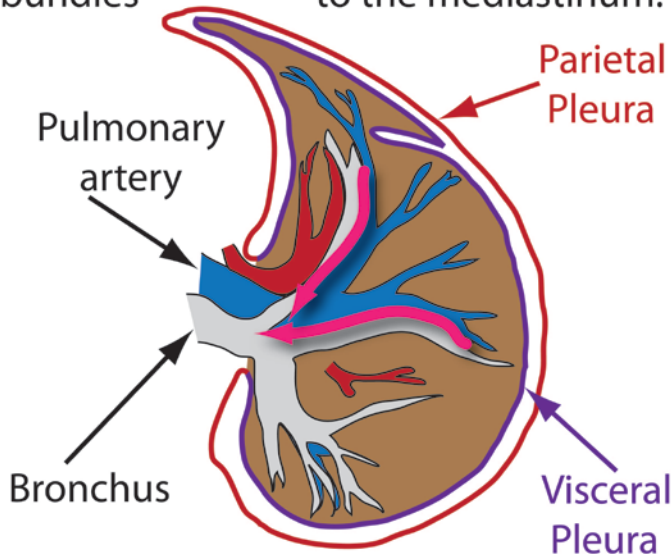
Etiologies: Ruptured air containing structures (tracheobronchial tree or esophagus) or increased intraalveolar pressure with alveolar rupture.

Coronal image, trachea, left bronchus



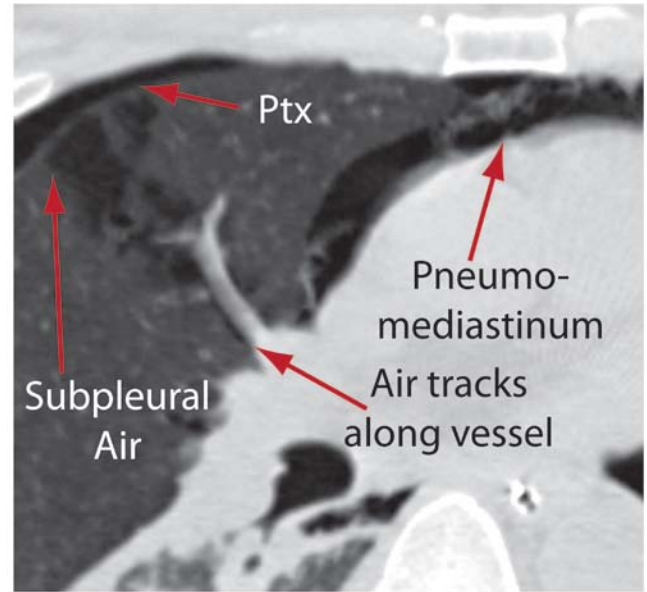
## 2. Pneumomediastinum

Mechanism: Increased intraalveolar pressure with alveolar rupture is similar to ptx, except that more central alveoli do not rupture into pleural space. Air (↑) tracks centrally along bronchovascular bundles to the mediastinum.



## 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.



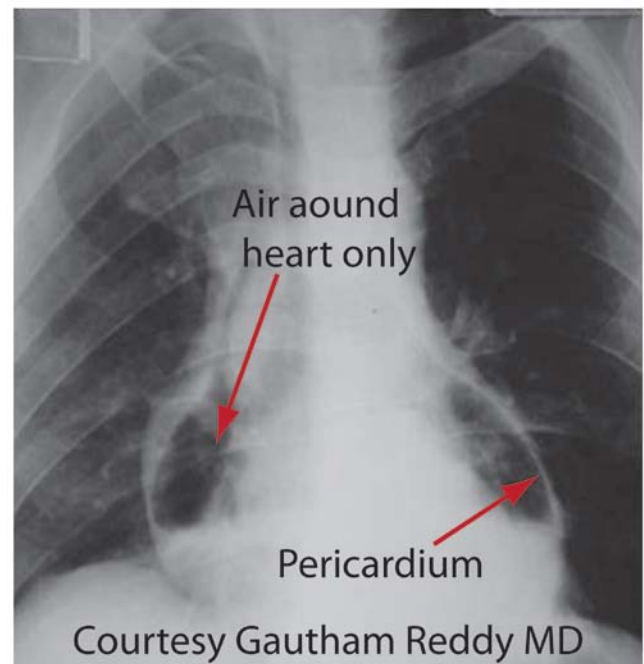
## 2. Pneumomediastinum

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



## 2. Pneumomediastinum

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

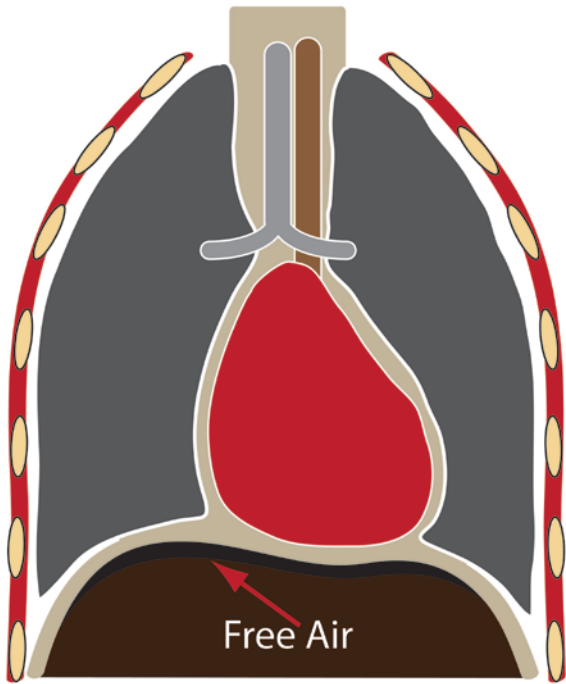


Courtesy Gautham Reddy MD



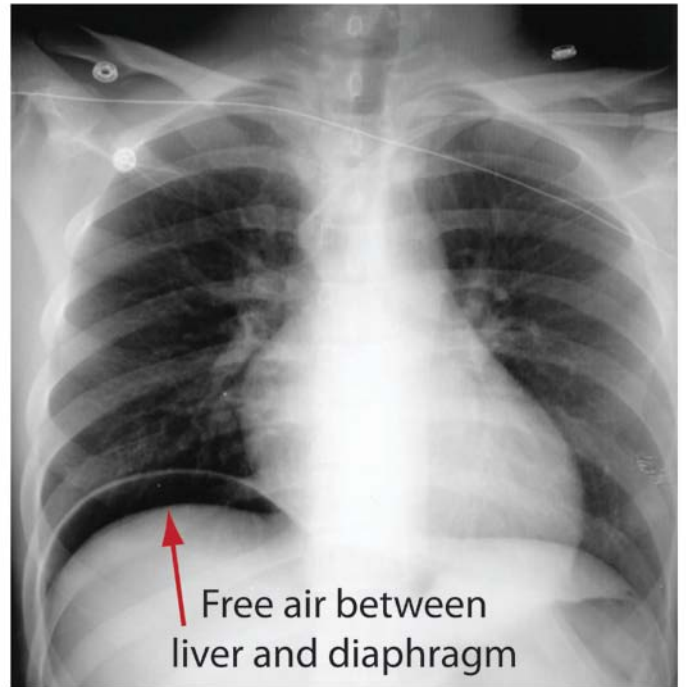
### 3. Pneumoperitoneum

Definition: Air outside bowel within the abdomen.



### 3. Pneumoperitoneum

X-Ray Findings: Lucent air below diaphragm.



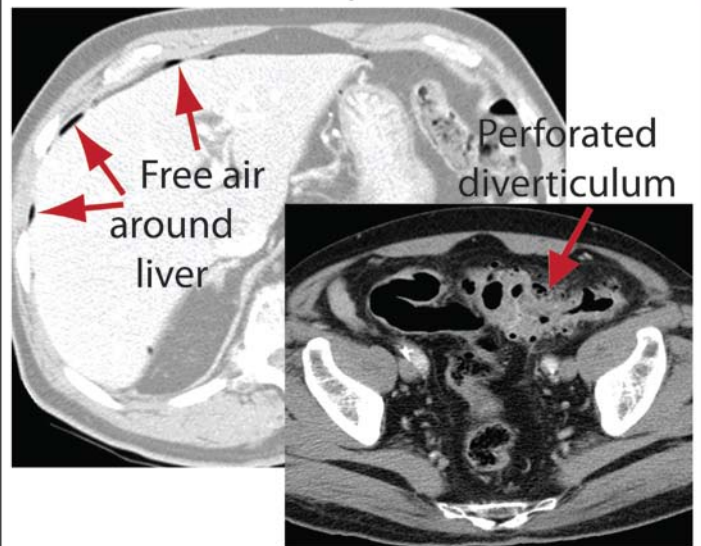
### 3. Pneumoperitoneum

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



### 3. Pneumoperitoneum

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



From Kim S et al.

*Radiographics* 2007;27:129-143



### 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

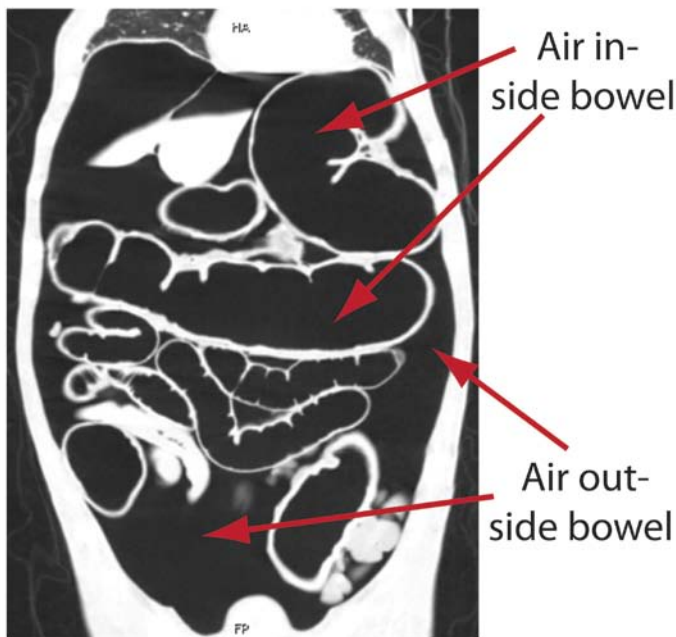
### 3. Pneumoperitoneum

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



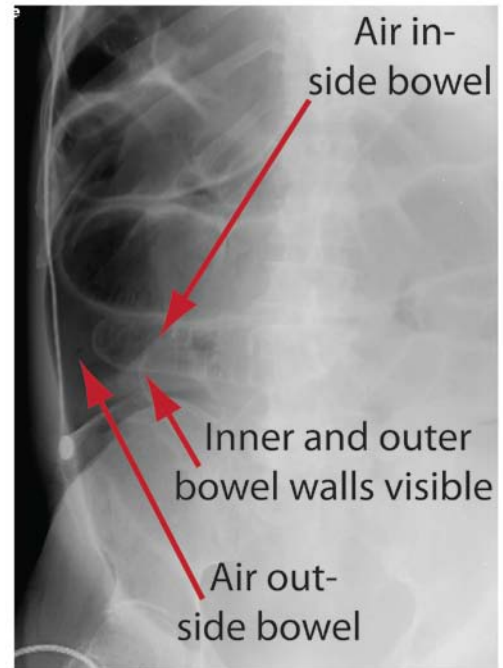
### 3. Pneumoperitoneum

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



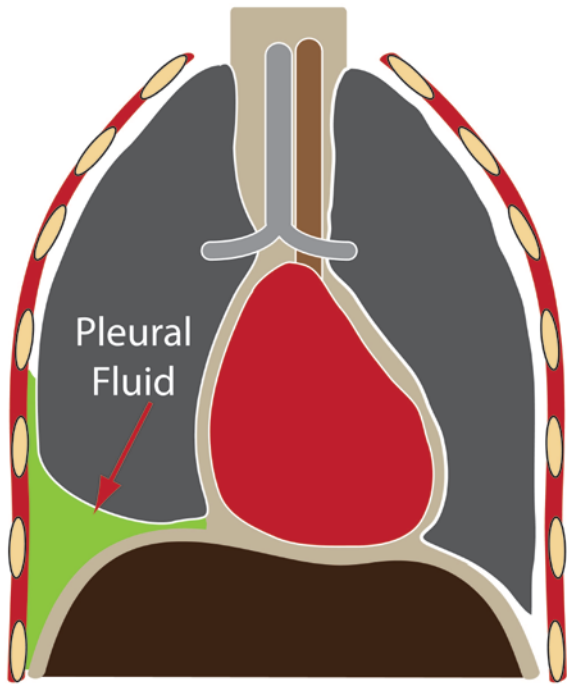
### 3. Pneumoperitoneum

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



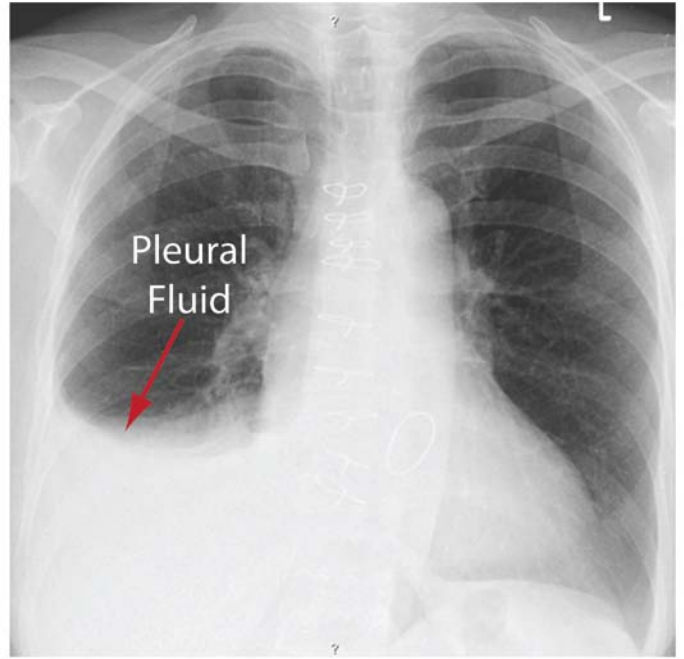
#### 4. Pleural Effusion

Definition: Fluid in the pleural space, between visceral and parietal pleura.



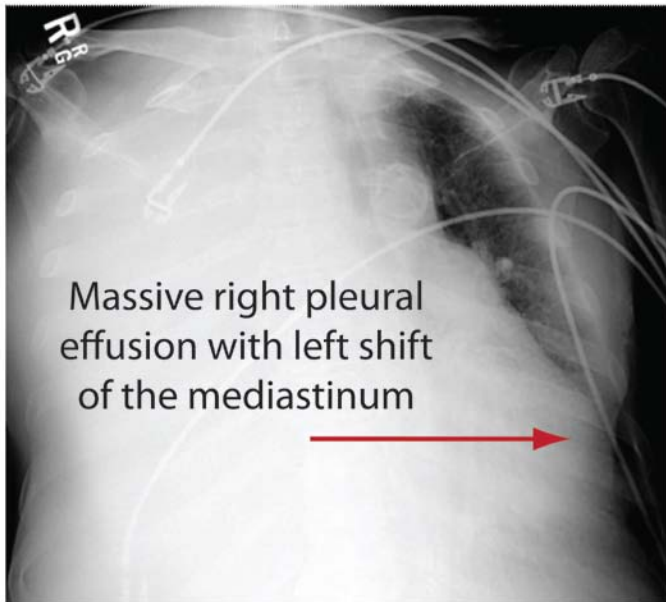
#### 4. Pleural Effusion

X-ray Findings: Soft tissue density "meniscus sign" in the lateral costophrenic angle if effusion is small.



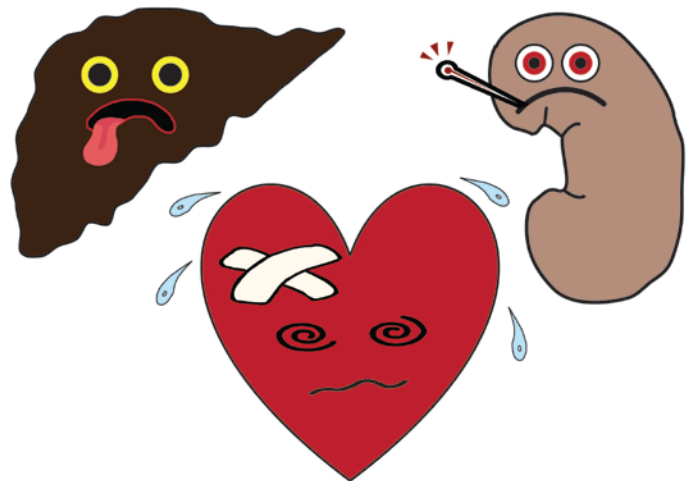
#### 4. Pleural Effusion

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



#### 4. Pleural Effusion

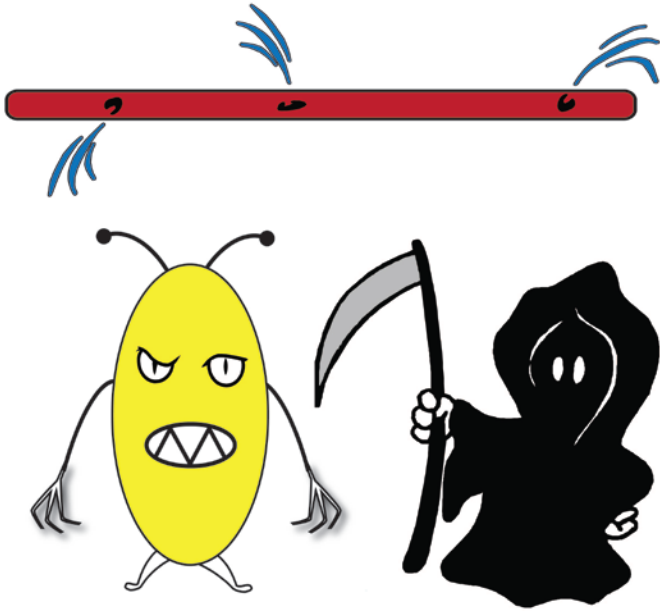
Mechanism of Injury: Transudative effusions occur when fluid leaks into the pleural space because of increased capillary pressure or low vascular oncotic pressure. This fluid has low protein and cell count and is usually due to CHF. Other causes: liver and renal failure.





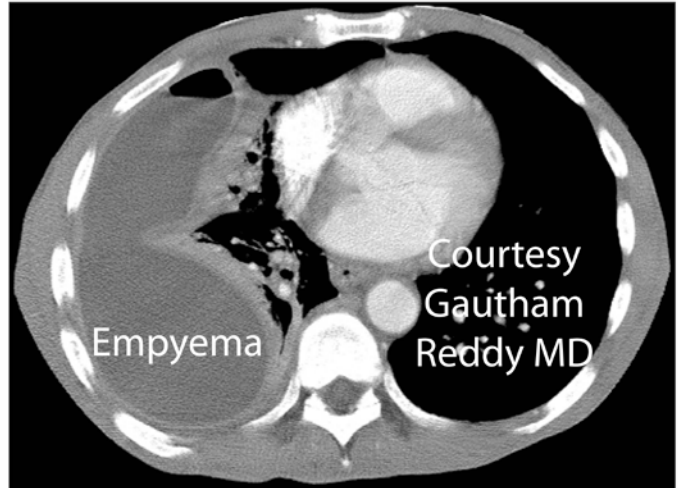
#### 4. Pleural Effusion

Mechanism of Injury: Leaky capillaries cause exudative effusions. The fluid has high protein and cell count and is often due to infection or cancer.



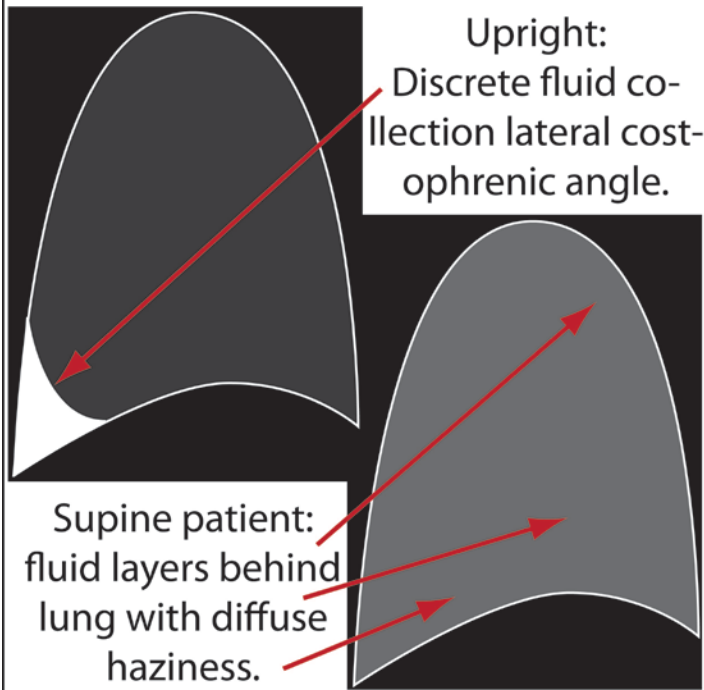
#### 4. Pleural Effusion

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.



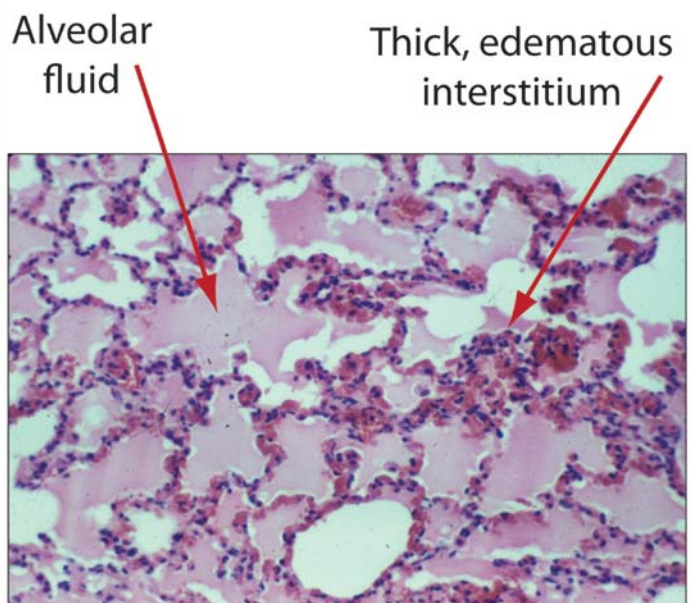
#### 4. Pleural Effusion

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



#### 5. Pulmonary Edema

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

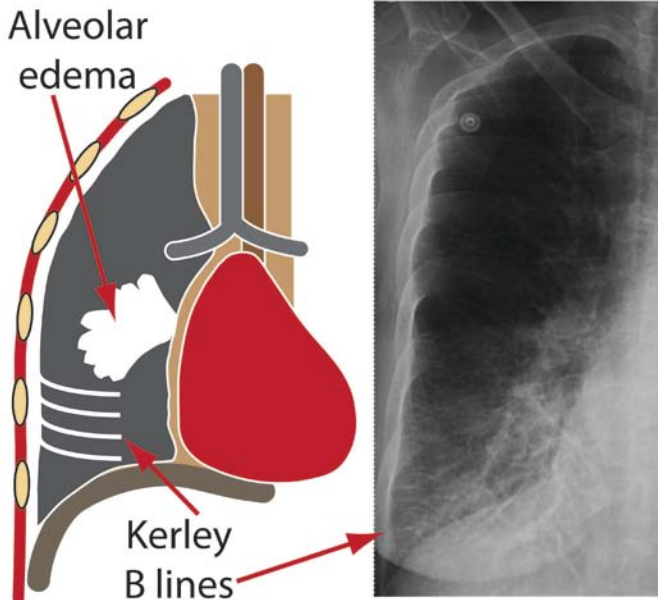


From: <http://research.vet.upenn.edu>



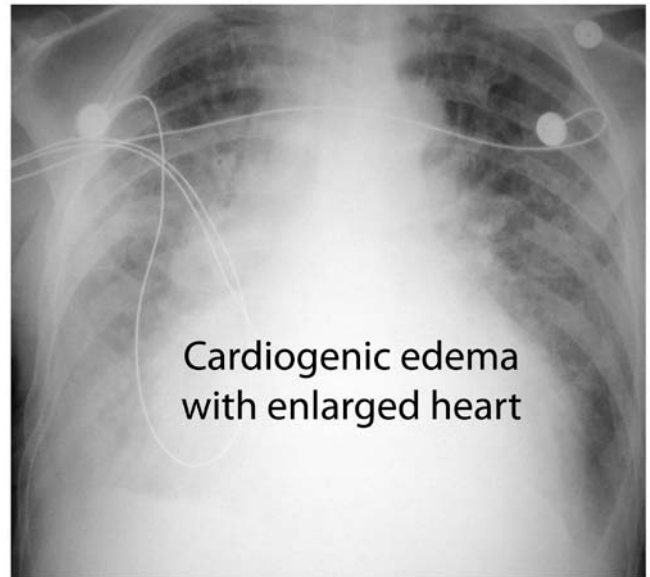
### 5. Pulmonary Edema

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



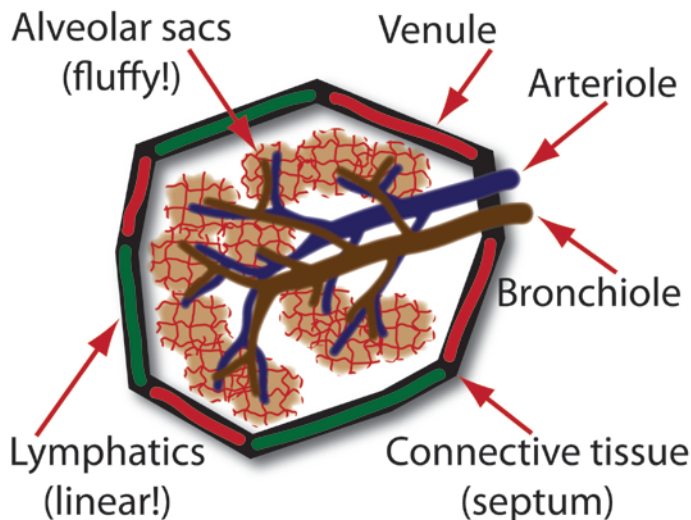
### 5. Pulmonary Edema

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



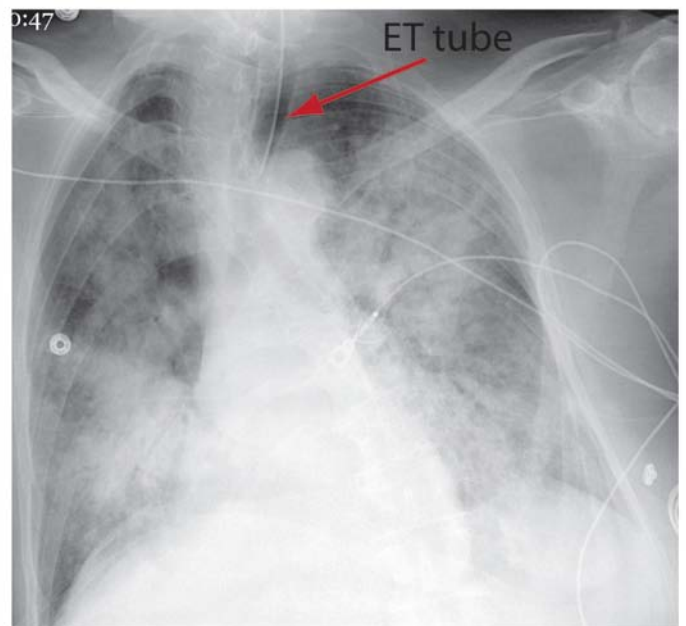
### 5. Pulmonary Edema

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.



