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Advanced Emergency Trauma Course

Thoracic Trauma

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Ghana Emergency Medicine Collaborative

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Ghana Emergency Medicine Collaborative
Advanced Emergency Trauma Course

Objectives

- Epidemiology
- Chest Wall Injury
- Pulmonary Injuries
- Cardiovascular Injuries
- Esophageal Injuries

http://www.trauma.org/images/image_library/21223463721July_125.jpg

Epidemiology

- Thoracic trauma results in 20-25% of deaths due to trauma
- Accounts for more than 16,000 deaths annually in the United States
- Immediate traumatic death is generally the result of rupture of myocardial wall or the thoracic aorta.
- Early deaths within 30 min – 3 hours are typically due to tension pneumothorax, cardiac tamponade, airway obstruction or uncontrolled thoracic hemorrhage
- Early deaths from thoracic injury are often preventable if appropriate Emergency Department and Trauma care is provided.

Chest Wall Injury

- Epidemiology
  - 50% of patients with thoracic trauma have chest wall injury
    - 10% will have minor trauma
    - 35% will have major trauma
    - 5% will have flail chest injuries
- Anatomy and Physiology
  - Intact chest wall is necessary for normal ventilation
  - Respiratory muscles cause outward expansion of thoracic wall and descent of diaphragm causing negative pressure and passive air entry during respiration
  - Chest trauma will impact the normal respiratory process and prevent adequate oxygenation and ventilation
  - Patients ability to compensate for injury depends on respiratory reserve
- Clinical Features
  - Inspect the chest for:
    - Adequate chest rise
    - Respiratory rate
    - Tidal volume
  - Palpate for:
    - Deformity
    - Tenderness
    - Crepitus
  - Auscultate for:
    - Lung sounds
    - Heart sounds
- Specific Injuries
  - Rib Fractures
  - Sternal Fracture
  - Flail Chest
  - Non-penetrating Ballistic Injury

Rib Fractures

- Epidemiology
  - Simple rib fractures account for more than 50% of non-penetrating trauma
  - Associated injuries are important to identify - Pneumothorax/Hemothorax
- Pathophysiology
  - Ribs break at point of impact or posterior angle (weakest structural point)
  - Ribs 1-3 = Relatively protected = Higher association with severe intrathoracic injury
  - Ribs 9-12 = More mobile = Higher association with intra-abdominal injury
    - Right sided rib fractures = 3X as likely to have hepatic injury
    - Left sided rib fractures = 4X as likely to have splenic injury
  - Fractures more common in adults due to inelasticity of the chest wall
  - Rib fractures = High potential for penetrating injury to pleura, lung, liver or spleen
  - Multiple rib fractures (2 or more) is associated with higher incidence of internal injury
  - Elderly patients with multiple rib fractures have fivefold increase in mortality compared with younger patients (<65)