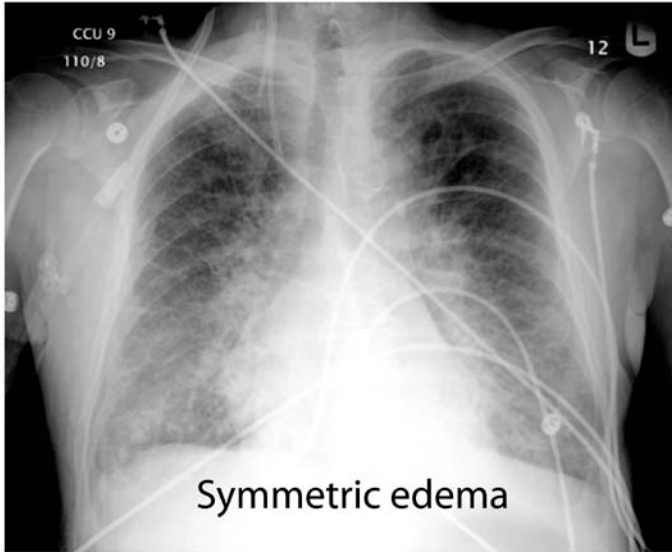
### 5. Pulmonary Edema

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



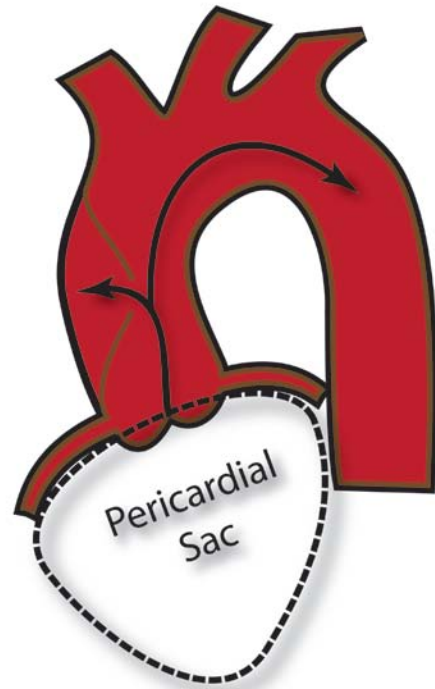
### 5. Pulmonary Edema

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.

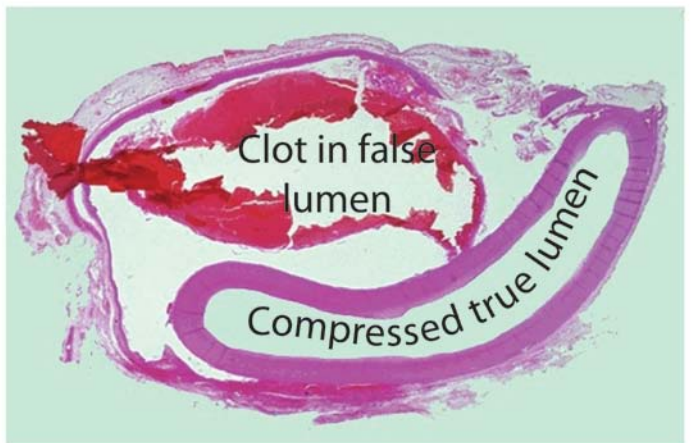


Wow!



### 6. Aortic Dissection

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

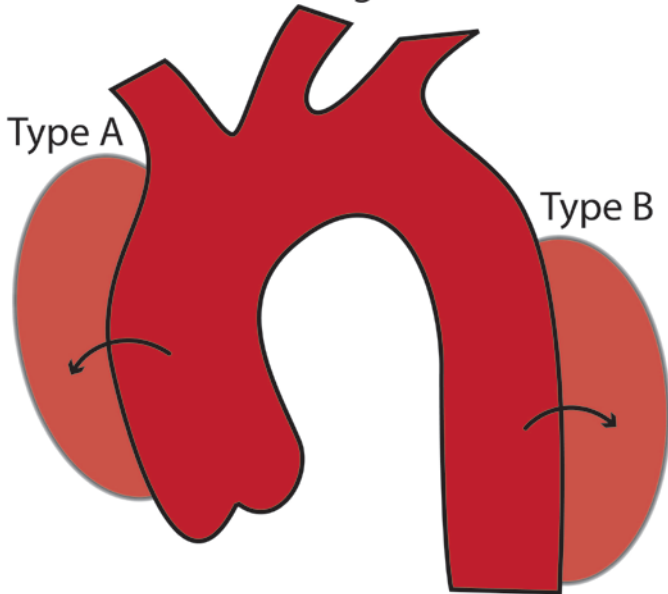


From: <http://library.med.utah.edu/WebPath>



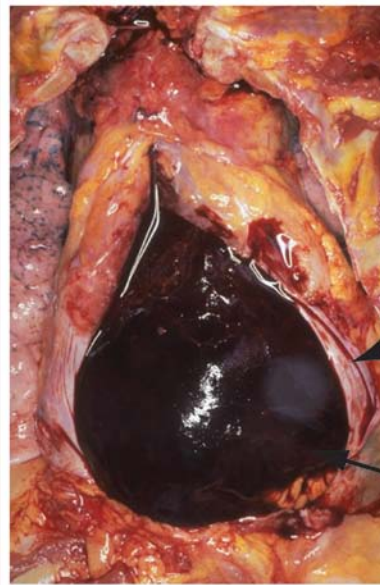
### 6. Aortic Dissection

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.



### 6. Aortic Dissection

Complications: Type A dissections more likely to propagate. Proximal propa-



gation into the pericardium may result in cardiac tamponade and death.

Pericardium (opened)

Blood

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

### 6. Aortic Dissection

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

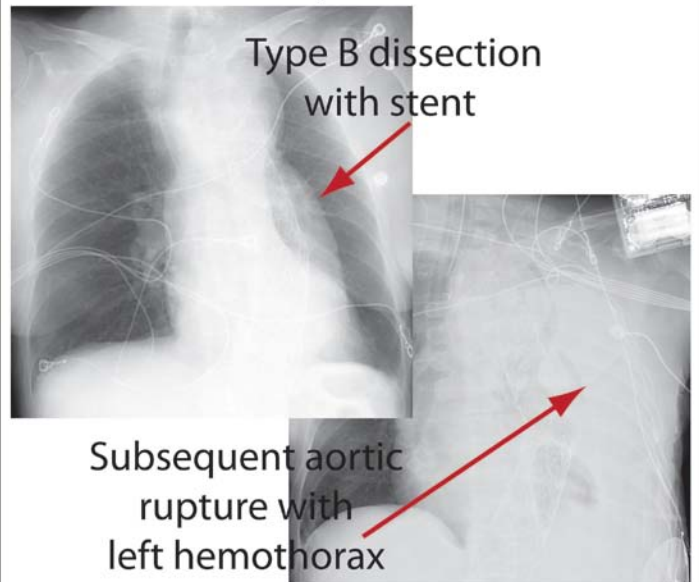
Dissection propagation to carotid artery with narrowing



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).



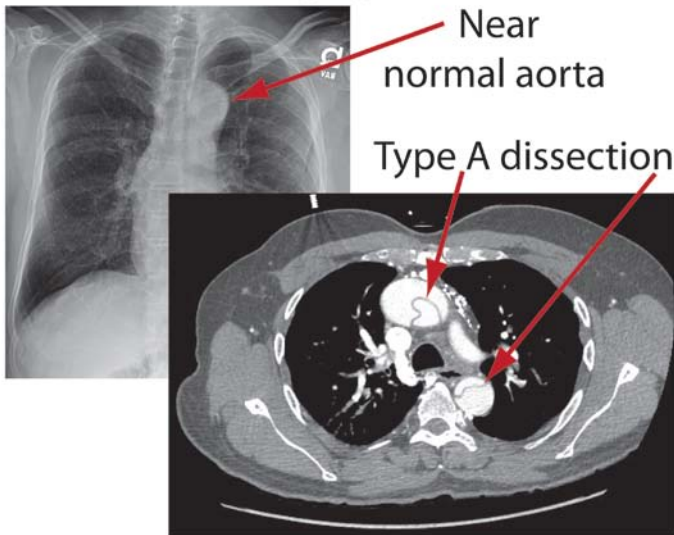
Type B dissection with stent

Subsequent aortic rupture with left hemothorax



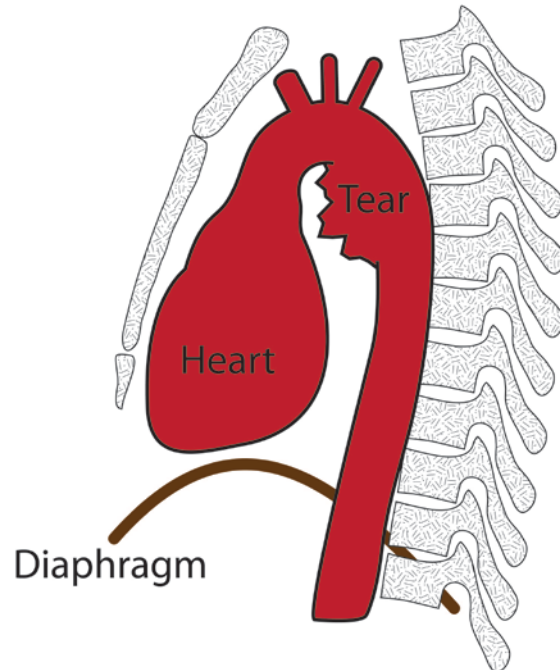
## 6. Aortic Dissection

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).



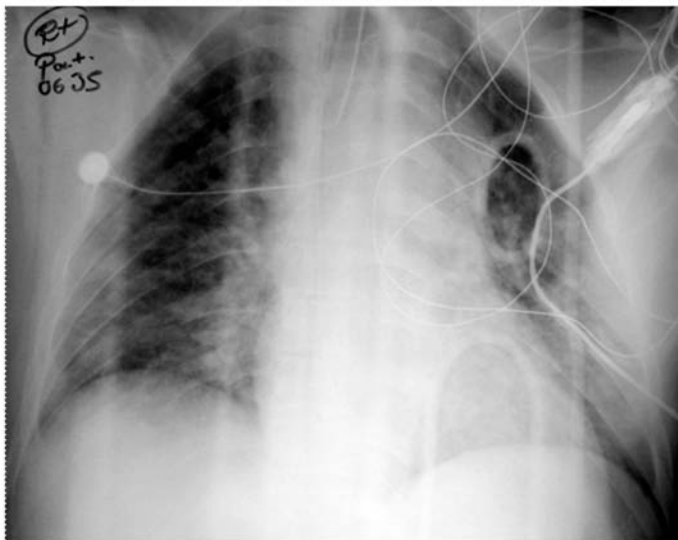
## 7. Aortic Rupture

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



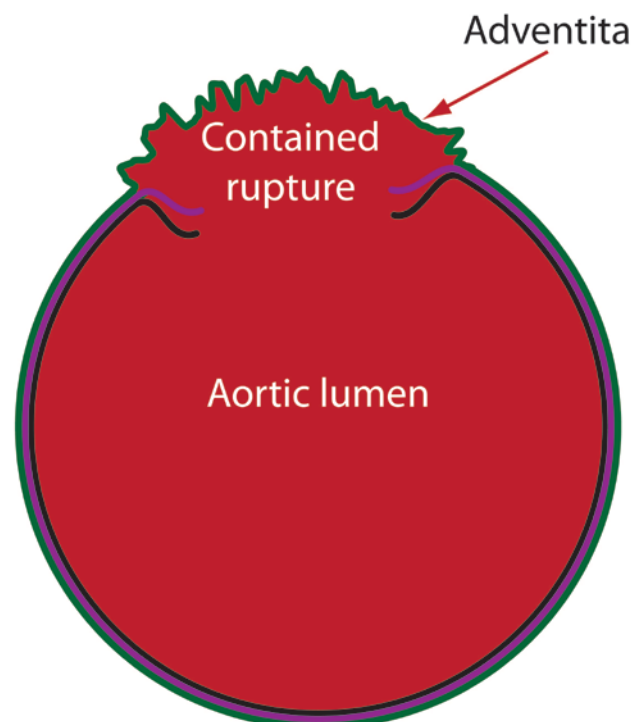
## 7. Aortic Rupture

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.



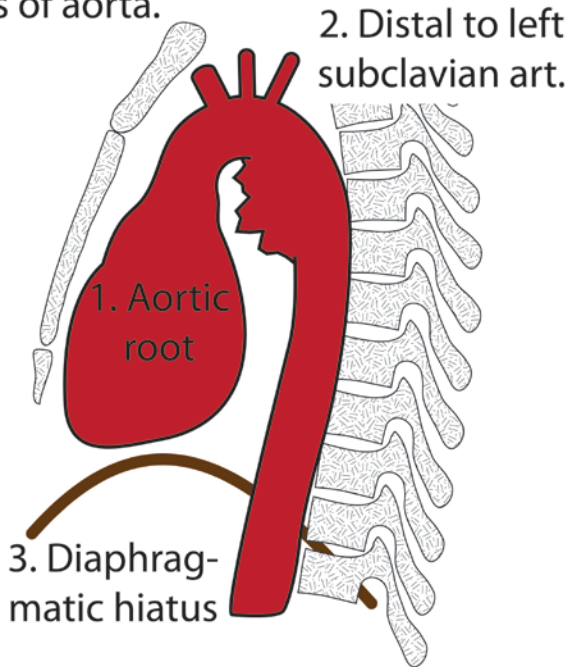
## 7. Aortic Rupture

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



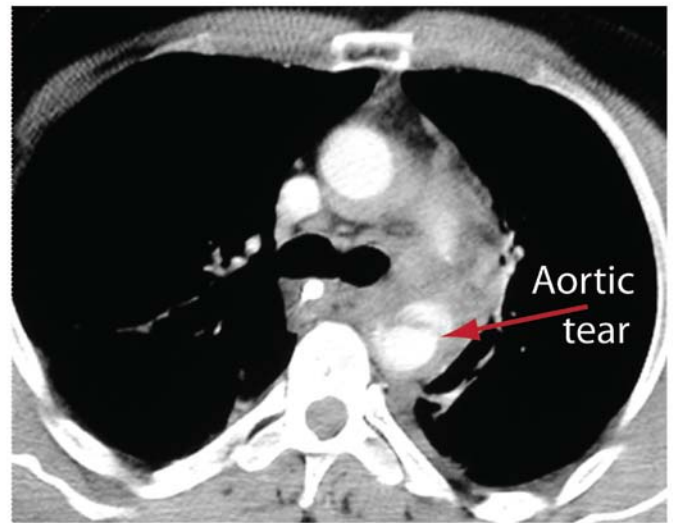
### 7. Aortic Rupture

Mechanism of Injury: Rapid deceleration in MVA or fall causes shearing at transition between fixed and mobile parts of aorta.



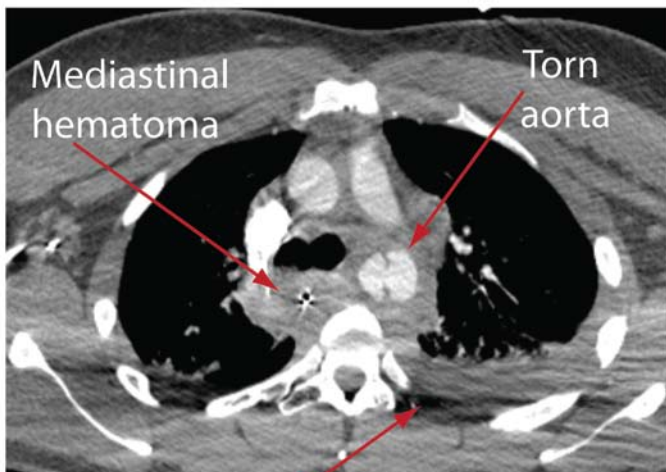
### 7. Aortic Rupture

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.



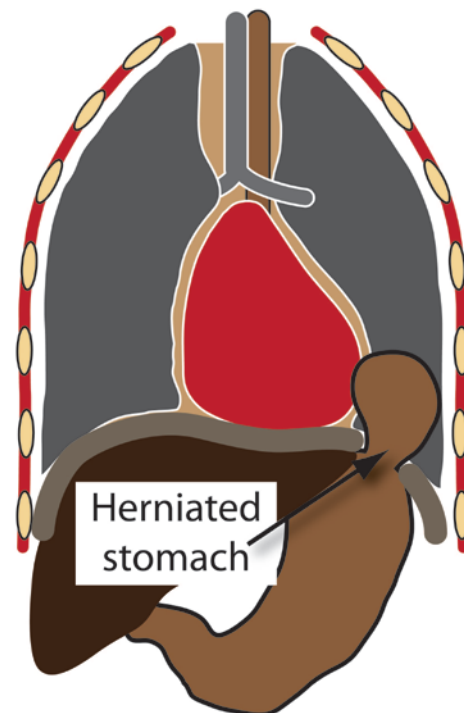
### 7. Aortic Rupture

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



### 8. Diaphragmatic Rupture

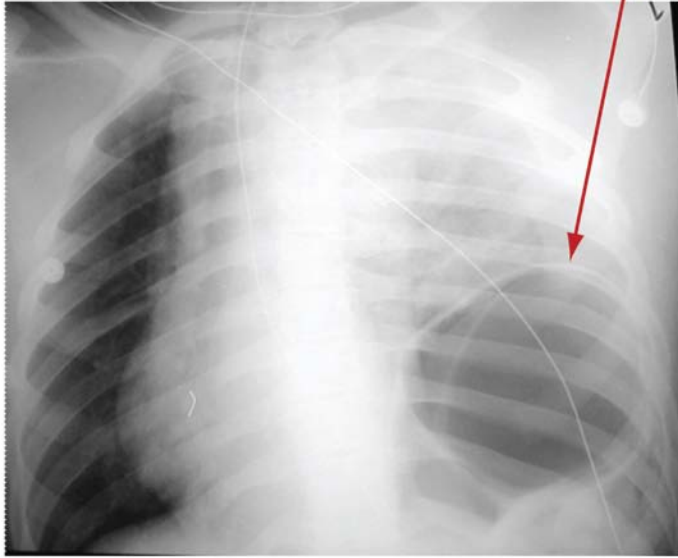
Definition: Post traumatic tear of diaphragm.



### 8. Diaphragmatic Rupture

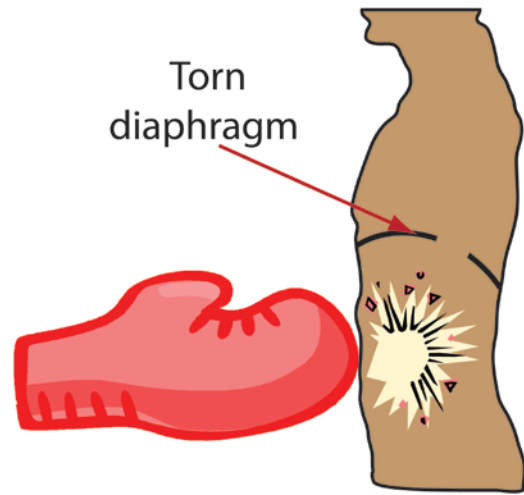
X-ray Findings: Don't see rupture itself, but displacement of abdominal contents into chest.

Stomach herniated into chest.



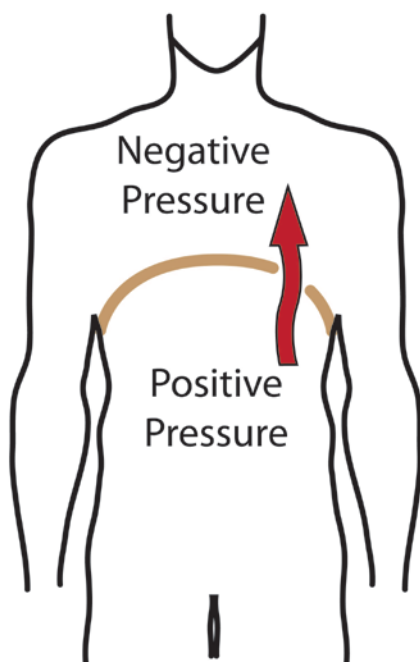
### 8. Diaphragmatic Rupture

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.



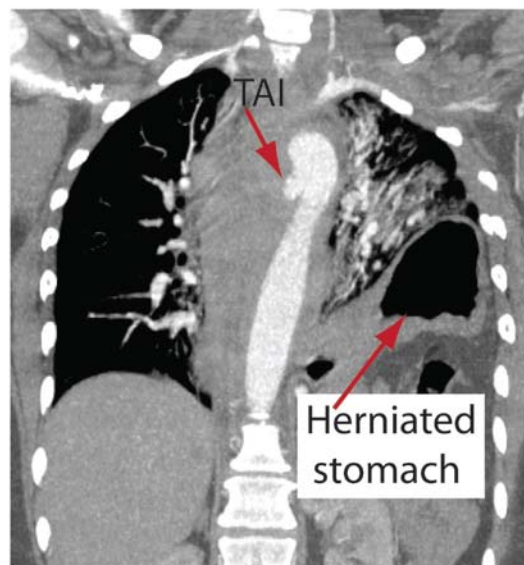
### 8. Diaphragmatic Rupture

Mechanism of Injury: Negative intra-thoracic pressure causes abdominal contents to herniate into the chest.



### 8. Diaphragmatic Rupture

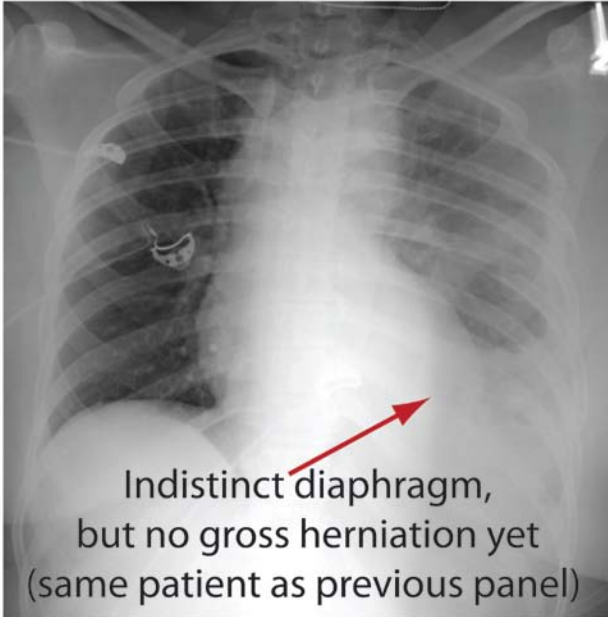
Complications: Herniated structures at risk for vascular compromise and occlusion. Compression of lungs may cause respiratory insufficiency. High likelihood serious other injuries (i.e.TAI).





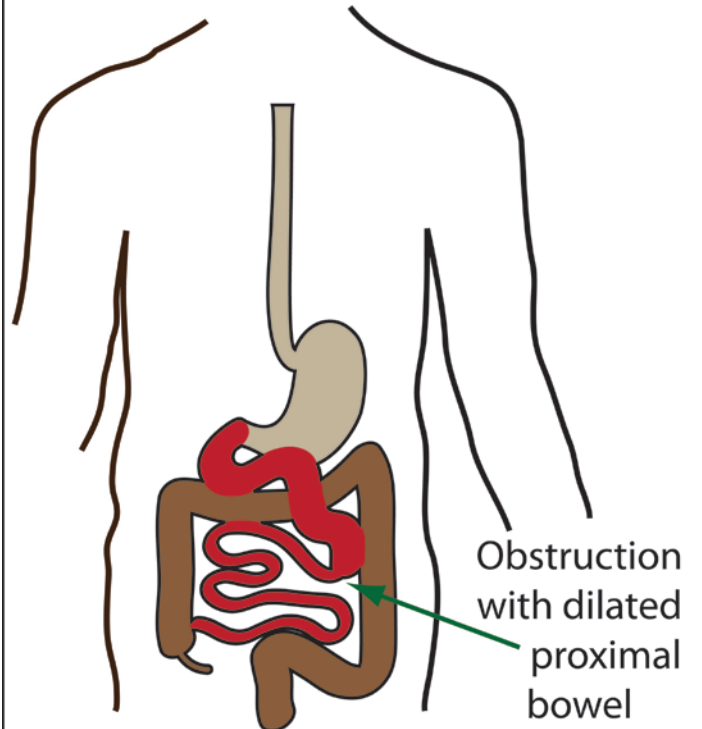
### 8. Diaphragmatic Rupture

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



### 9. Small Bowel Obstruction (SBO)

Definition: Obstruction of bowel lumen preventing transit of contents.

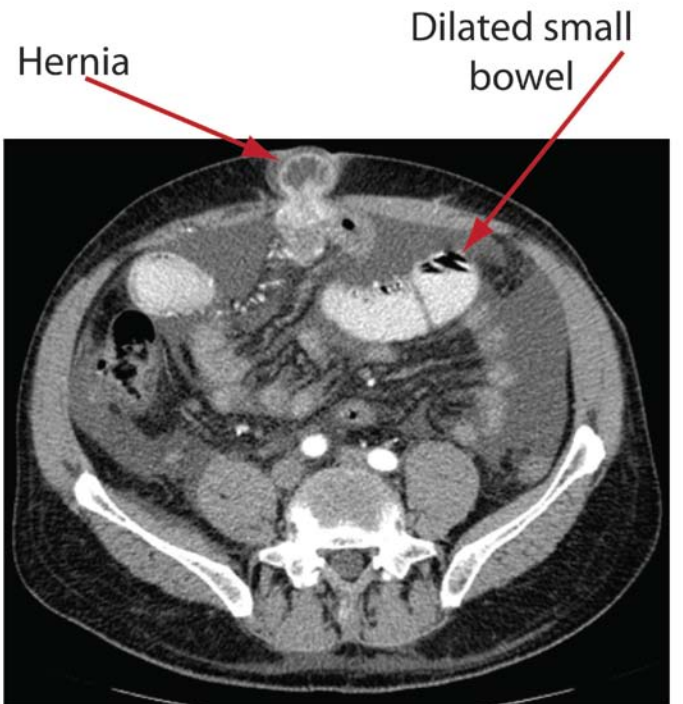


16

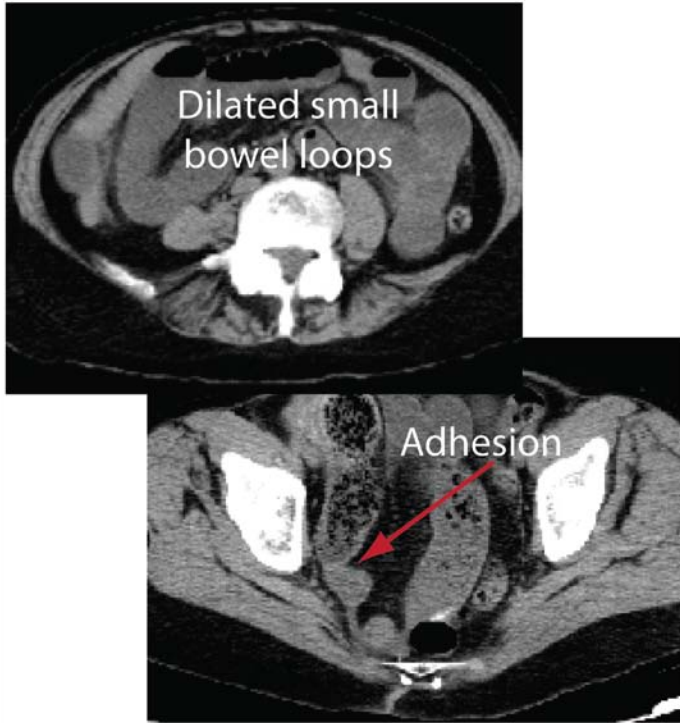
9. Small Bowel Obstruction (SBO)  
X-Ray Findings: Dilated small bowel, little or no large bowel gas, air-fluid levels on upright X-Ray.



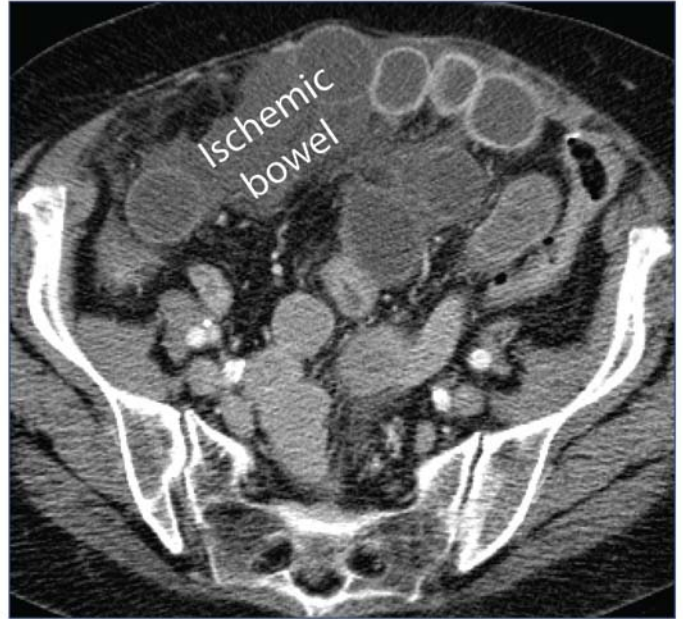
9. Small Bowel Obstruction (SBO)  
Etiology: Hernia, adhesions from prior surgery and tumor (least common).



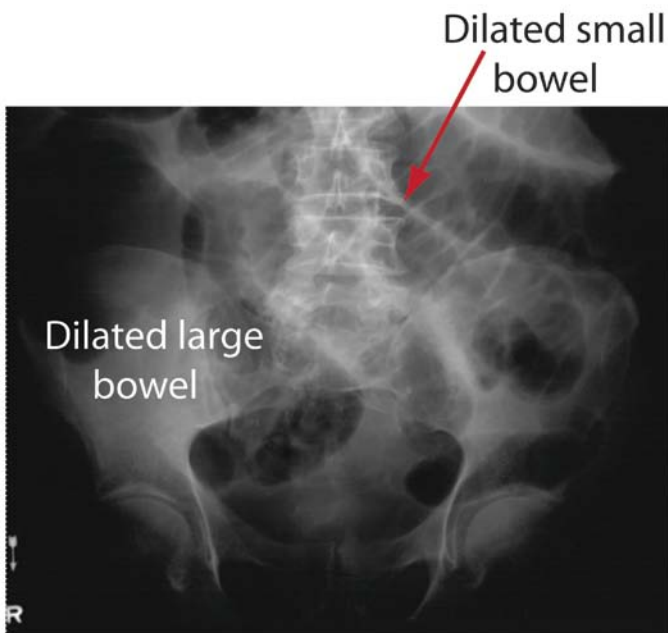
9. Small Bowel Obstruction (SBO)  
Mechanism of Injury: Hernia, adhesion or tumor narrows/occludes lumen.



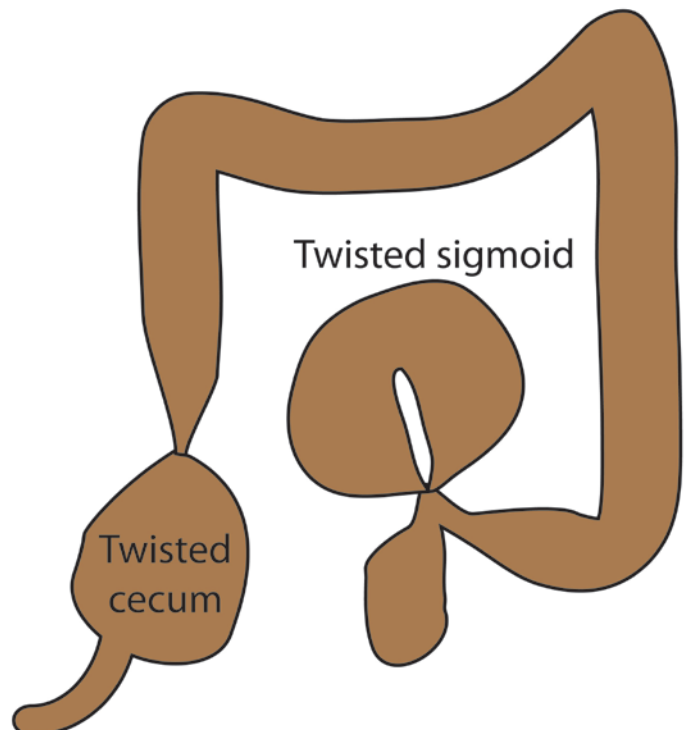
9. Small Bowel Obstruction (SBO)  
Complications: Dilated bowel may become ischemic and perforate. Vomiting may cause dehydration and aspiration.



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

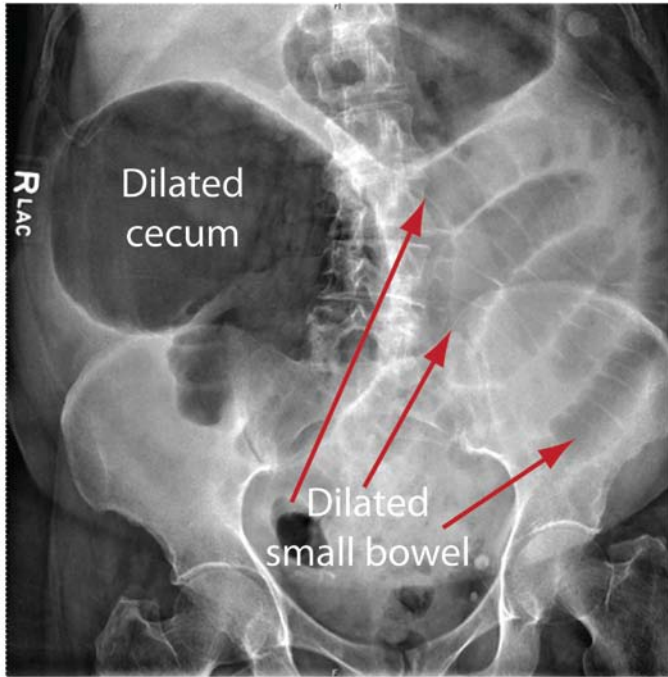


10. Cecal and Sigmoid Volvulus  
Definition: Twisting of the sigmoid colon or cecum resulting in obstruction.

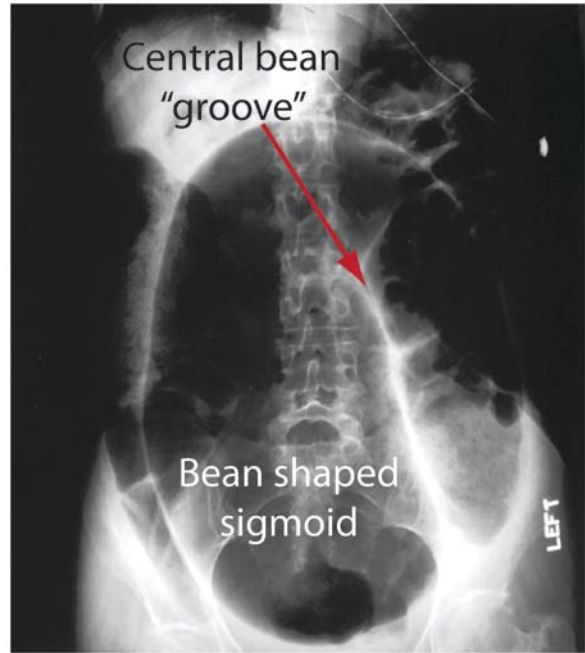




10. Cecal and Sigmoid Volvulus  
 X-Ray Findings: Dilated bowel RLQ and small bowel dilatation (cecal volvulus).



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



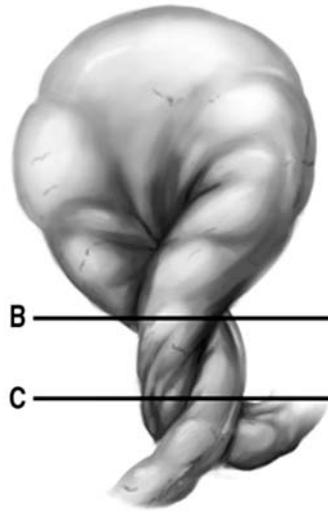
10. Cecal and Sigmoid Volvulus  
 Etiology: Twisting of mobile bowel around a fulcrum point.

Cecal volvulus



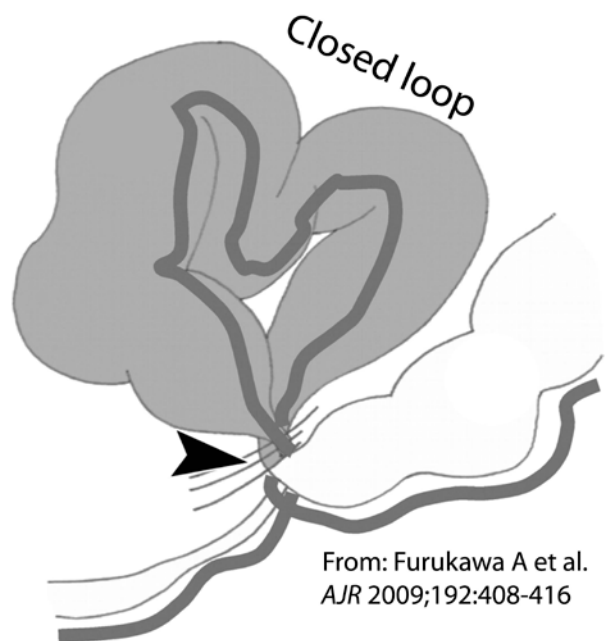
From: Moore C J et al.  
 AJR 2001;177:95-98

Sigmoid volvulus



From: Levsky J M et al.  
 AJR 2010;194:136-143

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



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

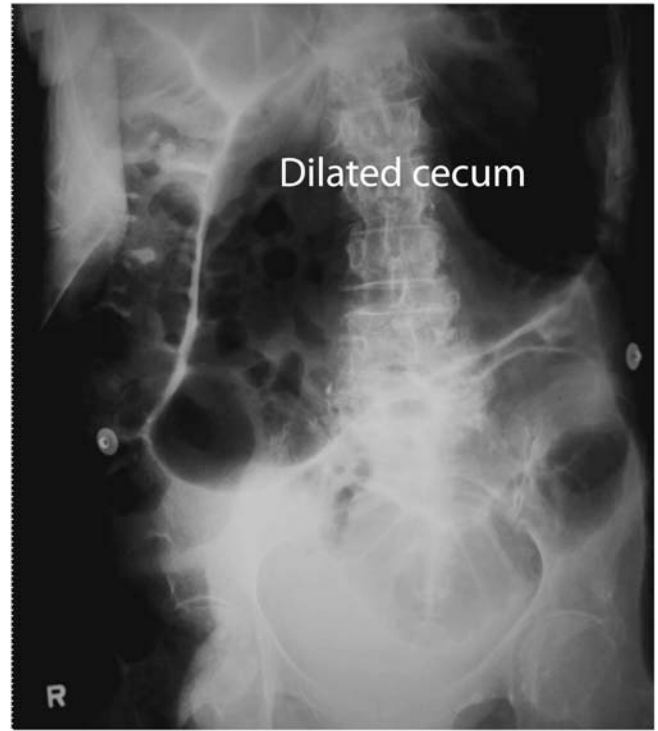


10. Cecal and Sigmoid Volvulus  
Complications: Bowel obstruction,  
ischemia, infarction and perforation.

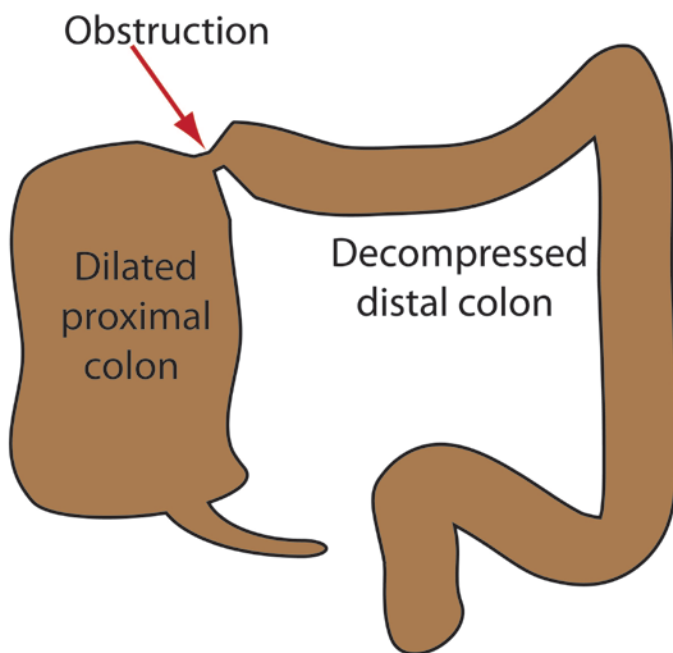
Gas in mesenteric veins (white  
circle) due to bowel infarction



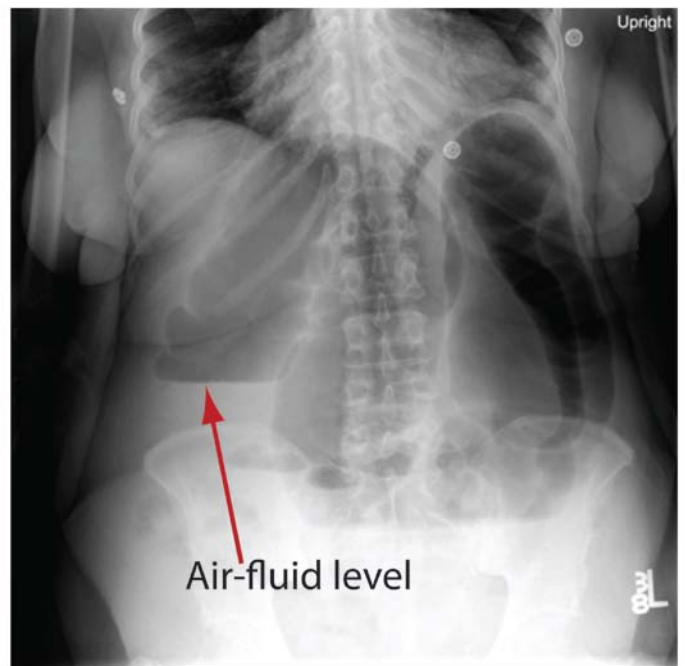
10. Cecal and Sigmoid Volvulus  
Pitfalls: Dilated cecum may "flop" toward  
the LUQ in cecal volvulus.



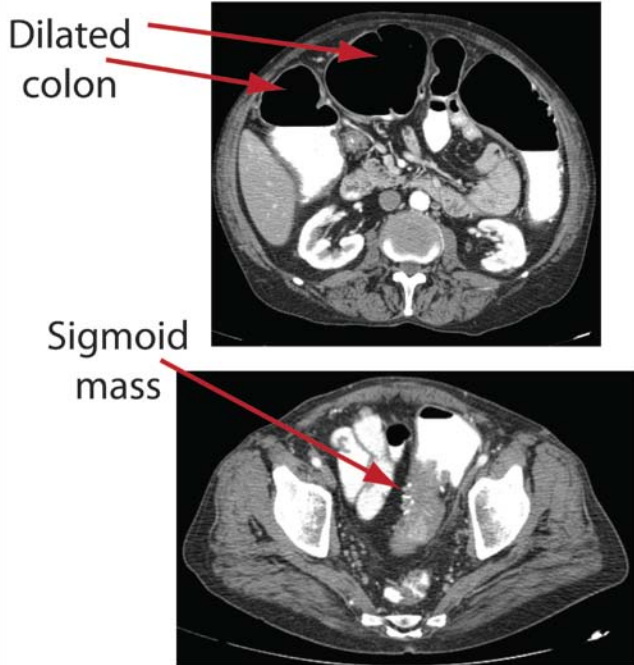
11. Large Bowel Obstruction (LBO)  
Definition: Obstruction of large bowel  
lumen preventing transit of contents.



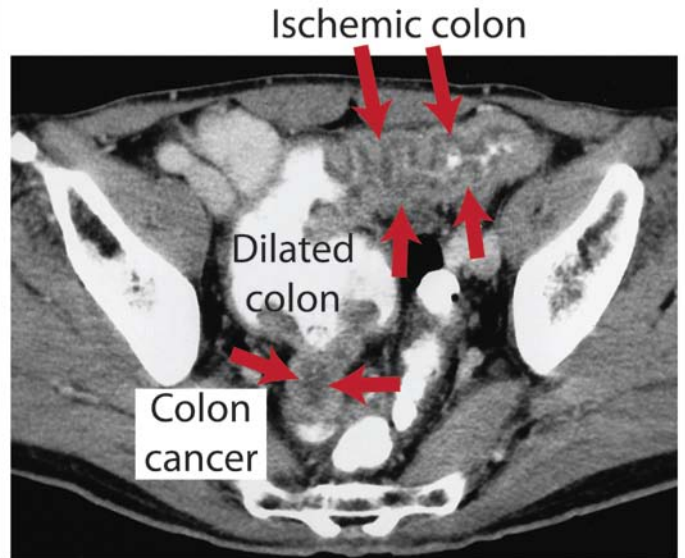
11. Large Bowel Obstruction (LBO)  
X-Ray Findings: Dilated colon with  
air-fluid levels on upright view.