Rib Fractures

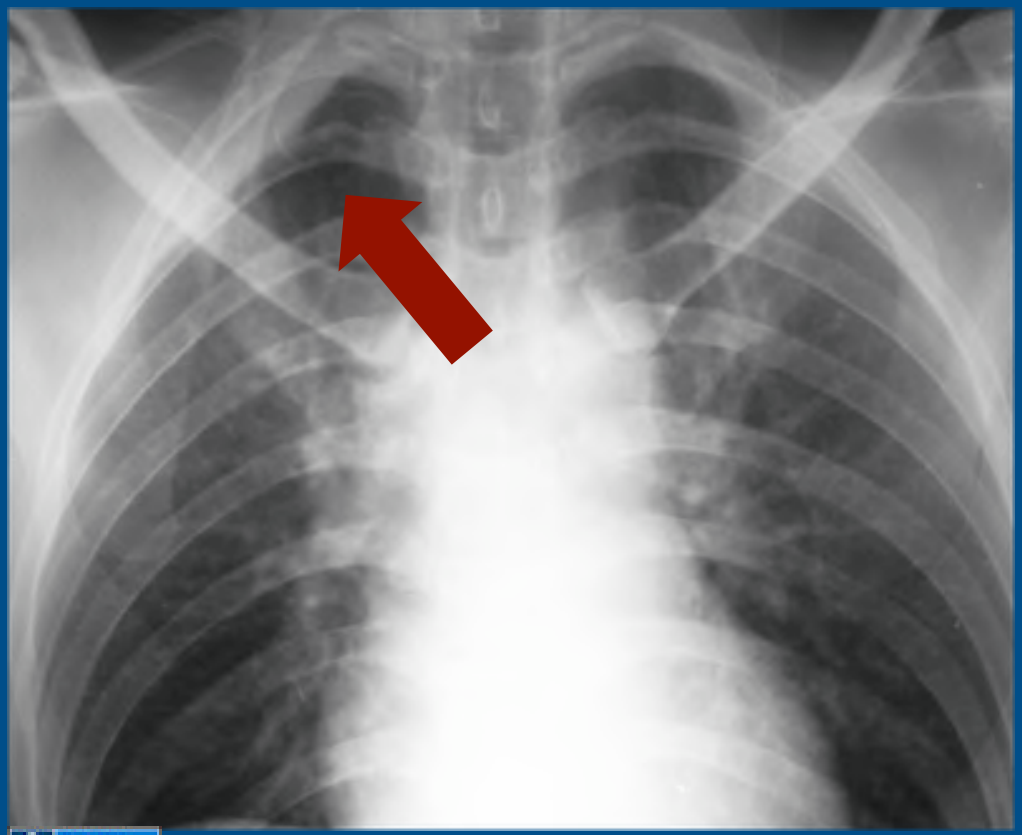
- Clinical Features
  - Clinical suspicion with tenderness, bony crepitus, ecchymosis and muscle spasm over the rib
  - Compression over the site of injury typically causes pain
- Diagnostic Strategies
  - CXR is mainstay of diagnosis – Mainly to evaluate for associated injuries
  - Dedicated rib films are of limited utility
  - Previously fractures of ribs 1-2 termed the hallmark of severe chest trauma
    - Required arteriography to evaluate intrathoracic injury
    - Numerous studies have now shown that without direct evidence of vascular or neurologic compromise that fracture of 1st or 2nd rib is not associated with increased mortality
    - However, multiple rib fractures that include the 1st or 2nd rib is associated with 10 fold increase in mortality
  - Helical CT has largely replaced arteriography for diagnosis of major vascular injuries and patients with multiple rib fractures with suspected vascular or intrathoracic injuries should undergo CT imaging

Rib Fractures

- Clinical Course
  - Rib fractures heal in 3-6 weeks
  - Gradual decrease in pain over time with analgesia needed for first 1-3 weeks
- Management
  - Pain control (PO Narcotics, IV Narcotics, Intercostal Nerve Blocks)
  - Maintenance of pulmonary function
  - Binders, belts and other restrictive devices should be avoided. They decrease pain but are noted to have increased risk of hypoventilation, atelectasis and subsequent pneumonia
  - Elderly patients may require admission for treatment with IV pain control and monitoring of respiratory status
  - Displaced rib fractures should be monitored and repeat CXR at 3 hours after presentation to evaluate for delayed pneumothorax development

Rib fractures

- 1st and 2nd Rib fracture, Small apical cap indicating localized hemorrhage



http://anaesthesia-drzek.blogspot.com/2008/09/fracture-rib.html

http://anaesthesia-drzek.blogspot.com/2008/09/fracture-rib.html

Sternal Fracture

- Epidemiology
  - Primarily, the result of anterior blunt trauma
    - E.g. Passenger's chest strikes steering wheel
  - Increased risk of sternal fracture with use of passenger restraint
    - Threefold increase since widespread seatbelt use
    - Expect decrease with air bag deployment (no data yet)
  - Sternal Fractures more common in older patients suffering blunt trauma (Less elastic chest wall doesn't distribute force evenly)
- Pathophysiology
  - Rapid deceleration injury from a frontal impact results in sternal fracture at site of seatbelt
  - Isolated sternal fractures are relatively benign with low mortality (0.7%)
  - Complications
    - Myocardial Contusion (1.5-6% of cases)
    - Spinal Fractures (< 10% of cases)
    - Rib Fractures (21% of cases)
    - No association between sternal fracture and blunt aortic injury

Sternal Fracture

- Pathophysiology (continued)
  - Associated mediastinal injuries should be considered including mediastinal hematoma from injury to underlying proximal great vessels
- Clinical Features
  - Anterior chest pain and point tenderness over the sternum, soft tissue deformity
- Diagnostic Management
  - Lateral radiograph is most helpful with diagnosis due to transverse nature of most fractures
  - Patients with sternal fracture should be screened for myocardial contusion with EKG and serial cardiac enzymes
- Management
  - Analgesia
  - Without any associated injuries, patients with isolated sternal fractures can be discharged