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



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



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

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

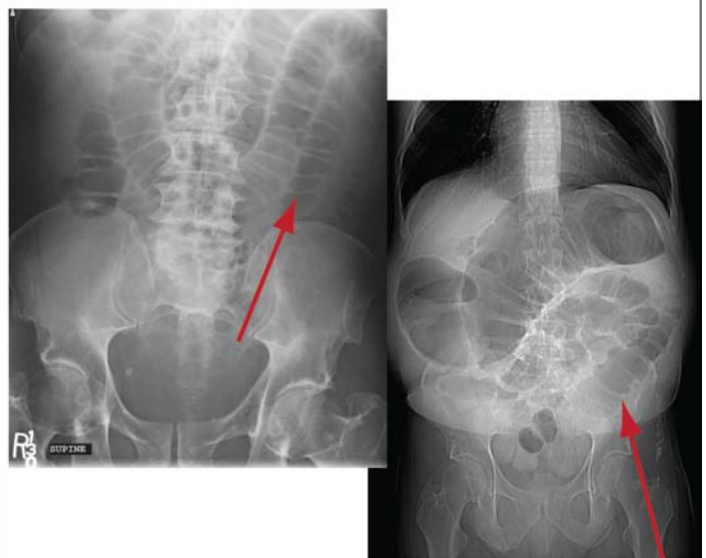
Diffuse colonic necrosis



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

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

SBO, markings completely traverse small bowel



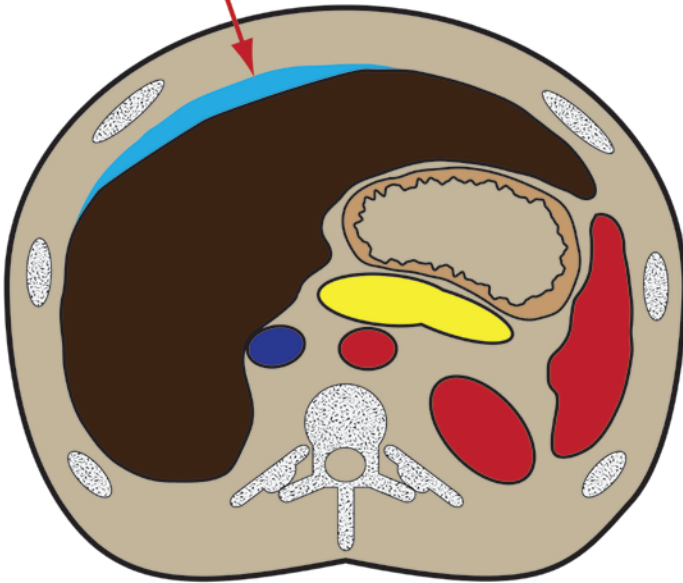
LBO, markings incompletely traverse large bowel



### 12. Ascites

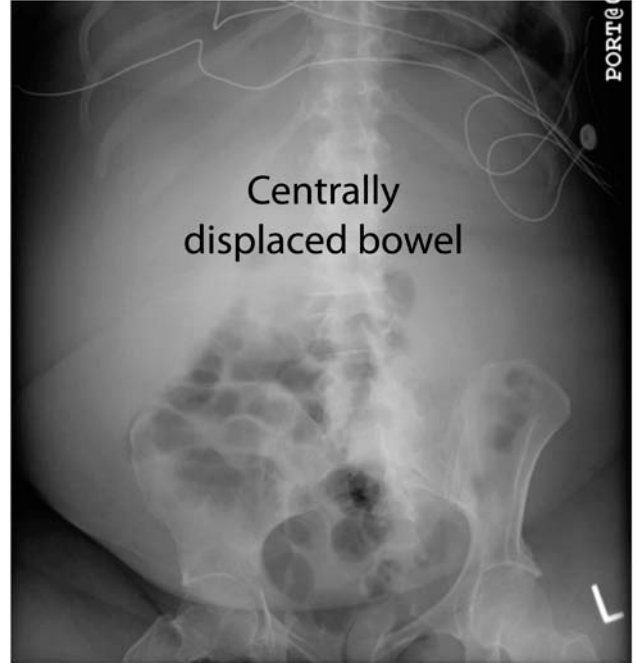
Definition: Fluid in peritoneum, outside solid or hollow organs.

Fluid around the liver



### 12. Ascites

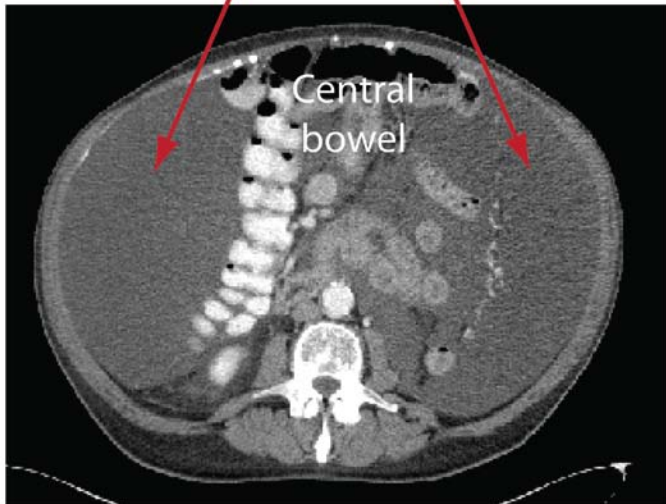
X-Ray Findings: If there is a lot of fluid, it collects in the flanks, pushing bowel to the center of the abdomen.



### 12. Ascites

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

Peripheral fluid



### 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





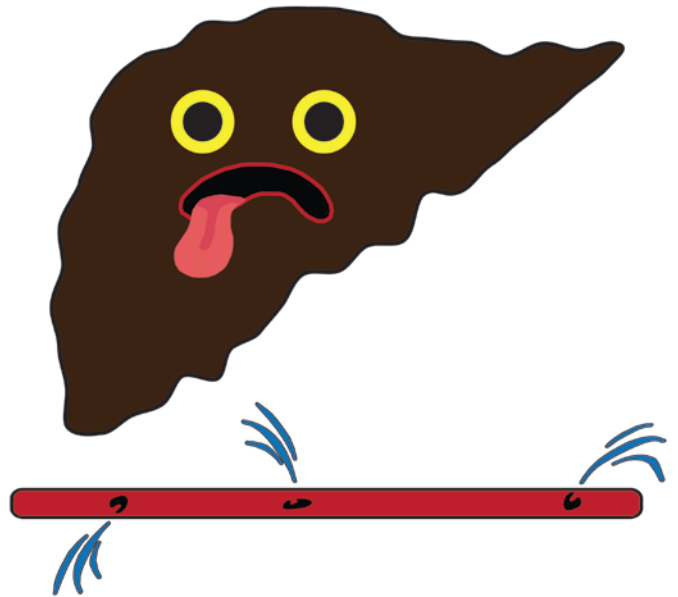
## 12. Ascites

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).

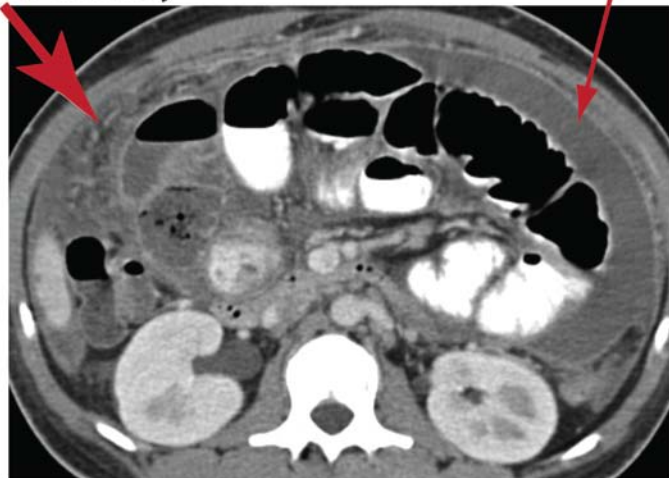


## 12. Ascites

Complications: Uncommon, treat underlying cause. Occasional infection.

Peritoneal nodularity

Ascites with TB infection



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

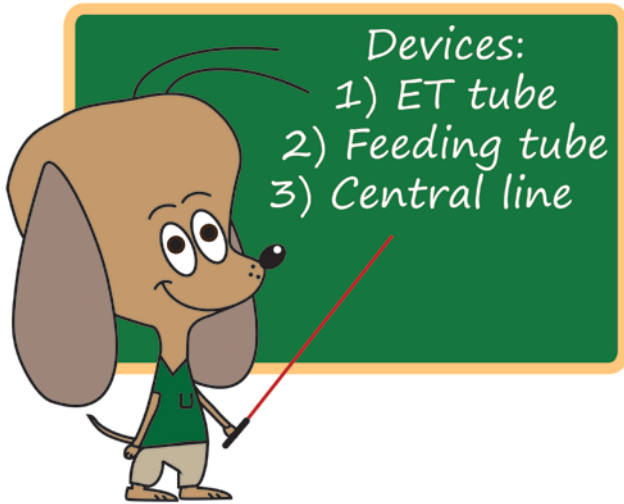
## 12. Ascites

Pitfalls: Unless fluid amount is large, CT or US needed.



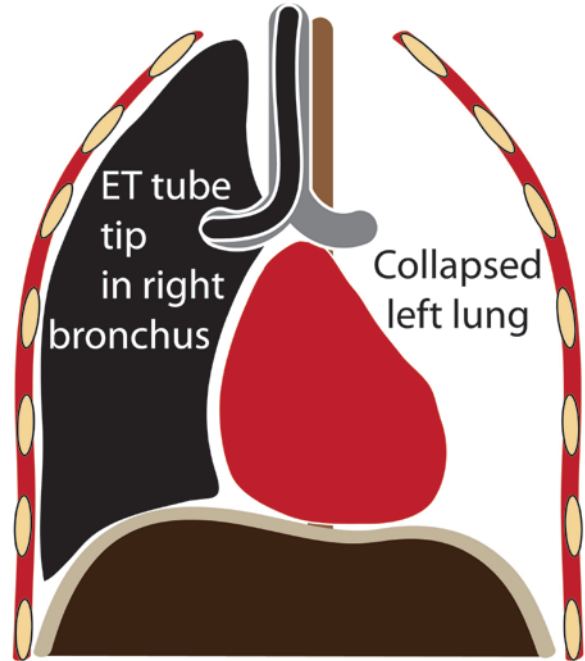
### 13. Misplaced Lines and Tubes

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



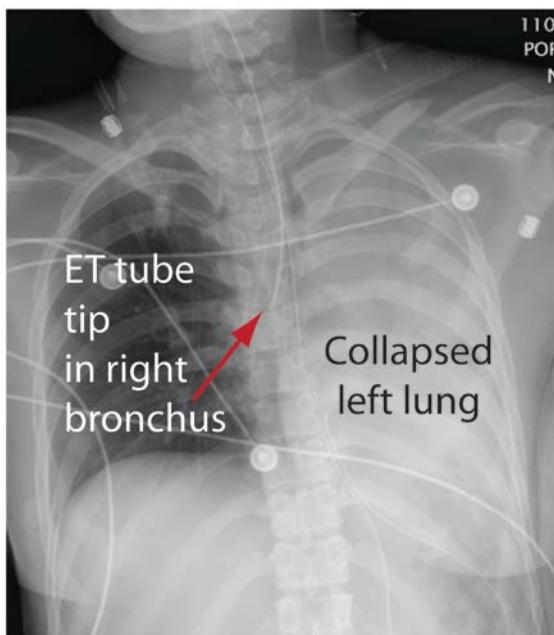
### 13. Misplaced Lines and Tubes

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



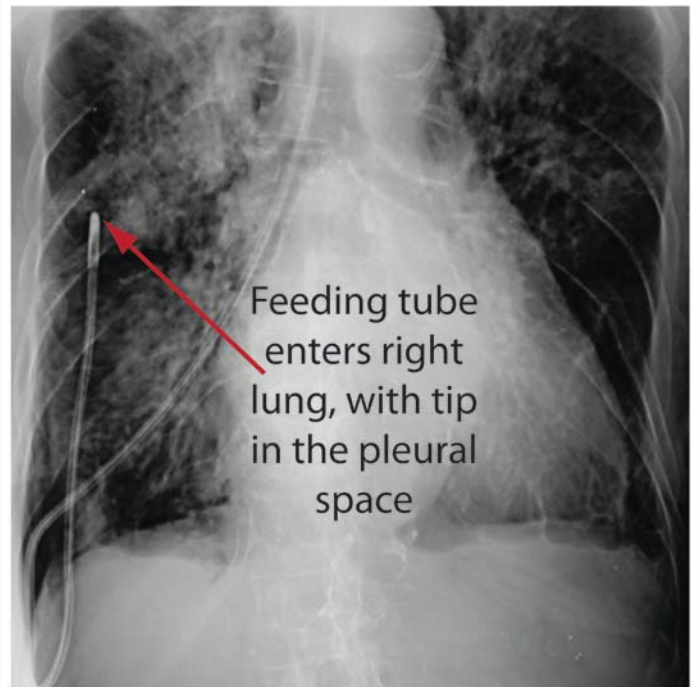
### 13. Misplaced Lines and Tubes

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.

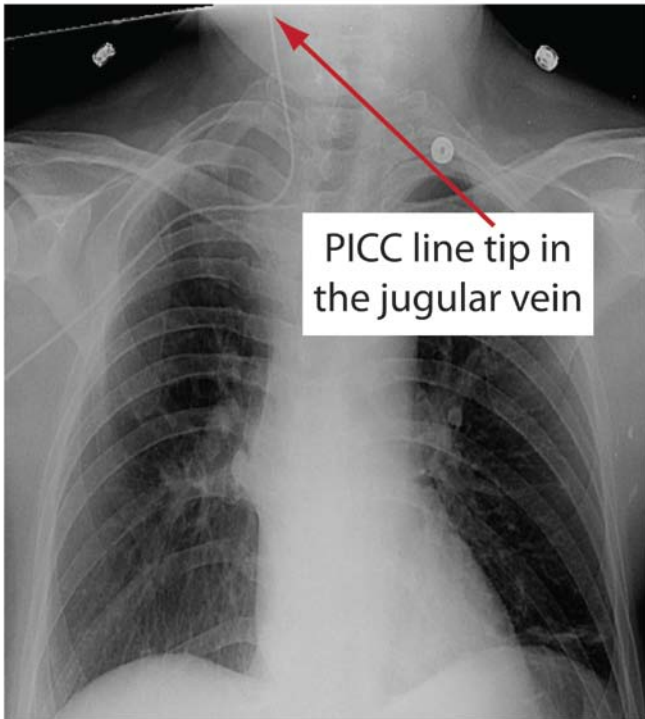


### 13. Misplaced Lines and Tubes

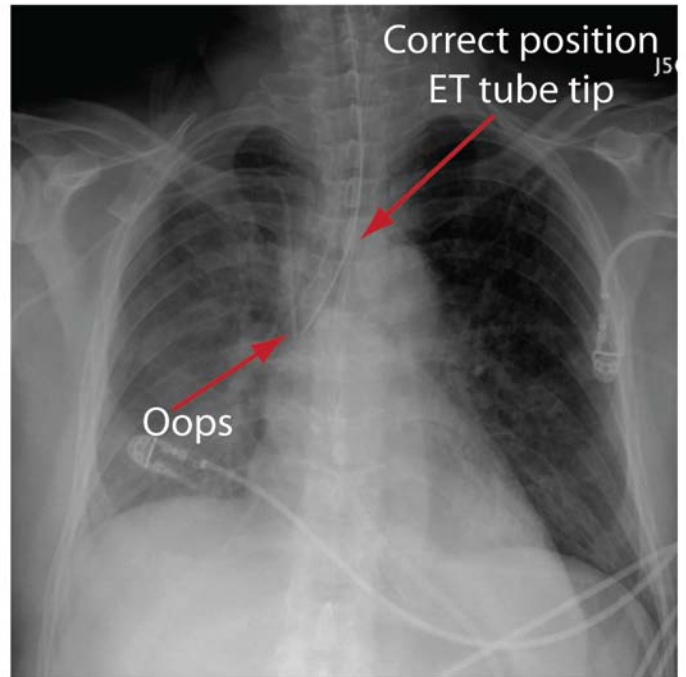
X-Ray Findings: Feeding tube tip should be in the GI tract, not the lungs!



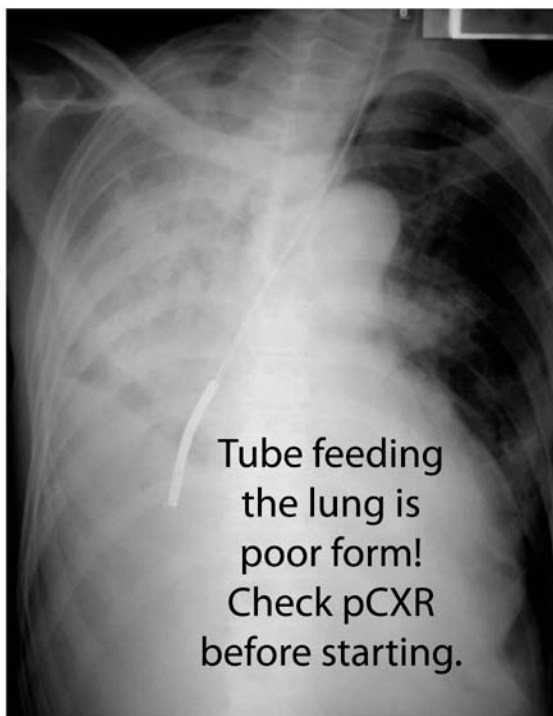
13. Misplaced Lines and Tubes  
X-Ray Findings: Central line tip should be in the SVC.



13. Misplaced Lines and Tubes  
Etiology: Device placement is usually done without imaging guidance. Devices may shift after placement.



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.





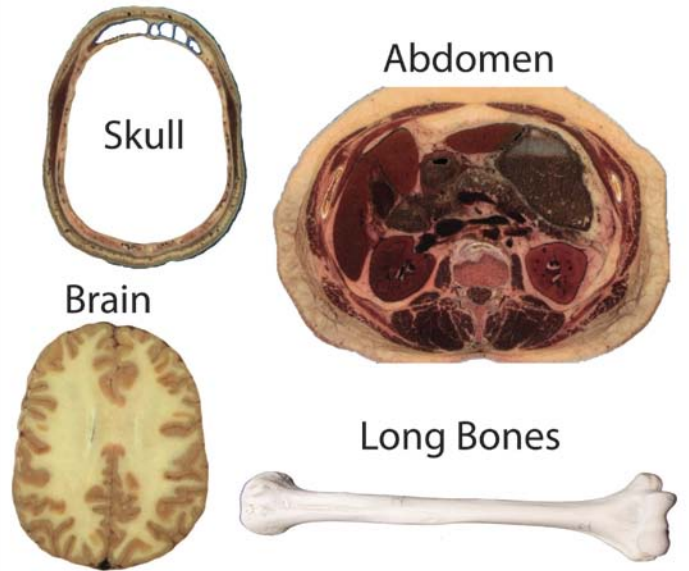
### 13. Misplaced Lines and Tubes

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.



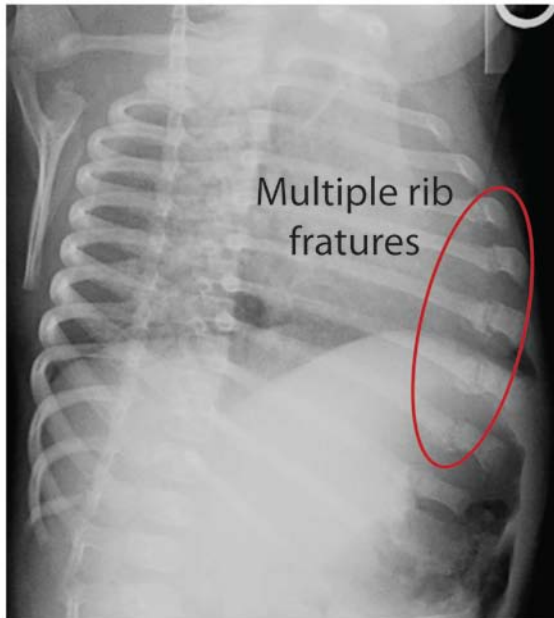
### 14. Child Abuse

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.



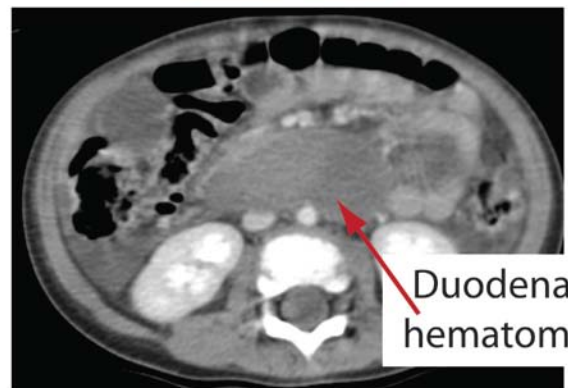
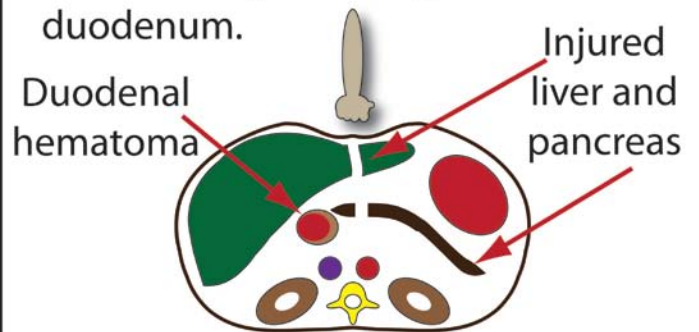
### 14. Child Abuse

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



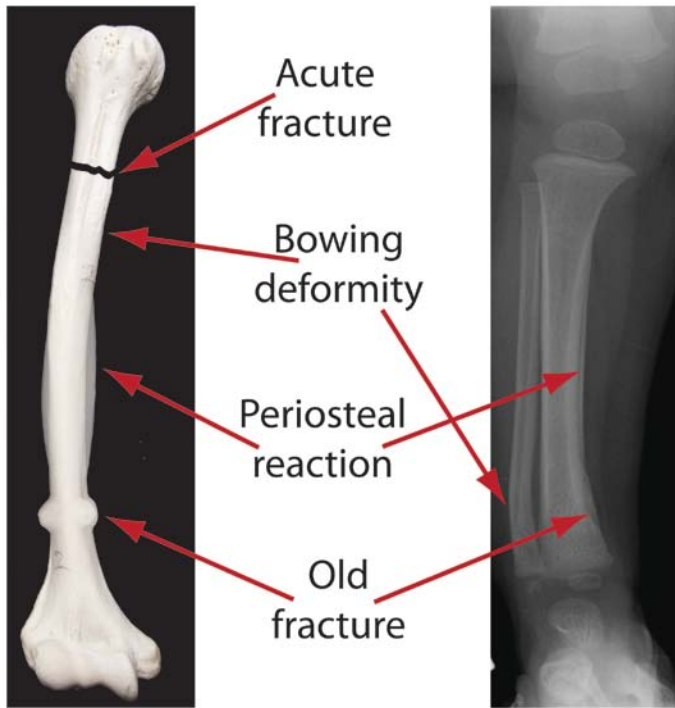
### 14. Child Abuse

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



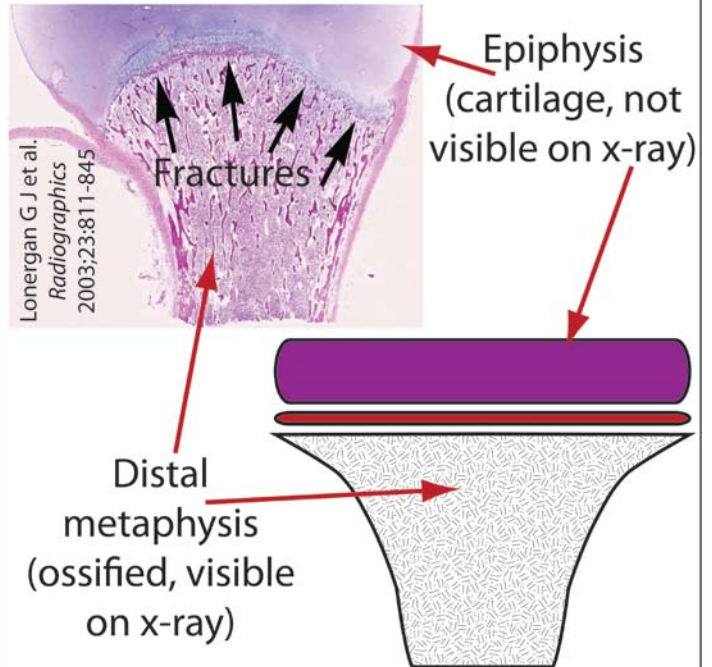
14. Child Abuse

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



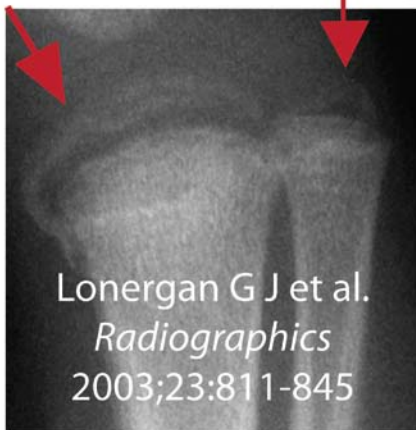
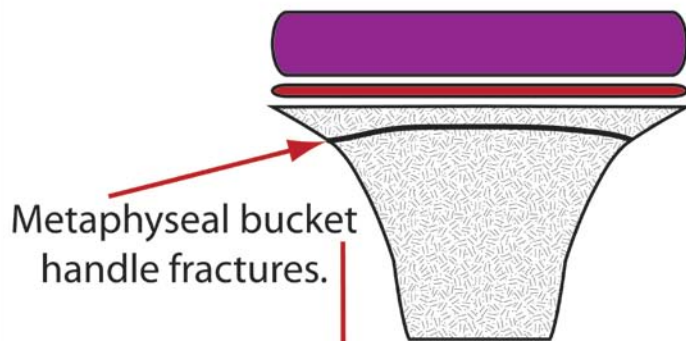
14. Child Abuse

X-Ray Findings: Characteristic long bone bucket handle and corner fractures that involve the distal metaphysis.



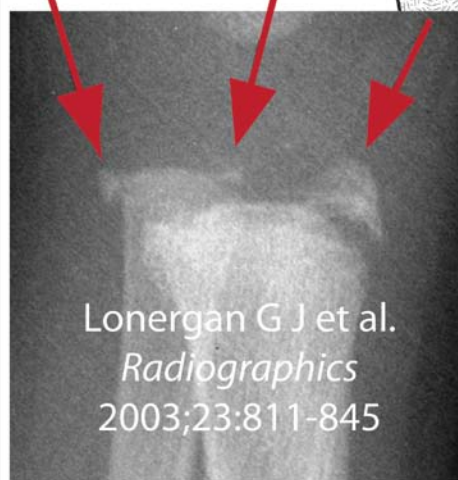
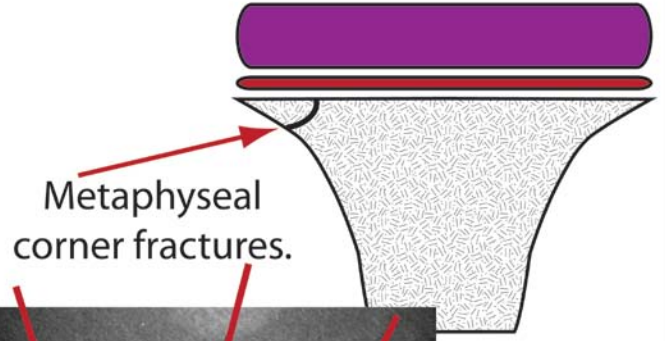
14. Child Abuse

X-Ray Findings: Bucket handle fractures.



14. Child Abuse

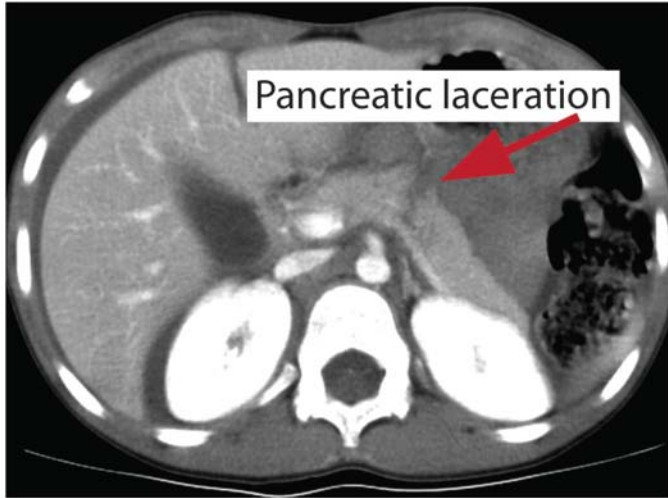
X-Ray Findings: Corner fractures.





### 14. Child Abuse

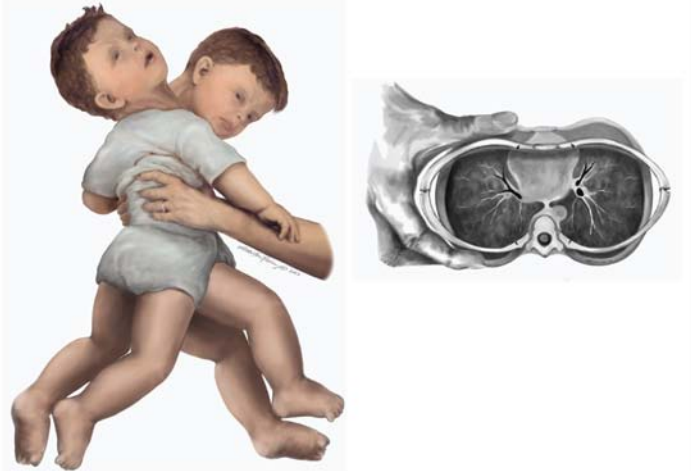
Etiology: Complex blend of social and economic factors. Abusers were often abused as children.



Lonergan G J et al. *Radiographics* 2003;23:811-845

### 14. Child Abuse

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



Lonergan 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.

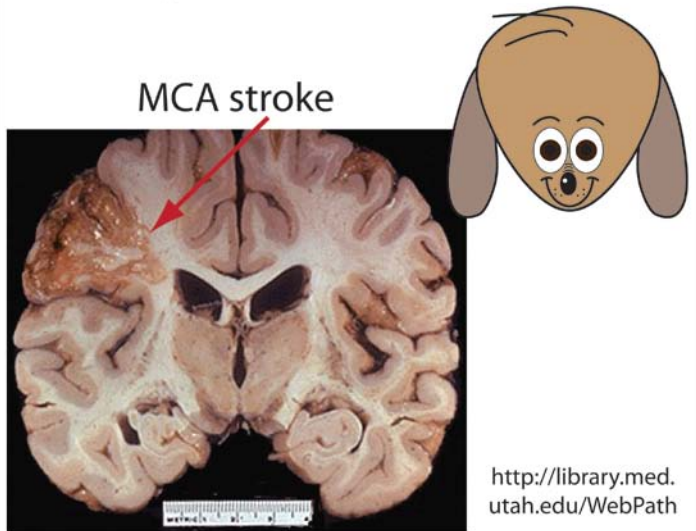
Osteogenesis imperfecta with bowing



Cheema J I 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.

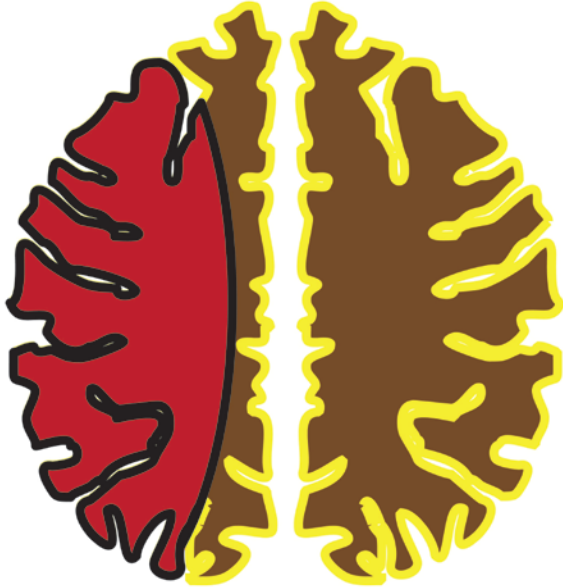


<http://library.med.utah.edu/WebPath>



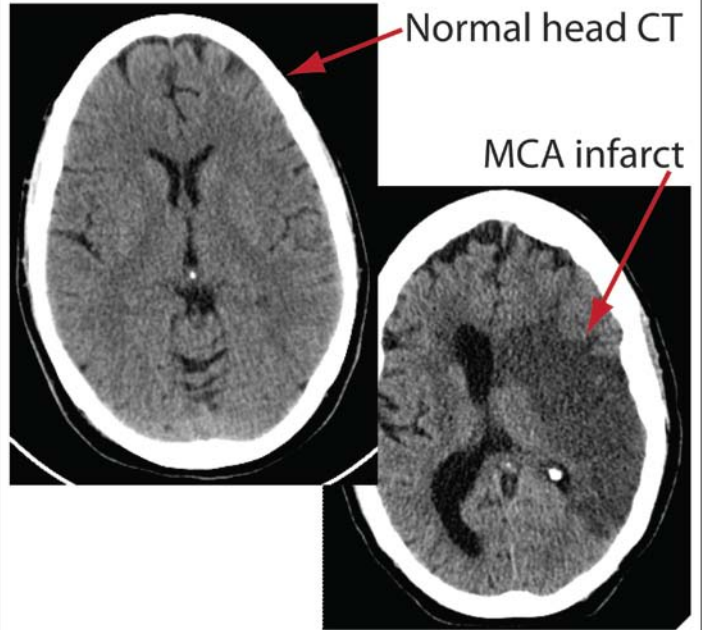
### 15. Stroke

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".



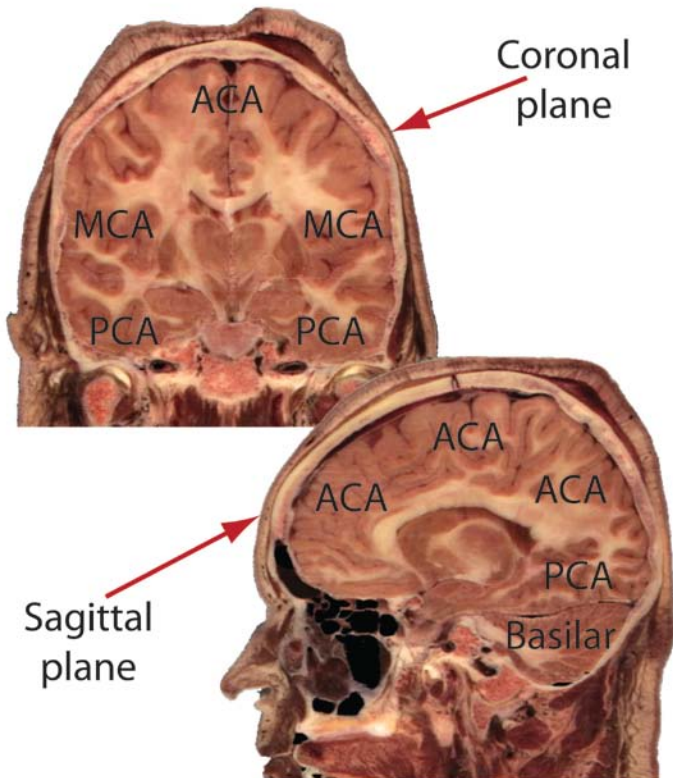
### 15. Stroke

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.



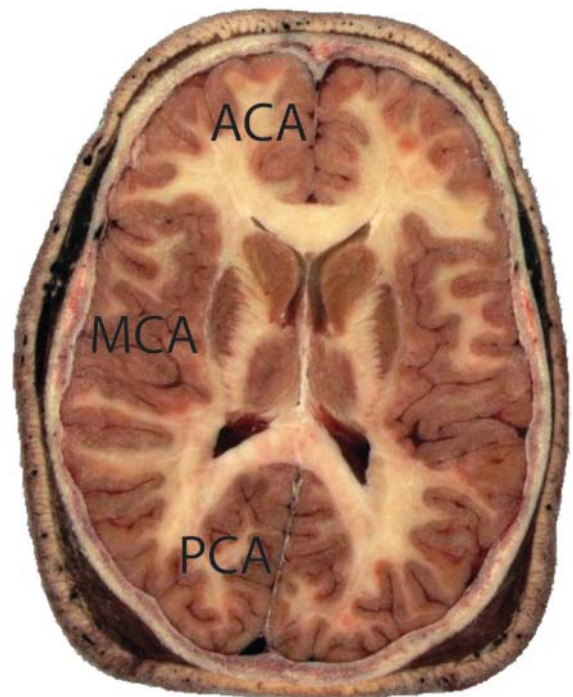
### 15. Stroke

X-Ray Findings: Vascular territories.



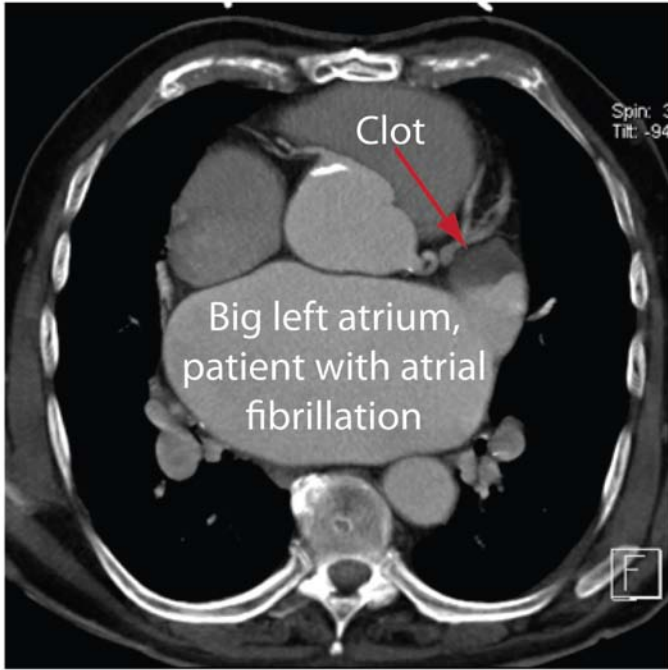
### 15. Stroke

X-Ray Findings: Vascular territories.  
Transverse plane



### 15. Stroke

Etiology: Acute vessel thrombosis or embolism from more proximal source.



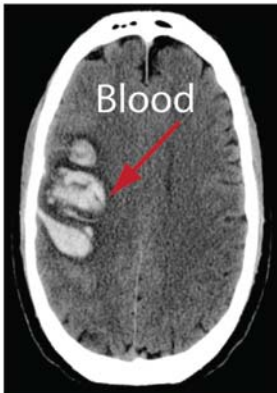
### 15. Stroke

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

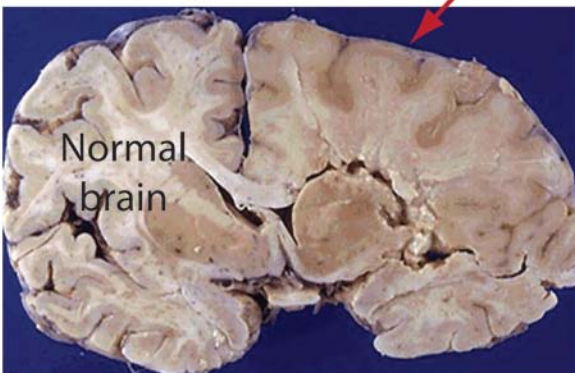


### 15. Stroke

Complications: Hemorrhage, edema.

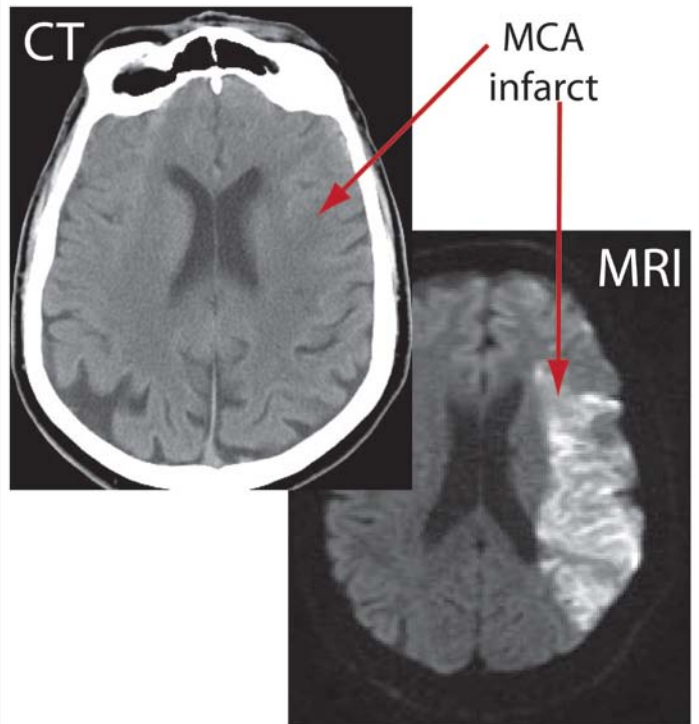


Swollen, edematous brain



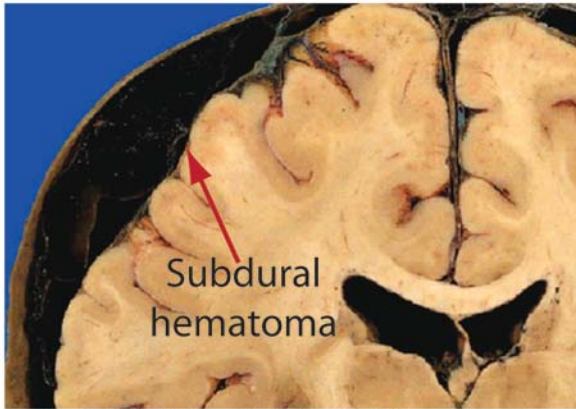
### 15. Stroke

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





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

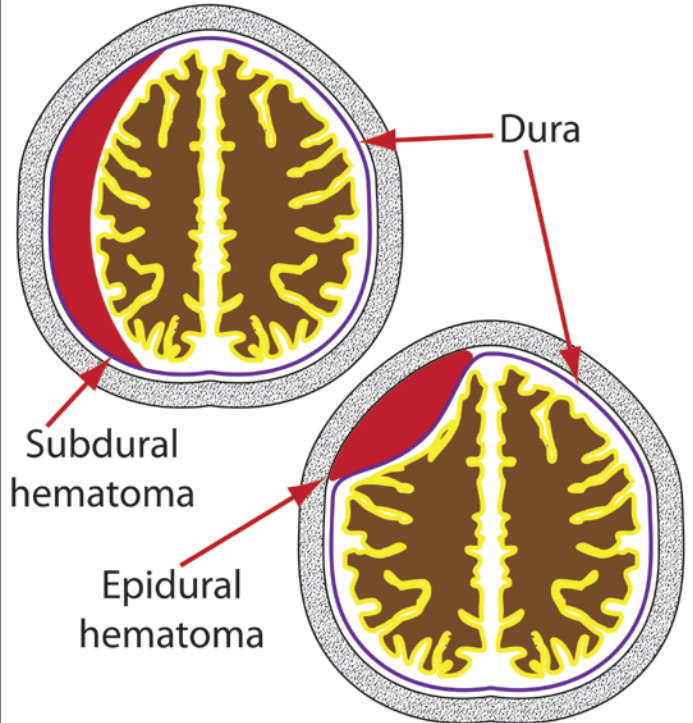


[http://missinglink.ucsf.edu/lm/ids\\_104\\_cerebrovasc\\_neuropath/Case2/MeningealHemorrhages.htm](http://missinglink.ucsf.edu/lm/ids_104_cerebrovasc_neuropath/Case2/MeningealHemorrhages.htm)



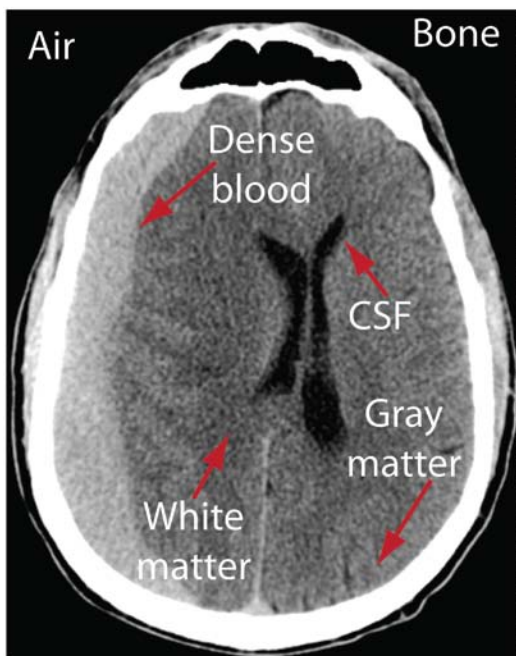
Epidural hematoma

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

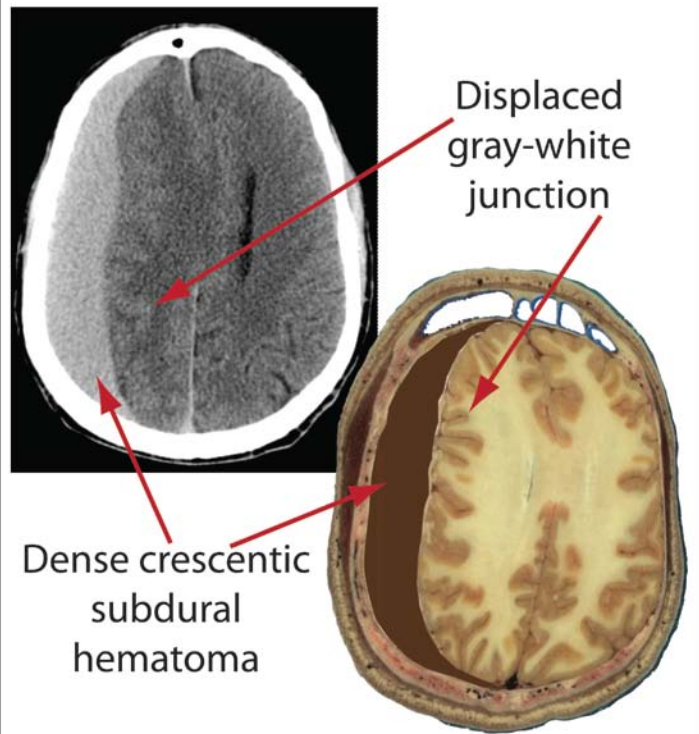


30

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

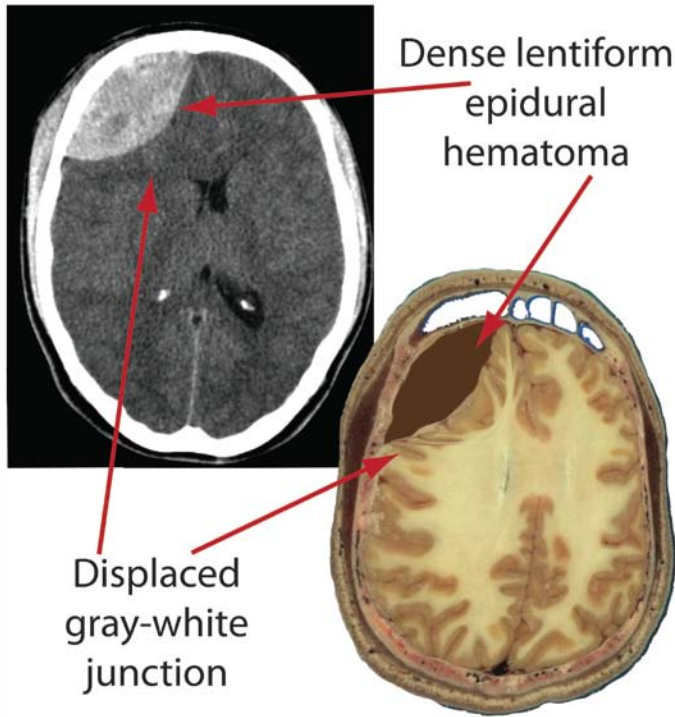


16. Intracranial Traumatic Hemorrhage  
 X-Ray Findings: Subdural hematoma is crescentic and crosses sutures.

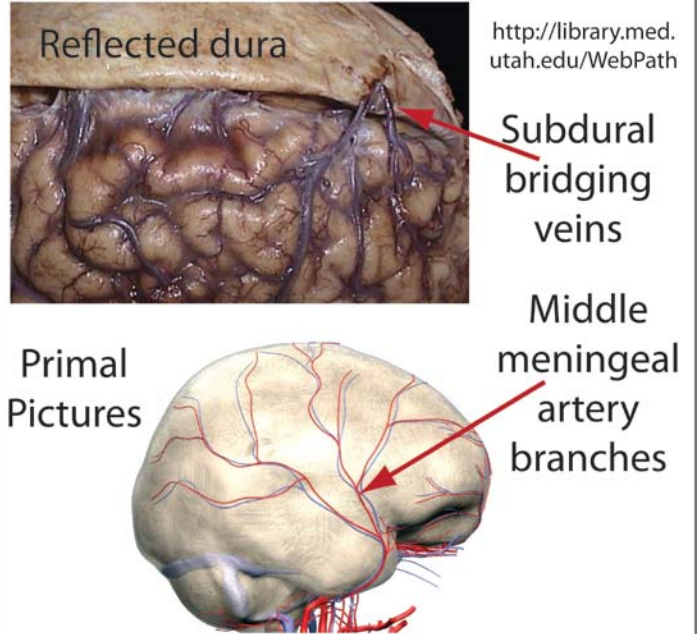




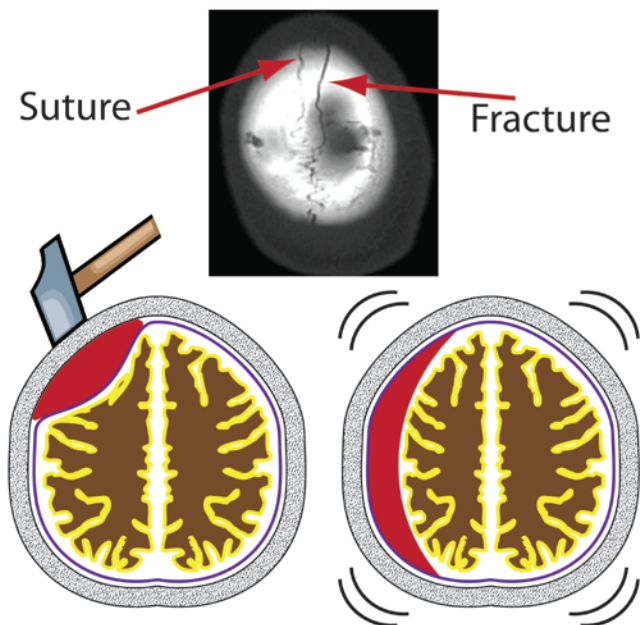
16. Intracranial Traumatic Hemorrhage  
 X-Ray Findings: Epidural hematoma is lentiform and does not cross sutures.