Sternal Fracture

- Pectus Excavatum

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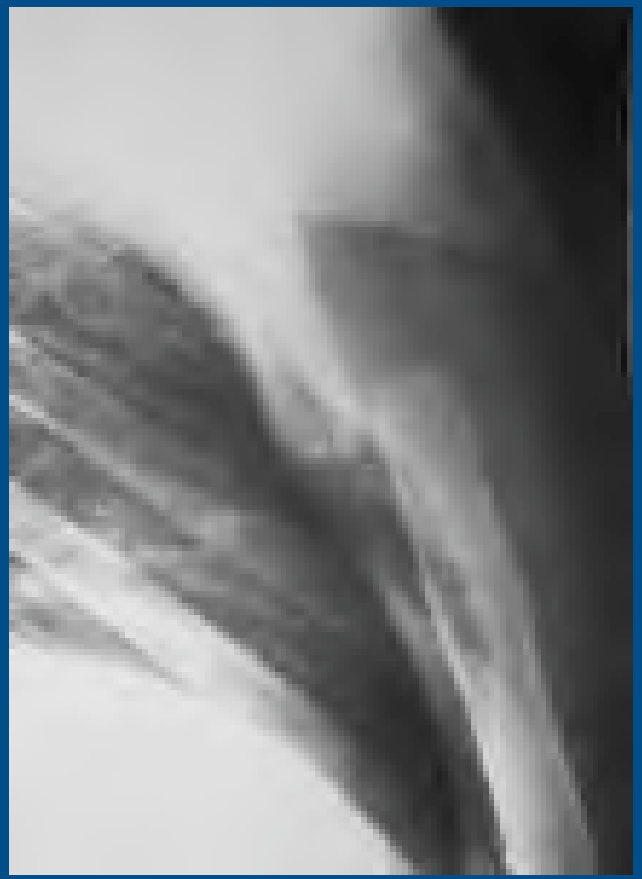
http://www.jssm.org/vol4/n3/14/F1.htm

- Sternal Fracture



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www.radrounds.com

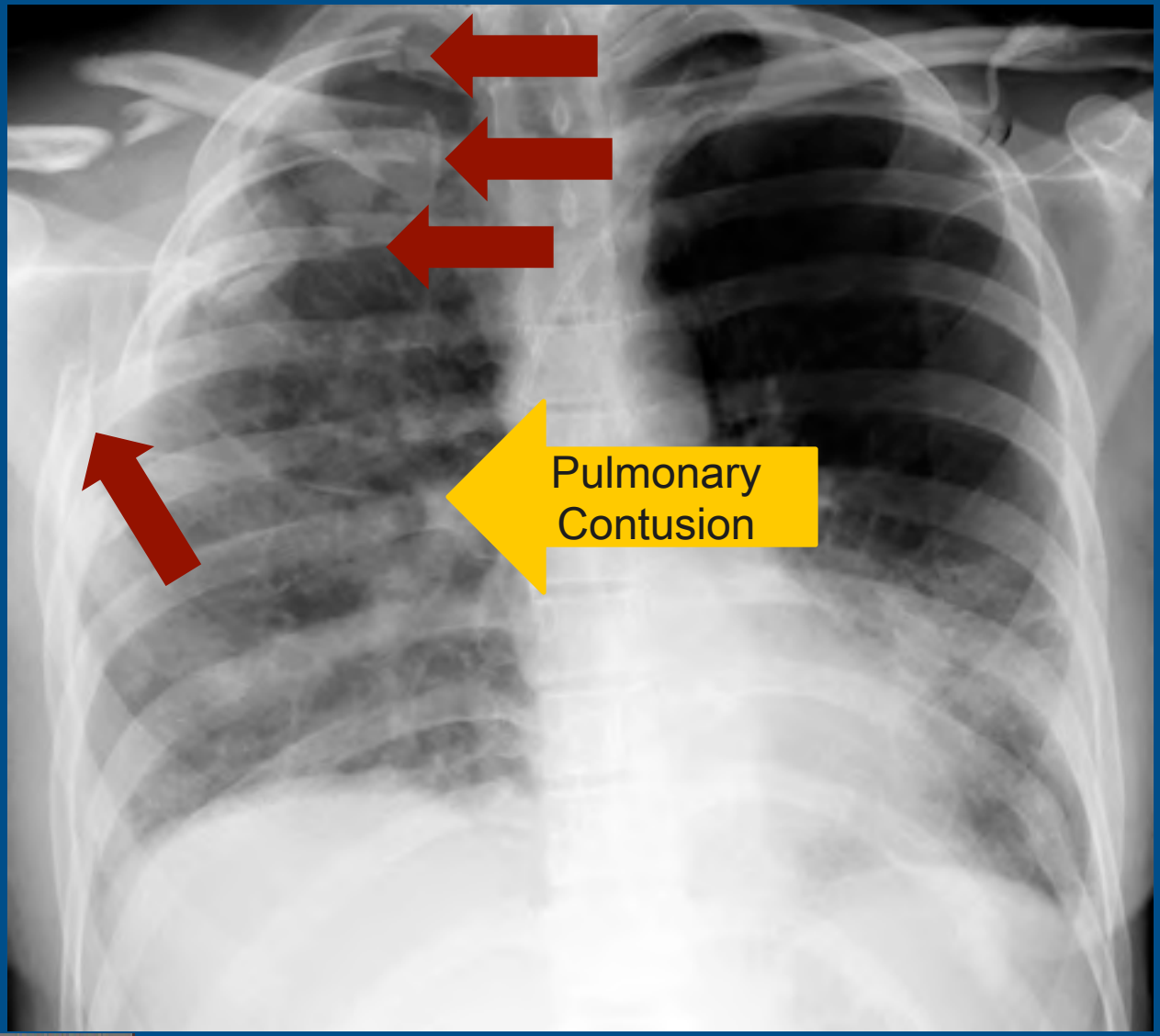
Flail Chest

- Epidemiology
  - Occurs in 1/3 of major trauma patients with major chest injuries
- Pathophysiology
  - Three of more adjacent ribs are fractured at two points, resulting in a freely moving segment of chest wall
  - Segment moves in paradoxical motion with underlying normal chest movement
  - High association with underlying pulmonary contusion
  - Underlying pulmonary contusion is major cause of respiratory insufficiency
  - Severe pain associated with injury results in muscular splinting and resultant atelectasis and hypoxemia

Flail Chest

- Clinical Features
  - Examine for paradoxical segment movement
  - Pain, tenderness and crepitus are often seen
- Diagnostic Strategies
  - CXR will often show multiple rib fractures and underlying pulmonary contusion
  - CT scan – more accurate than CXR and will help define extent of underlying injury
- Management
  - Aggressive pulmonary physiotherapy
  - Effective analgesia
  - Selective use of mechanical ventilation and endotracheal intubation
  - Close observation of respiratory status
  - Early operative fixation of flail segment results in quicker recovery, decreased complications and improved cosmetic and functional results
  - Mortality associated with flail chest = 8-35% and is directly related to underlying injuries

Flail Chest



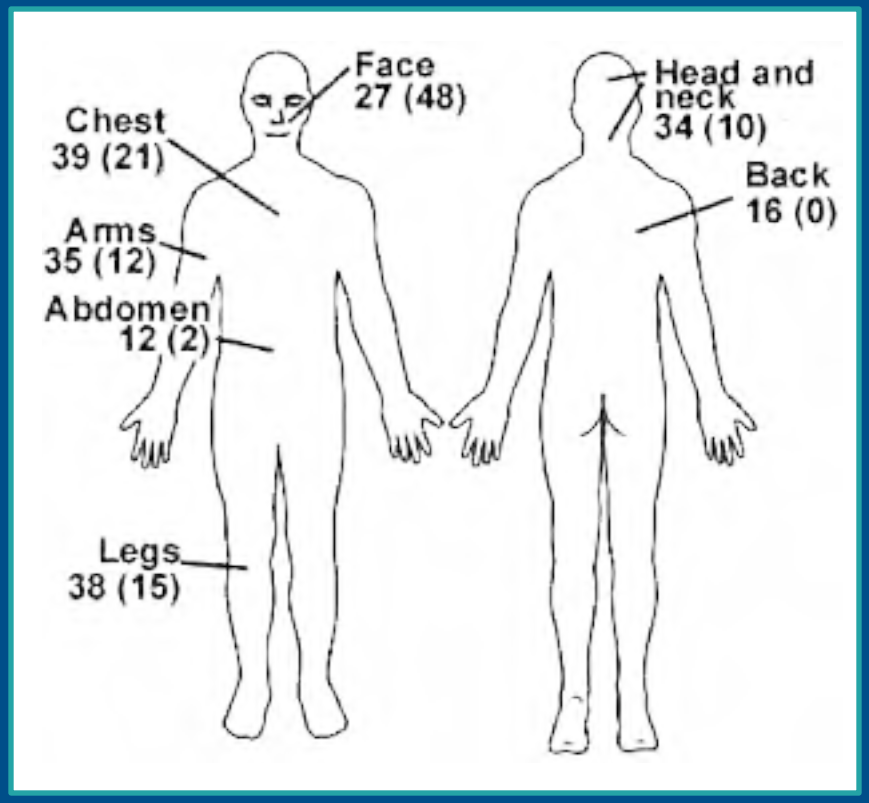
http://virtual.yosemite.cc.ca.us/lylet/rc211/Case1FlailChest.gif