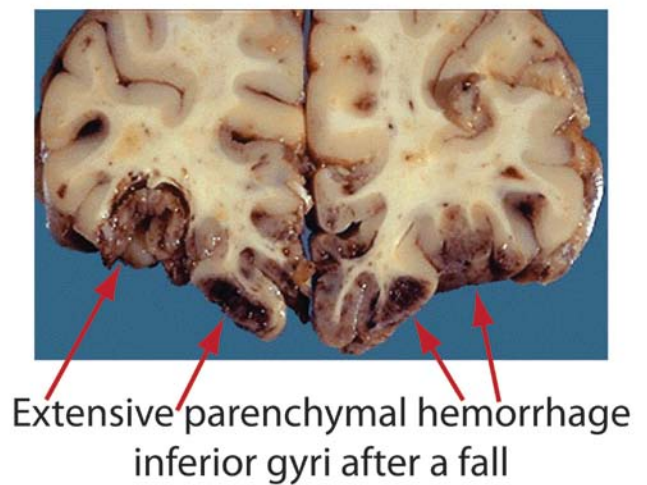
16. Intracranial Traumatic Hemorrhage  
 Etiology: Subdural hematoma occurs if subdural bridging veins tear. Middle meningeal artery tear causes epidural bleeding.



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



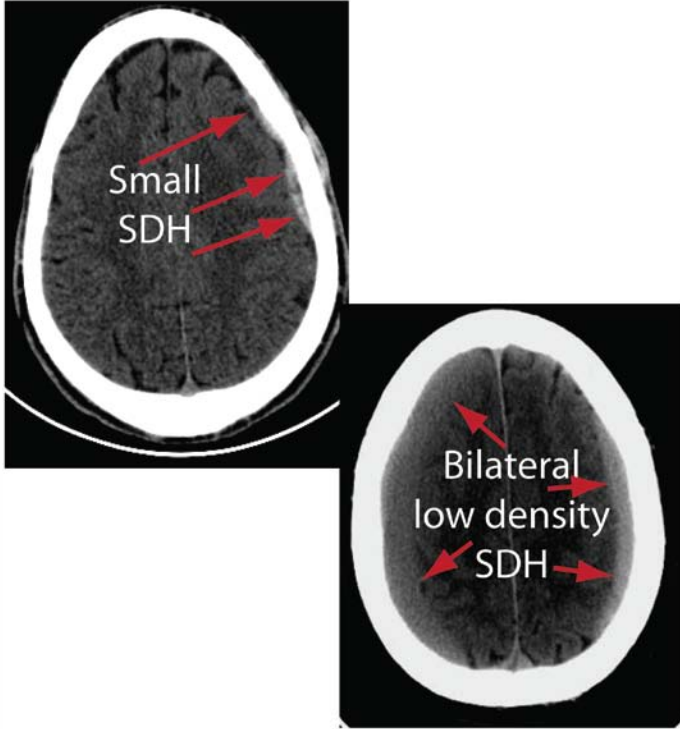
16. Intracranial Traumatic Hemorrhage  
 Complications: Cerebral edema, injury of adjacent brain parenchyma. SDH has higher likelihood of parenchymal injury.



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



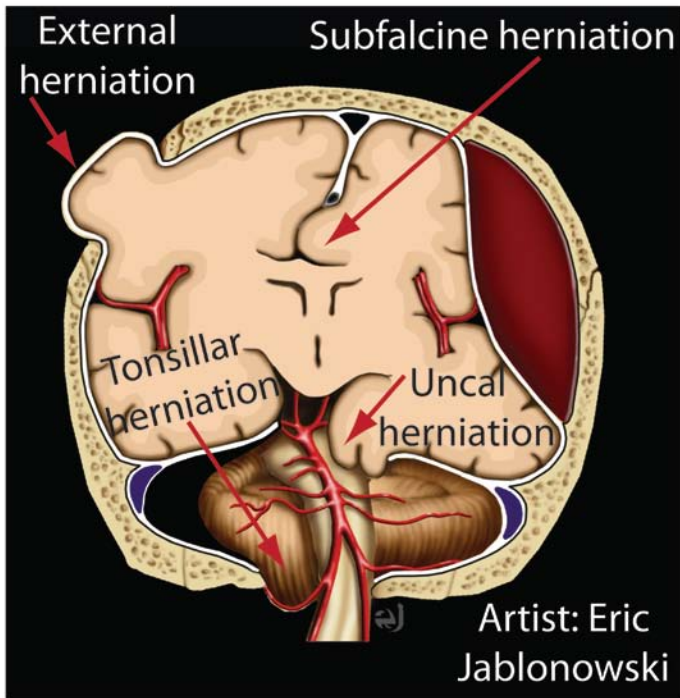
16. Intracranial Traumatic Hemorrhage  
 Pitfalls: Small bleeds, anemic patients may have blood isodense to brain.



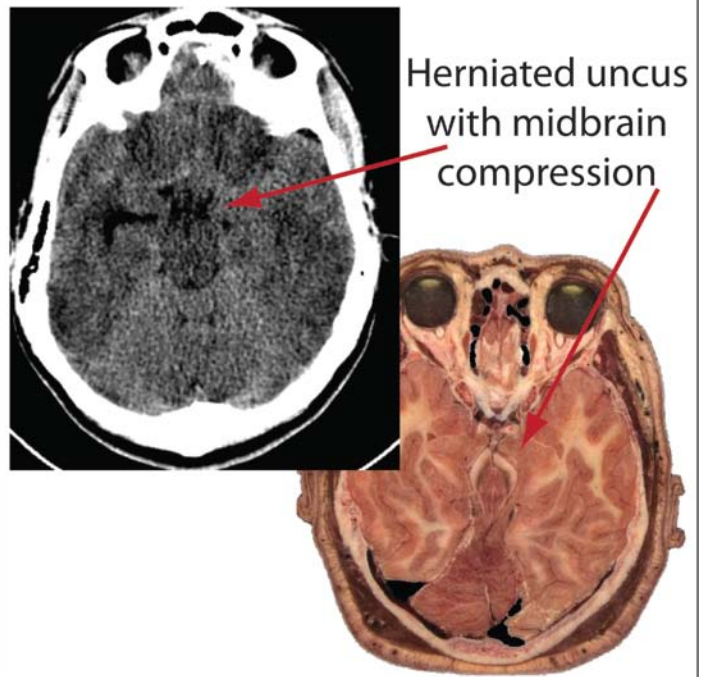
17. Increased Intracranial Pressure  
 Definition: Pressure in the skull/brain may increase in certain conditions. High pressure is bad! The skull is a completely filled rigid box, if pressure increases, the brain may squirt out!



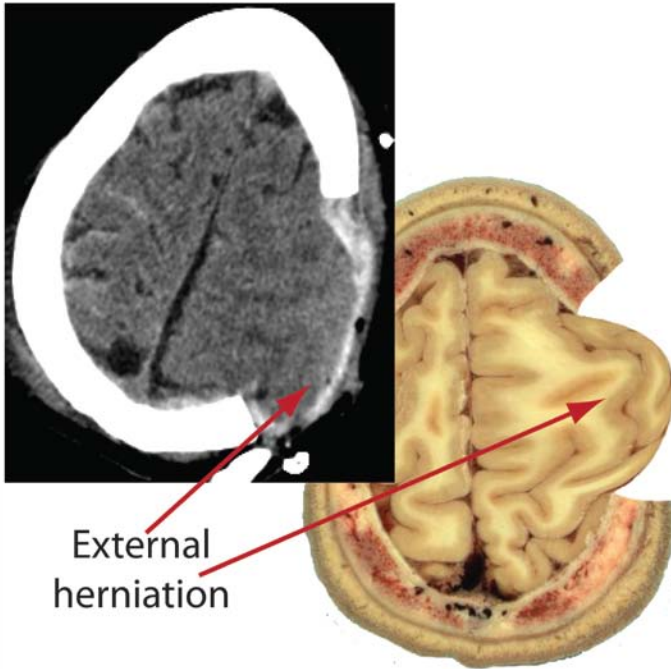
17. Increased Intracranial Pressure  
 Definition: Technical term for "squirting out" is herniation.



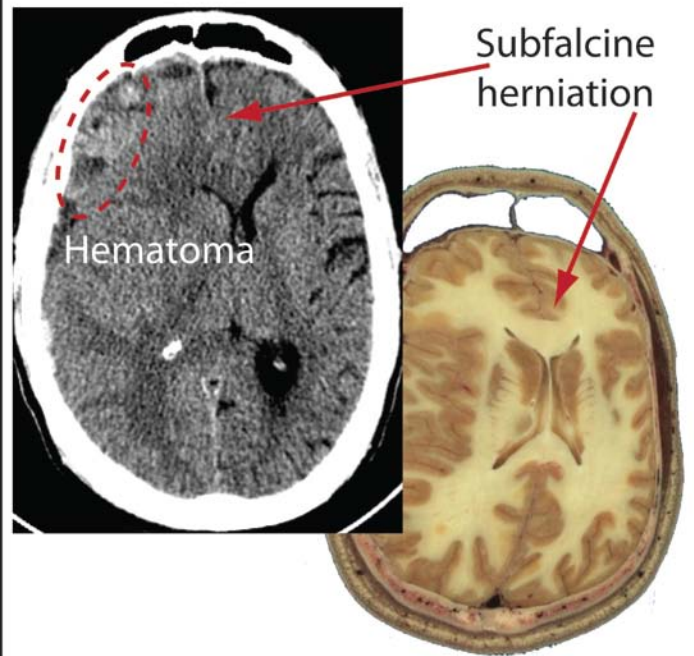
17. Increased Intracranial Pressure  
 X-Ray Findings: No plain film findings, CT and MRI show displaced and compressed structures.



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

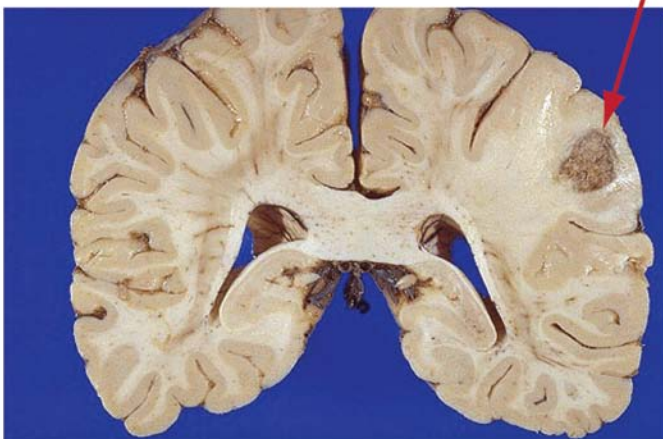


17. Increased Intracranial Pressure  
 X-Ray Findings: No plain film findings,  
 CT and MRI show displaced and  
 compressed structures.



17. Increased Intracranial Pressure  
 Etiology: Any cause of brain edema, like  
 ischemia, trauma, tumor etc.

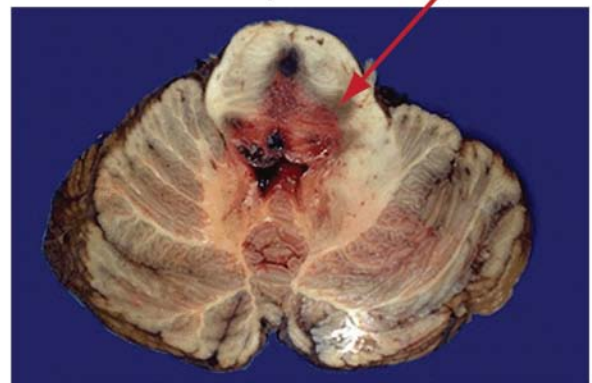
Solitary lung cancer metastasis  
 with edema, compare to opposite side



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

17. Increased Intracranial Pressure  
 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



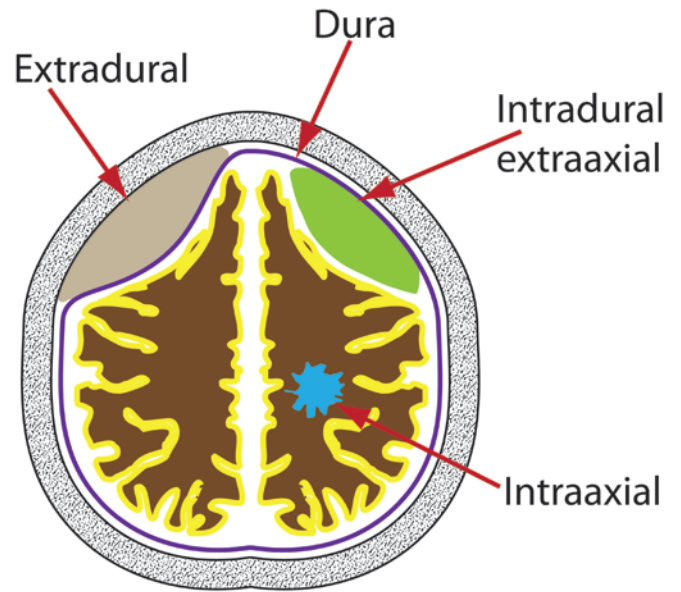
<http://library.med.utah.edu/WebPath>



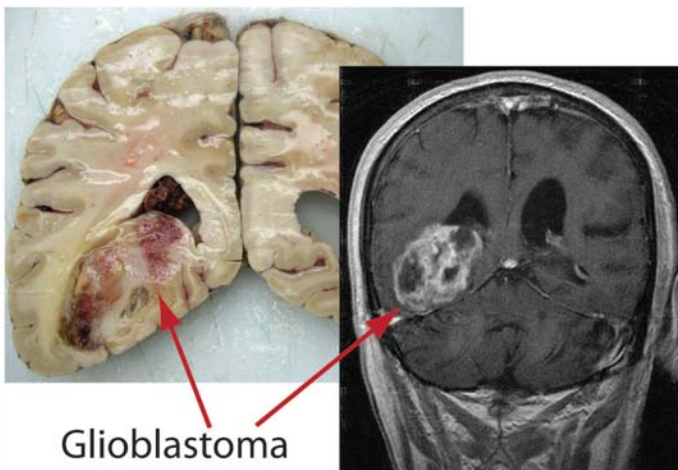
17. Increased Intracranial Pressure  
 Pitfalls: Alas, Dr. Dog is not a neuroradiologist, so many of the findings appear subtle to him, BUT, even he can recognize midline shift and obliteration of the lateral ventricle.



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



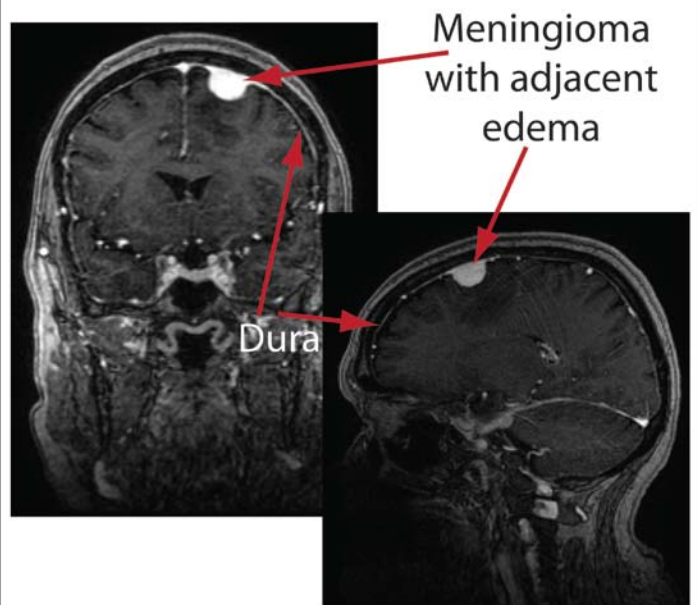
18. Intracranial Space Occupying Lesions  
 X-Ray Findings: Plain x-rays generally normal, CT or MRI required. Intraaxial lesions arise in the brain parenchyma. Differential includes primary/metastatic tumors, abscess, clot etc.



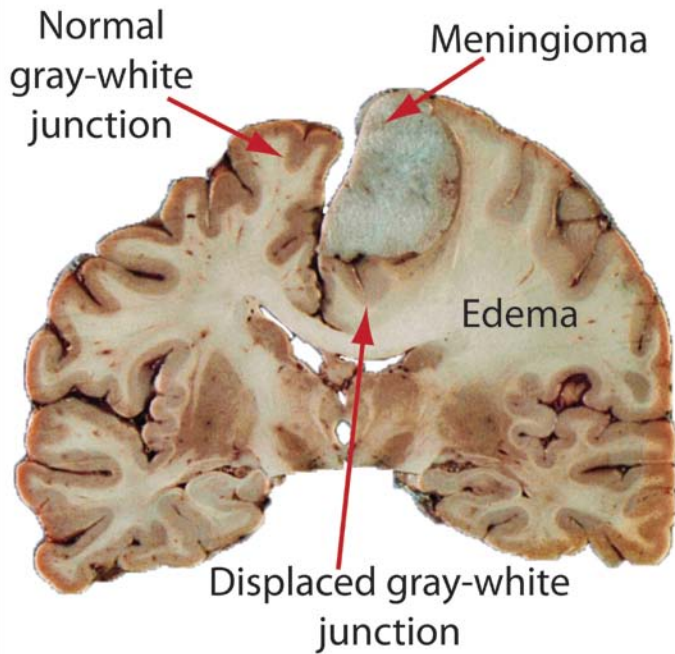
Glioblastoma multiforme

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.

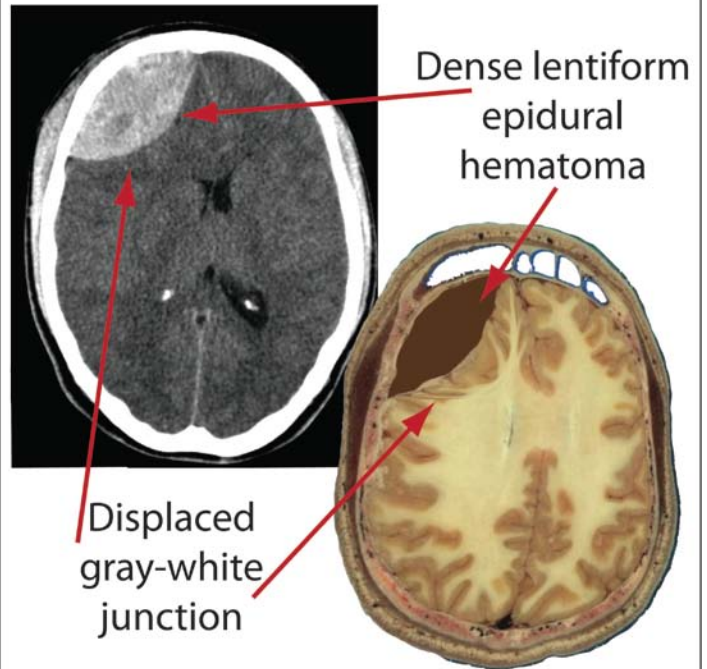


18. Intracranial Space Occupying Lesions  
 X-Ray Findings: Extraaxial lesions will displace the gray-white junction.

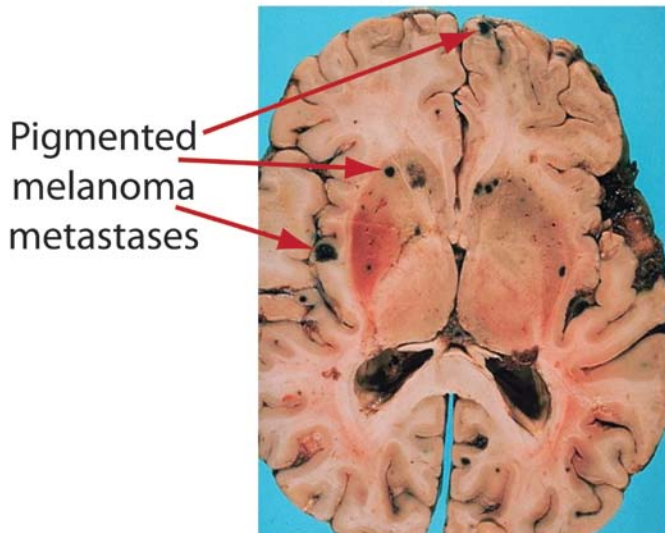


From: <http://anocef.org/atlas/images/n/nPI17a2.jpeg>

18. Intracranial Space Occupying Lesions  
 X-Ray Findings: You already know an example of an extradural lesion: epidural hematoma.



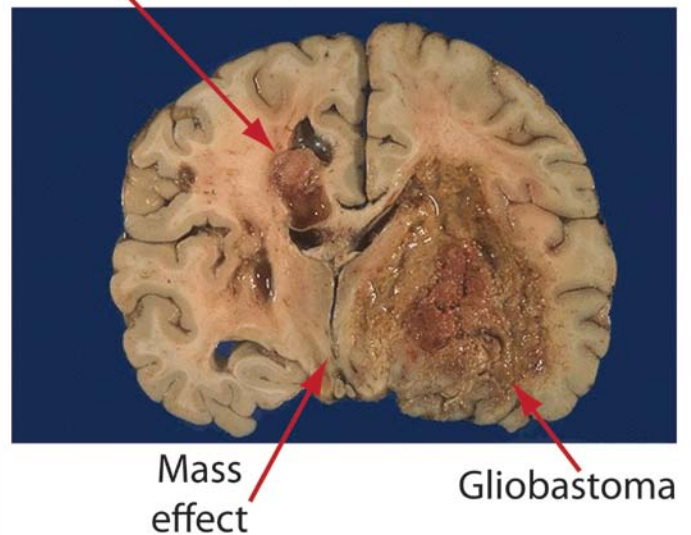
18. Intracranial Space Occupying Lesions  
 Etiology: Many possible etiologies given wide variety of causes. For example, metastases reach the brain hematogenously in embolic showers and tend to be multiple.



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

18. Intracranial Space Occupying Lesions  
 Mechanism of Injury: Increase intracranial pressure, damage to adjacent normal structures and diffuse spread.

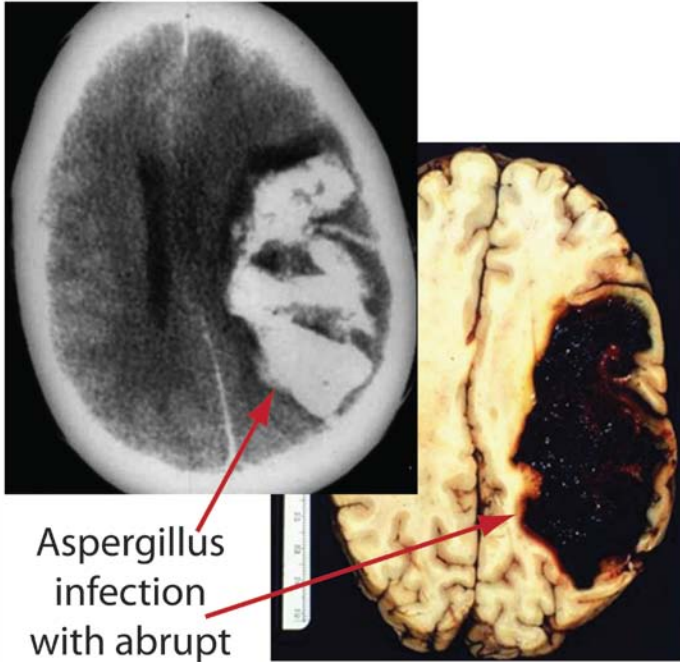
Contralateral spread



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

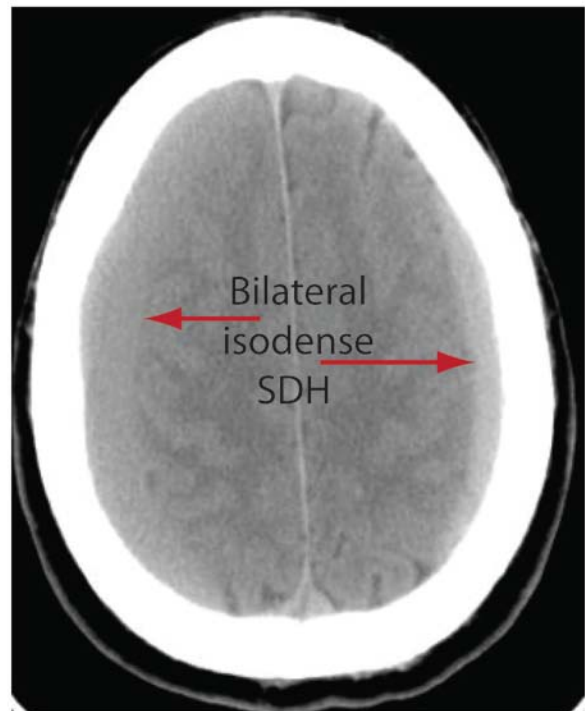


18. Intracranial Space Occupying Lesions  
Complications: Lesions may bleed with catastrophic rise intracranial pressure.



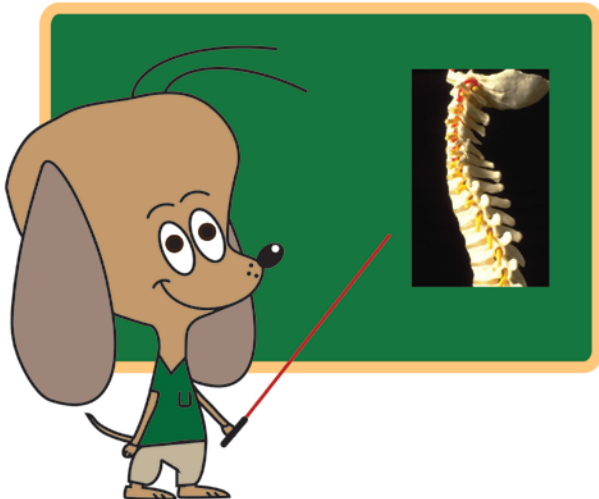
Smith A B et al. *Radiographics* 2008;28:2033-2058

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

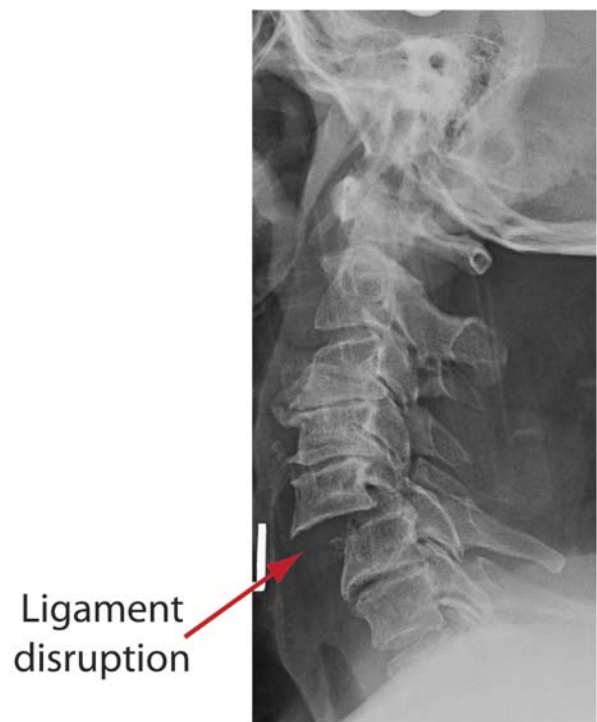


36

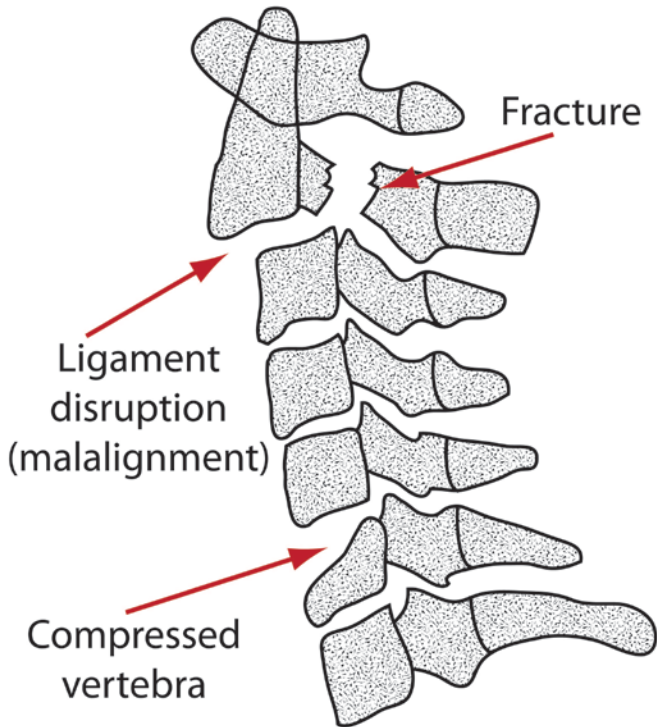
19. Cervical Spine Injury  
Wow, another huge topic. Entire books have been written on these injuries. We will have a limited exploration of this subject and introduce some key concepts, but you will need to do more reading on your own.



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



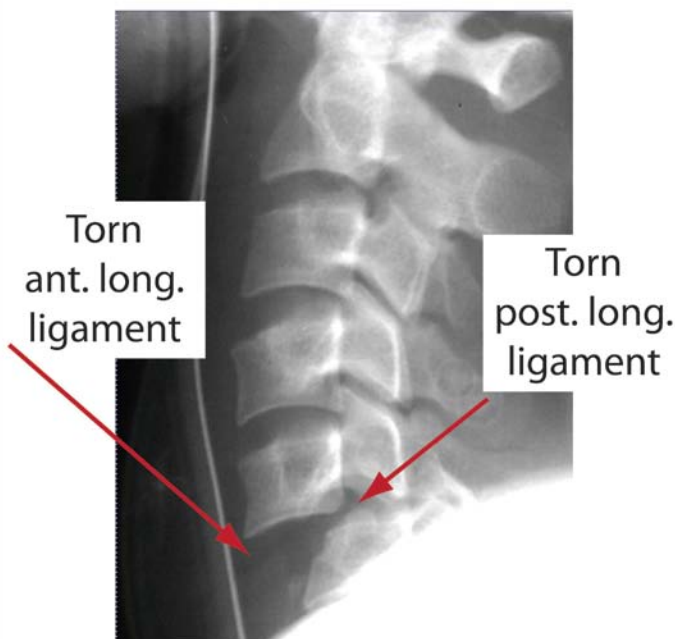
19. Cervical Spine Injury  
 X-Ray Findings: Malalignment, vertebral body height loss, fracture lines.



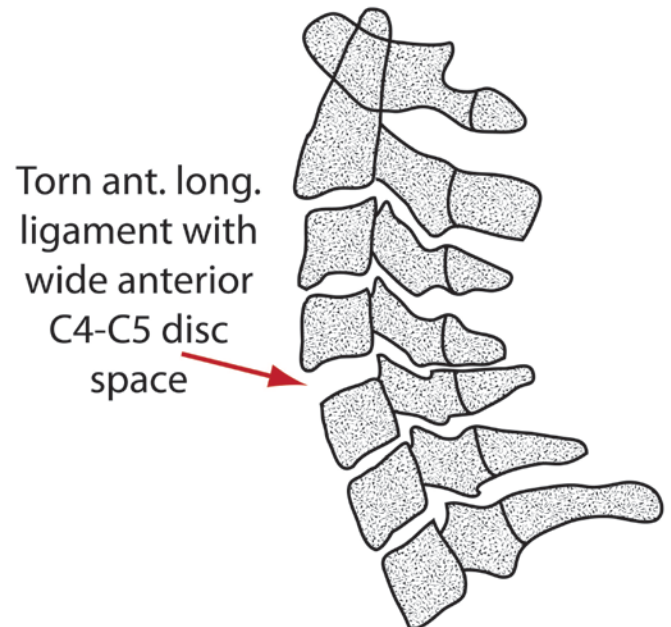
19. Cervical Spine Injury  
 X-Ray Findings (alignment): Mentally draw 3 lines, along the front and back of the vertebral bodies and along the spinolaminar junction. Normally, these lines should be smooth.



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.



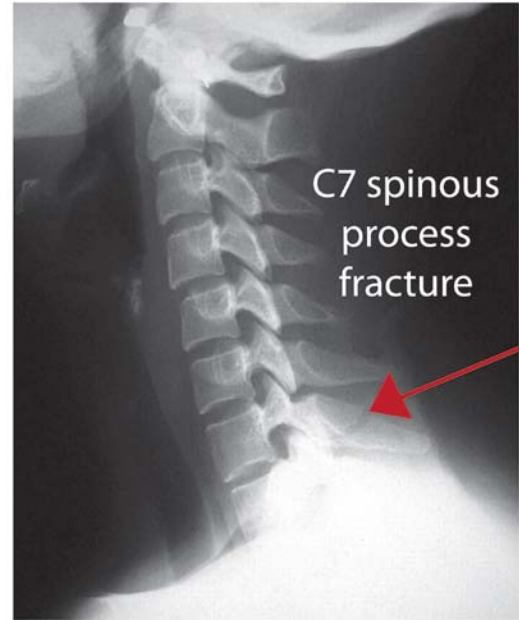


19. Cervical Spine Injury  
X-Ray Findings (height loss): Axial load or hyperflexion compresses vertebral body with fracture and loss of height.

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



19. Cervical Spine Injury  
X-Ray Findings (fracture line): Most easily recognized sign of injury.



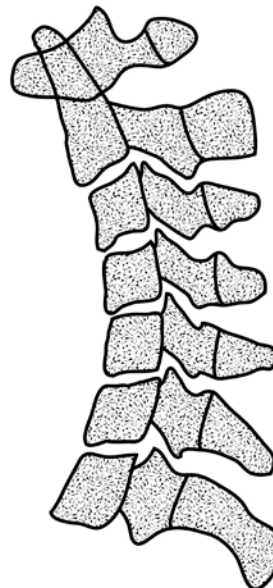
Lee P et al. *Radiographics*  
2004;24:1009-1027

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

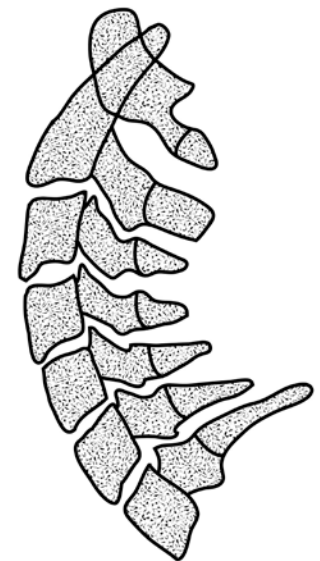


19. Cervical Spine Injury  
Mechanism of Injury: Many, we will cover only hyperflexion & hyperextension.

Hyperflexion

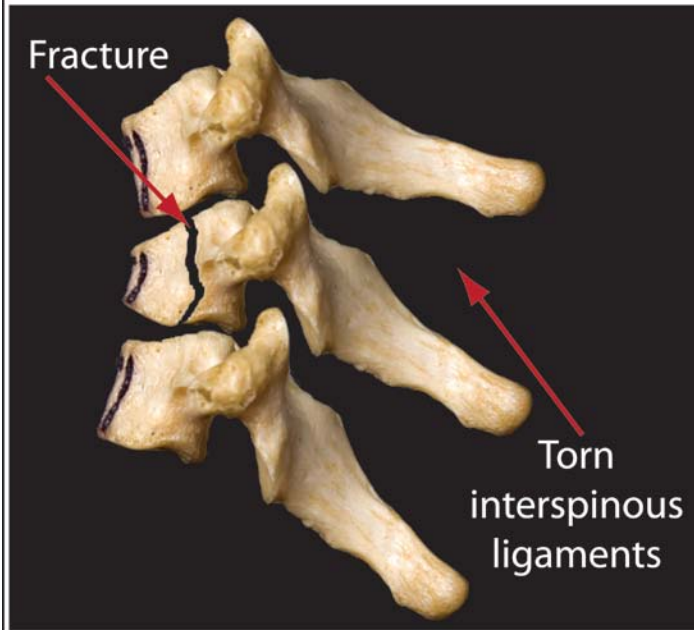


Hyperextension



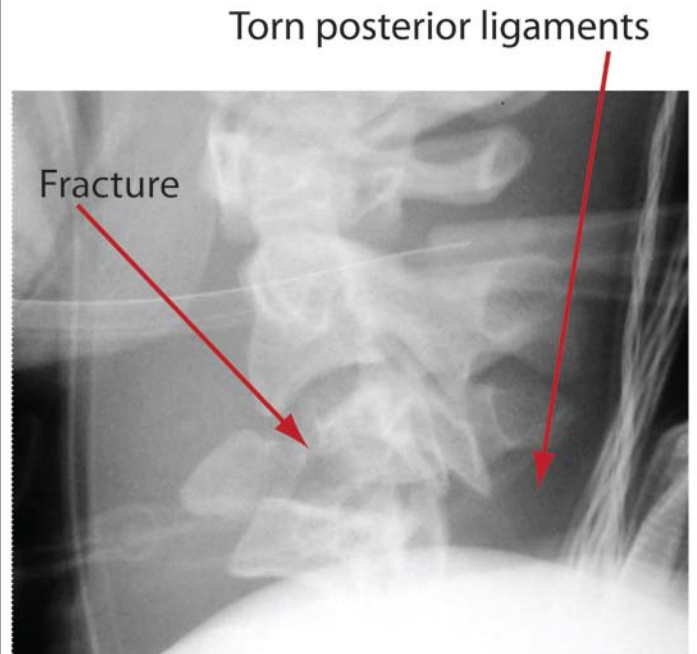
### 19. Cervical Spine Injury

Mechanism of Injury: Hyperflexion results in crush injuries (fractures) of the anterior spine and tension injuries (torn ligaments) of the posterior spine.



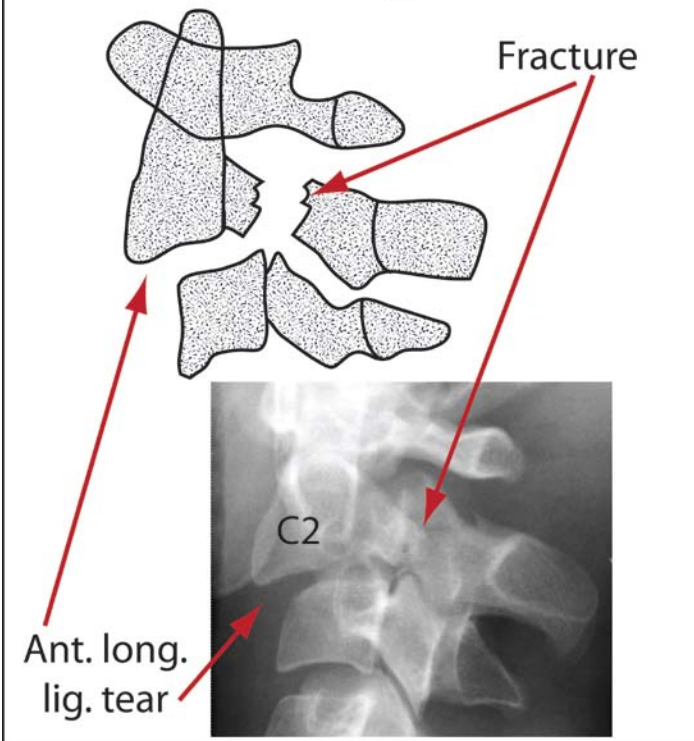
### 19. Cervical Spine Injury

Mechanism of Injury: Flexion "tear drop" fracture with torn posterior ligaments.



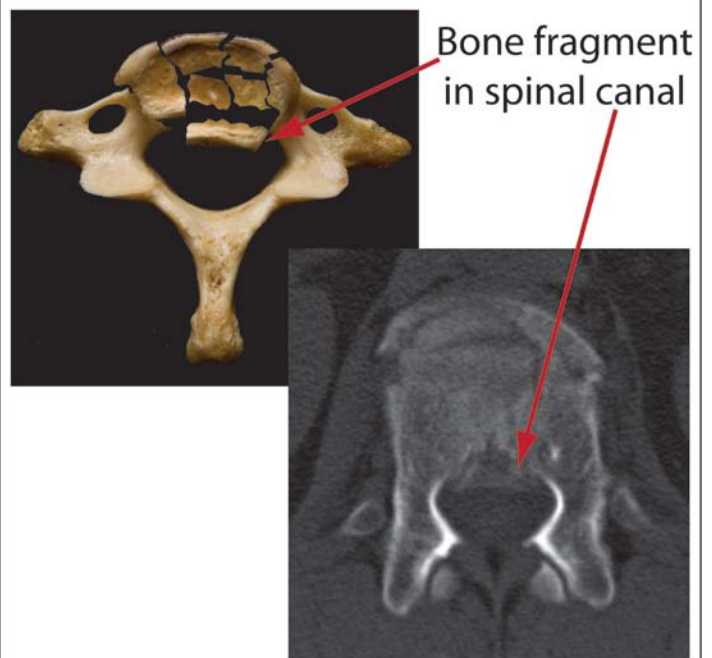
### 19. Cervical Spine Injury

Mechanism of Injury: "Hangman's" fracture of C2 due to hyperextension.



### 19. Cervical Spine Injury

Complications: Potential neurologic damage, especially if bone fragments are displaced into 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!

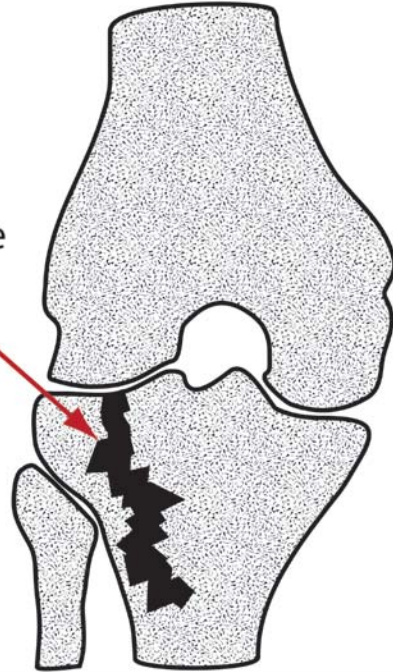
L1 and L5 fractures



### 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.

Fracture



### 20. Fracture with Extension into Joint

X-Ray Findings: Fracture line can be followed into joint.

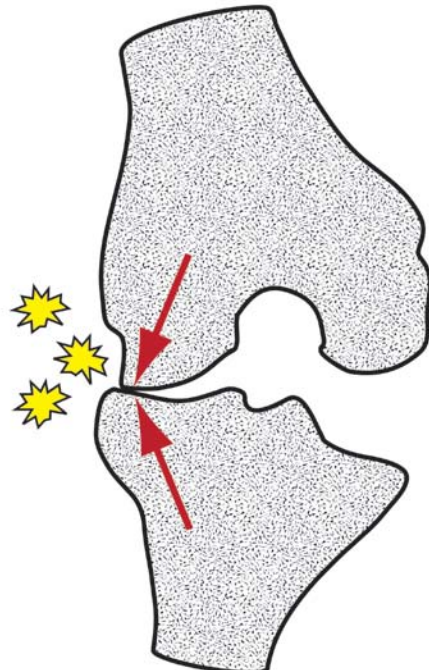
Fracture

Wrist joint

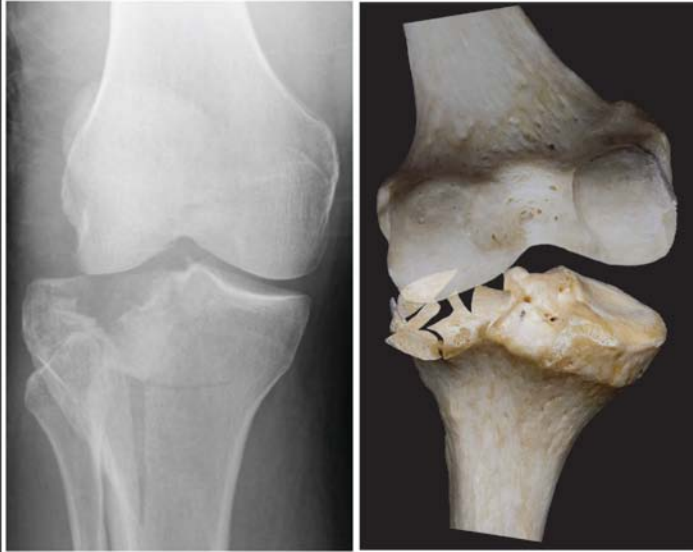


### 20. Fracture with Extension into Joint

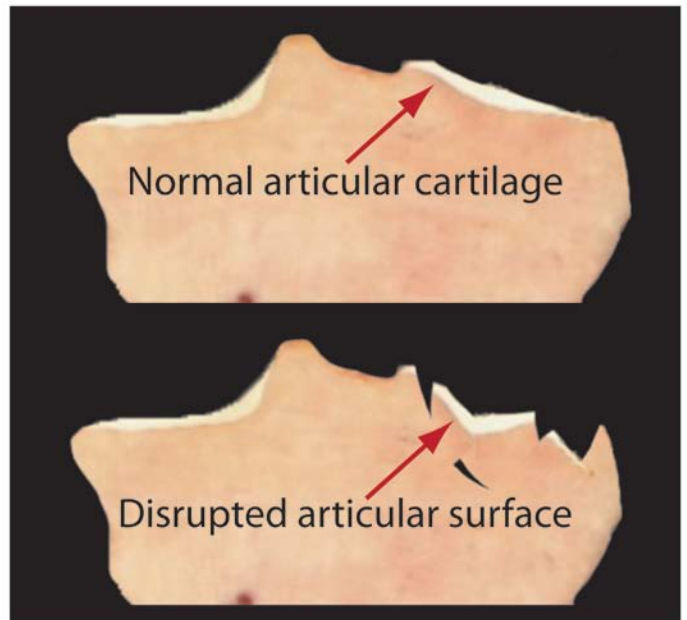
Etiology: Often due to impaction of one bone on another, sometimes associated with abnormal bending.



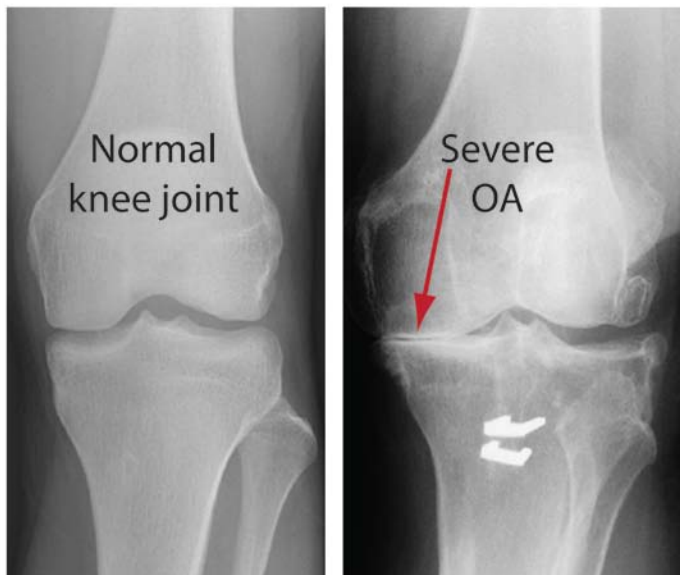
20. Fracture with Extension into Joint  
 Etiology: The lateral tibial plateau is commonly fractured due to a blow to the lateral knee resulting in a valgus force with impaction of the lateral tibia and the lateral femoral condyle.



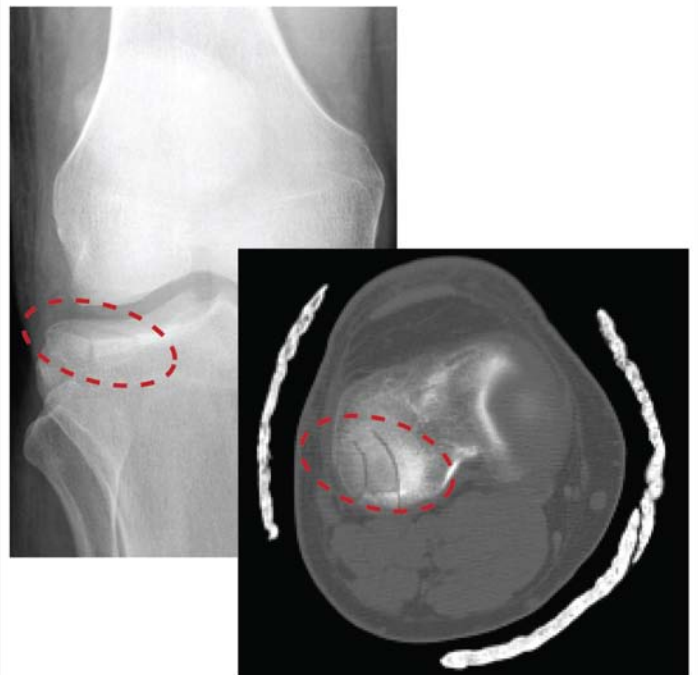
20. Fracture with Extension into Joint  
 Mechanism of Injury: When fractures extend into the joint space, the articular cartilage is damaged.



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



20. Fracture with Extension into Joint  
 Pitfalls: Fractures may be subtle, if clinical suspicion persists CT should be obtained.

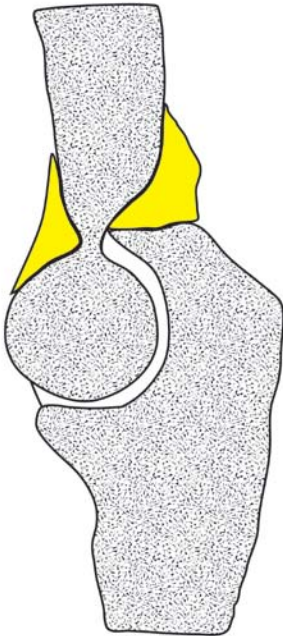




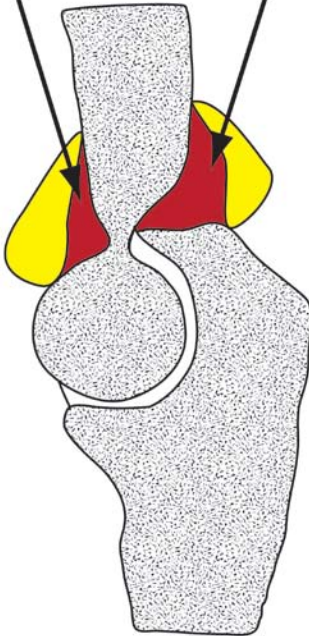
### 21. Elbow Joint Effusion

Definition: Abnormal elbow joint fluid collection.

Normal elbow



Elbow effusion



### 21. Elbow Joint Effusion

X-Ray Findings: Distended fat pads.

Distended anterior fat pad

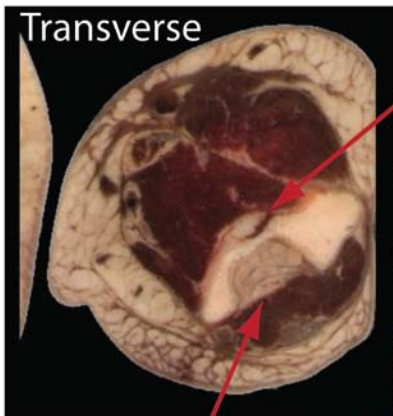


Distended posterior fat pad

### 21. Elbow Joint Effusion

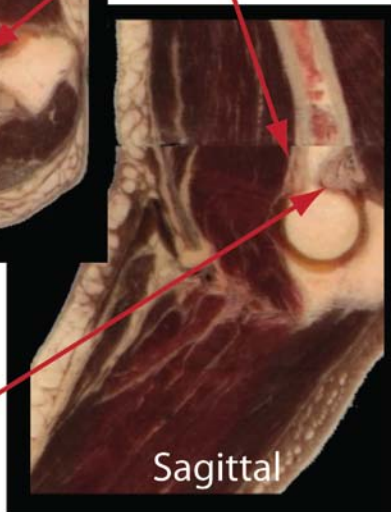
X-Ray Findings: Normal fat pads are hidden within the coronoid and olecranon fossae.

Transverse



Normal anterior fat pad

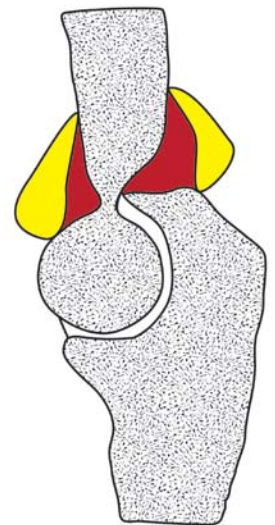
Normal posterior fat pad



Sagittal

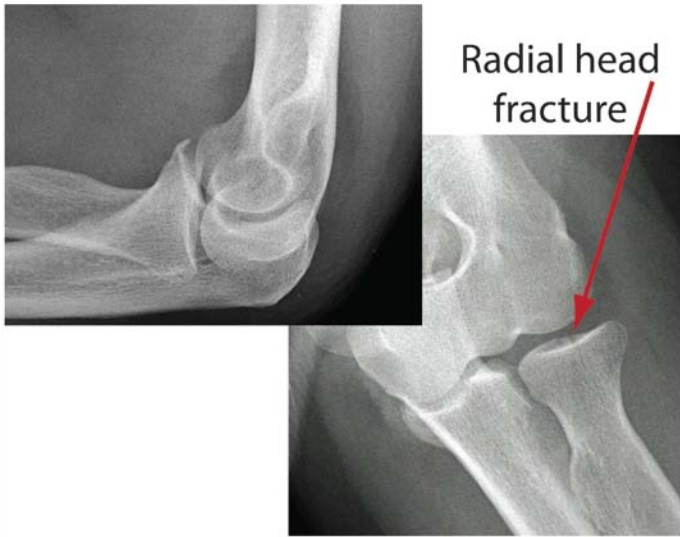
### 21. Elbow Joint Effusion

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 hemarthrosis due to radial head fracture (adult) or humeral supracondylar fracture (child). History is typically "FOOSH", fall on outstretched hand.



### 21. Elbow Joint Effusion

Complications: Missing any fracture is considered poor form, but missing a septic joint is worse because of rapid joint destruction.



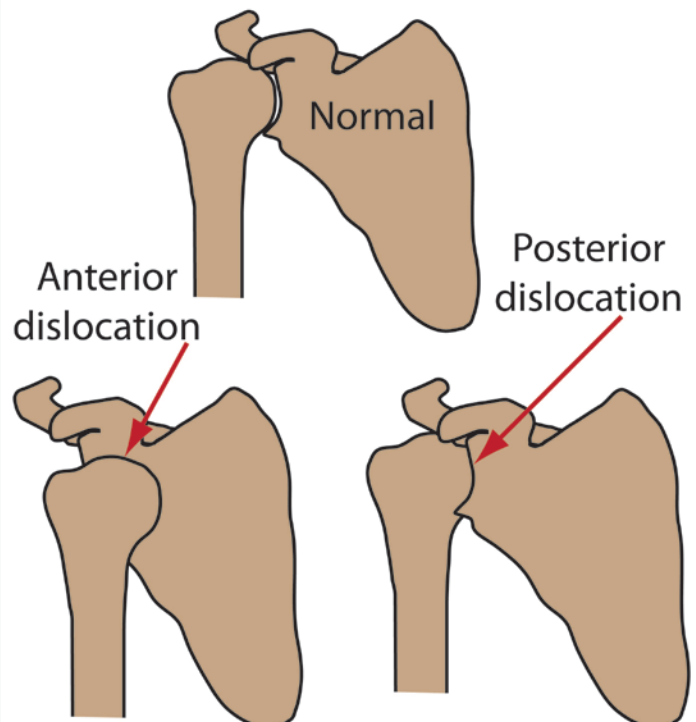
### 21. Elbow Joint Effusion

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.



### 22. Shoulder Dislocation

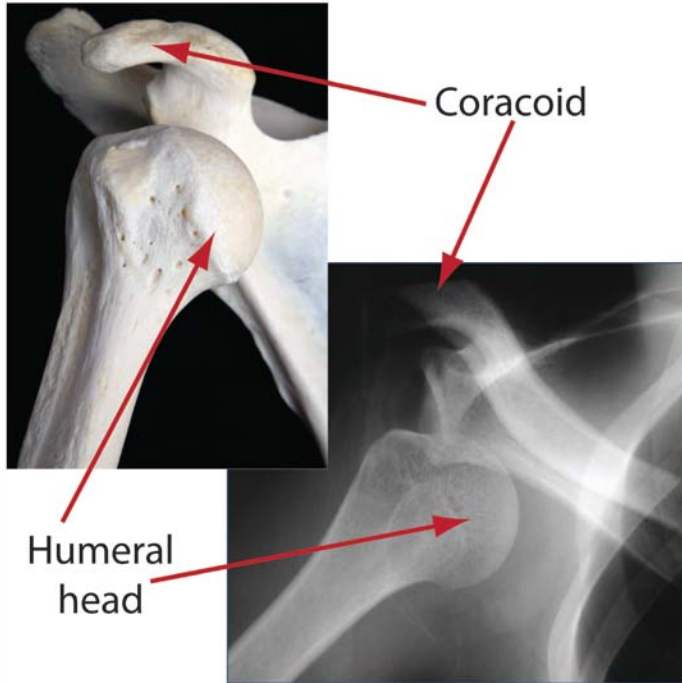
Definition: We will discuss only 2 types of glenohumeral joint dislocation.





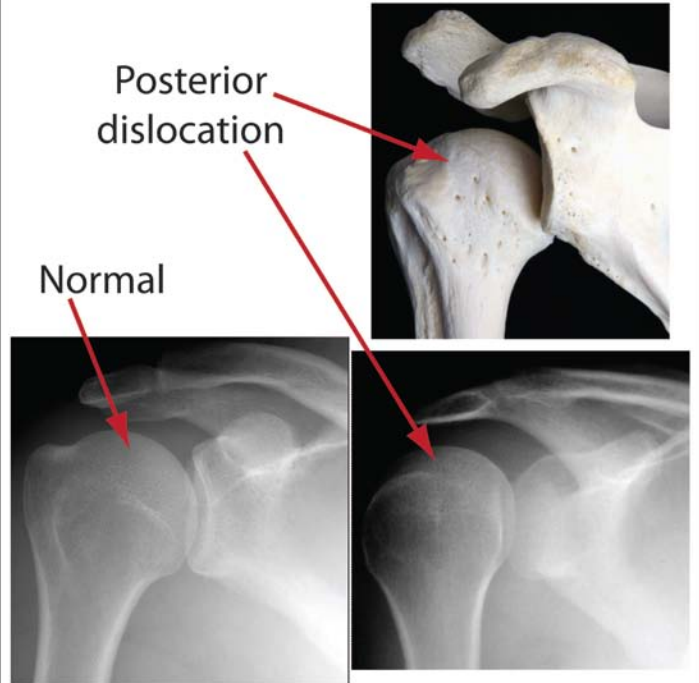
## 22. Shoulder Dislocation

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



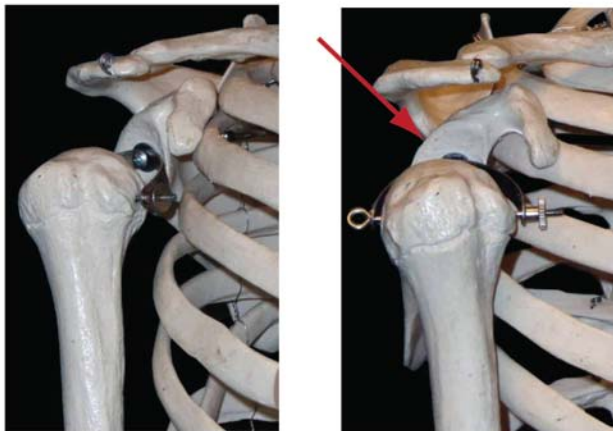
## 22. Shoulder Dislocation

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.

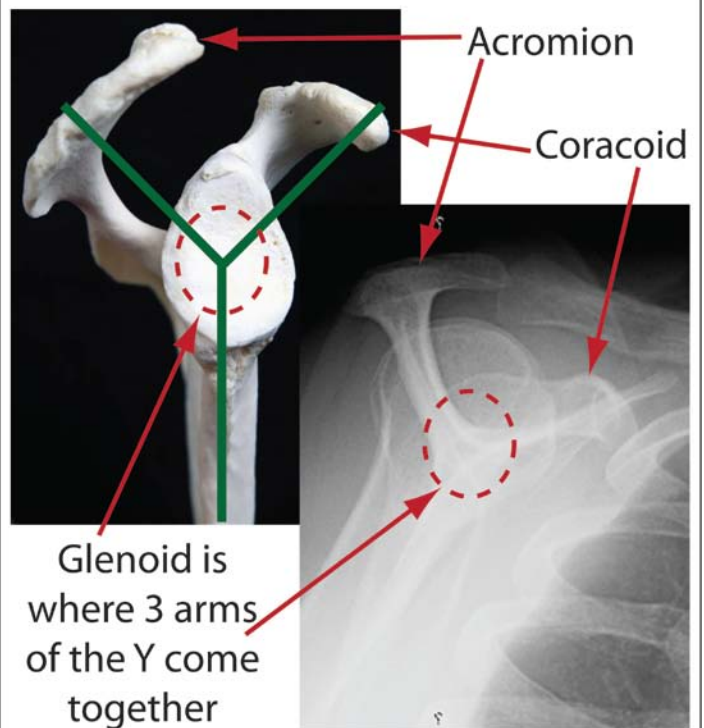


AP ("frontal") shoulder positioning

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

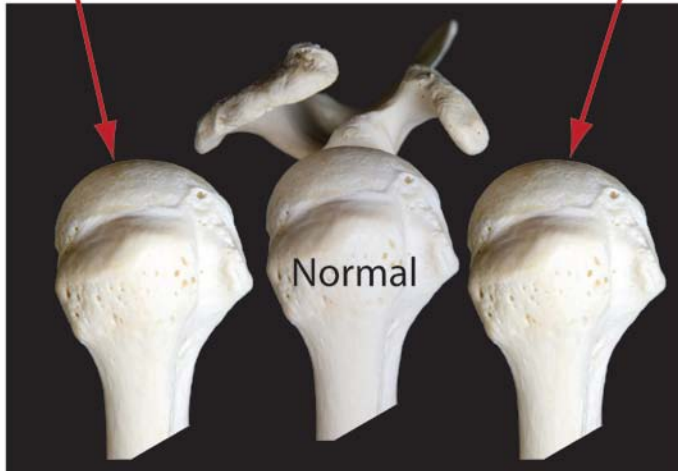
## 22. Shoulder Dislocation

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

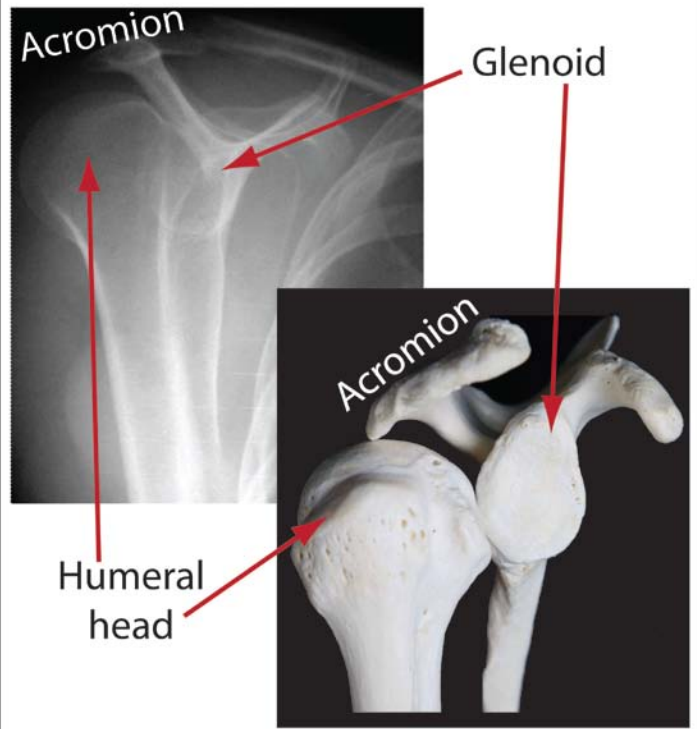


22. Shoulder Dislocation  
X-Ray Findings: Dislocations on scapular Y view.

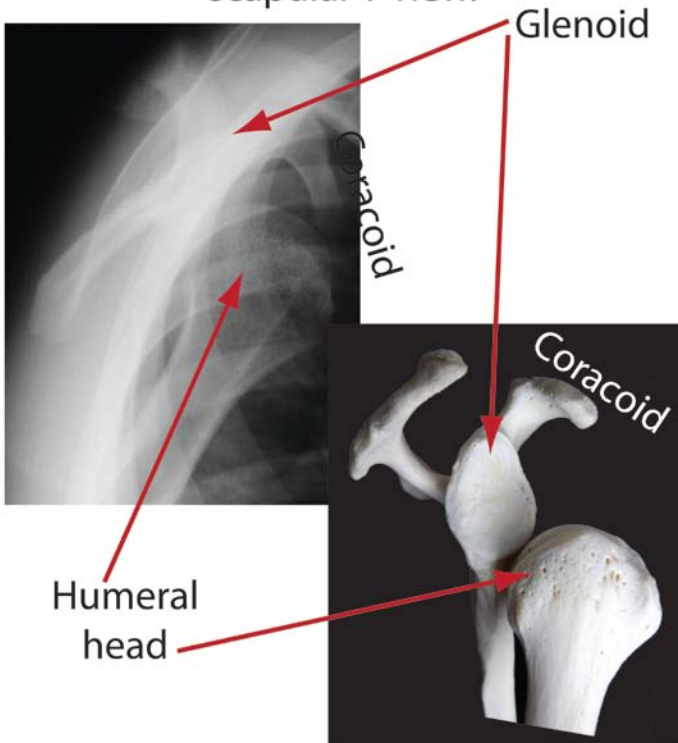
Posterior dislocation is in direction of acromion  
Anterior dislocation is in direction of coracoid



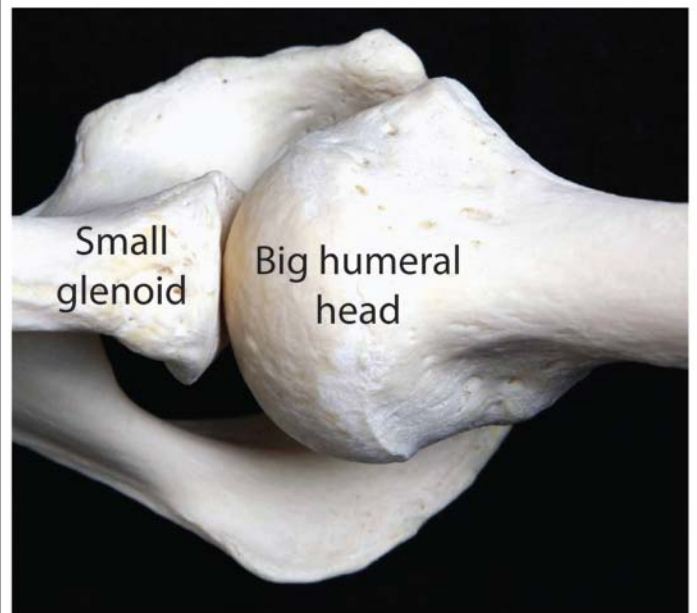
22. Shoulder Dislocation  
X-Ray Findings: Posterior dislocation on scapular Y view.



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



22. Shoulder Dislocation  
Etiology: Shoulder extremely mobile, therefore unstable.



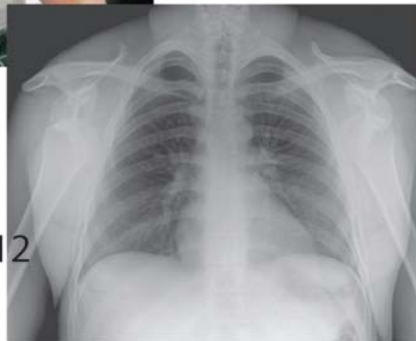


## 22. Shoulder Dislocation

Mechanism of Injury: Most (95%) are anterior caused by combined abduction, extension and external rotation. Posterior dislocations are less common (4%), associated with seizures.



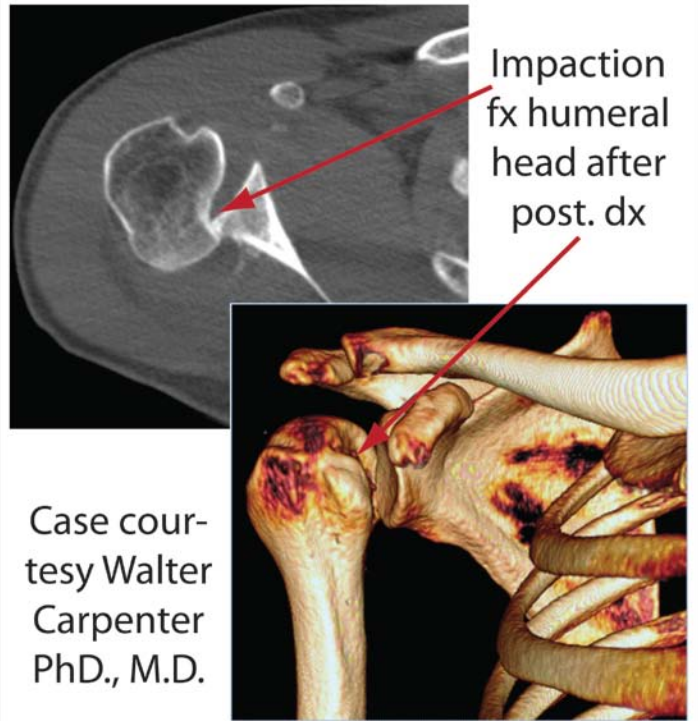
Bilateral ant. shoulder dislocations



NEJM 367;8  
August 23, 2012

## 22. Shoulder Dislocation

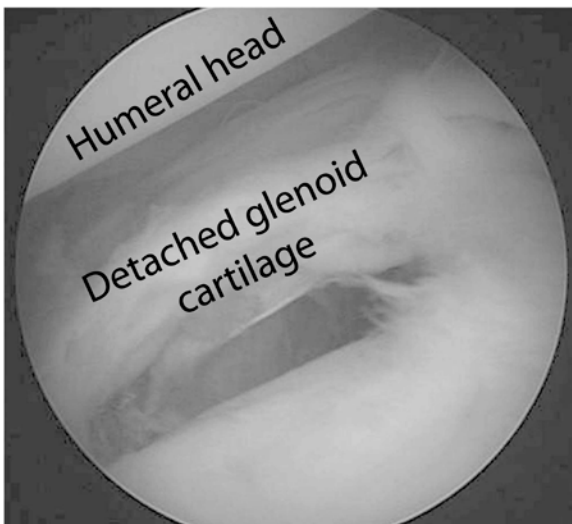
Complications: Axillary nerve injury, fractures/cartilage damage.



Case courtesy Walter Carpenter PhD., M.D.

## 22. Shoulder Dislocation

Pitfalls: Posterior dislocations, small fracture fragments & cartilage injury will be invisible on x-ray, may need CT, MRI or arthroscopy (example below).



Sugimoto H et al.  
Radiology 2002;224:105-111

## 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.