Non-penetrating Ballistic Injury

- Definition
  - Non-penetrating ballistic injury includes injury from:
    - Rubber bullets (Used by police for crowd control)
    - Beanbag shotgun shells
    - “Bullet Proof Vests” = Bullet resistant vests
- Pathophysiology
  - Projectile injury from penetrating bullet is inhibited by non-penetrating ballistic injuries
  - Kinetic energy of projectile can be transmitted through to patient and still cause injury
- Clinical Features
  - Erythema, Ecchymosis and Tenderness over impacted area
  - Evaluate area for any subcutaneous emphysema, crepitis or bony step-offs
- Diagnostic Strategies
  - CXR to evaluate for intra-thoracic injuries, retained foreign body or violation of the bone
- Management = Close observation

Non-Penetrating Ballistic Injury

- Rubber Bullet Injuries



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http://www.mindfully.org/Health/2002/Rubber-Bullets-Israeli-Arab25may02.htm

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Source Undetermined

Traumatic Asphyxia

- Pathophysiology
  - Rare syndrome characterized by severe sudden compression of the thorax by heavy object
  - Causes marked increase in thoracic and superior vena caval pressure
  - Retrograde flow of blood from right heart into great veins of head and neck
- Clinical Features
  - Deep violet color of skin of the head or neck
  - Bilateral subconjunctival hemorrhages, Petechiae and Facial Edema are typically present, indicative of sudden increase in blood flow
  - Benign and Self-limited condition
- Diagnosis
  - Clinical significance is in diagnosing intrathoracic injury from severity of force required to cause traumatic asphyxia
  - Chest wall and pulmonary injuries are most common
  - Neurologic bleeding is rare
  - CT Imaging should be obtained
- Management
  - Neurologic manifestations resolve within 24-48 hours
  - Mainstay of treatment is treatment of underlying injuries and supportive care

Pulmonary Injuries

- Subcutaneous Emphysema
- Pulmonary Contusion
- Pneumothorax
- Hemothorax
- Tracheobronchial Injury

Subcutaneous Emphysema

- Pathophysiology
  - Subcutaneous emphysema in the presence of the chest wall is indicative of a more serious thoracic injury
  - Type of air entry
    - Extrapleural
      - Tracheobronchial tree injury allows air to leak into mediastinum and then up to the soft tissues of anterior neck
    - Intrapleural
      - Intrapleural leakage typically creates a pneumothorax and then air leaks through the parietal pleura and into the thoracic wall
  - Location
    - Adjacent to penetrating wound
      - May indicate localized infiltration from external environment
    - Localized subcutaneous air over chest wall
      - Indicates presence of traumatic pneumothorax
    - Localized over supraclavicular area and anterior neck
      - Typically indicates pneumomediastinum
    - Massive subcutaneous air of the face and neck
      - Typically the result of ruptured bronchus

Subcutaneous Emphysema

- Diagnosis
  - Palpation of chest wall and neck reveals crepitance
  - Auscultation may reveal Hamman's crunch indicative of air in mediastinum
  - CXR may show subcutaneous air tracking through soft tissue
- Management
  - Mostly subcutaneous air is benign and self limited and can be treated with high flow oxygen
    - Facilitates re-absorption of nitrogen from tissues
  - Key is identifying underlying injury
  - Massive accumulations may be uncomfortable to a patient

Subcutaneous Emphysema

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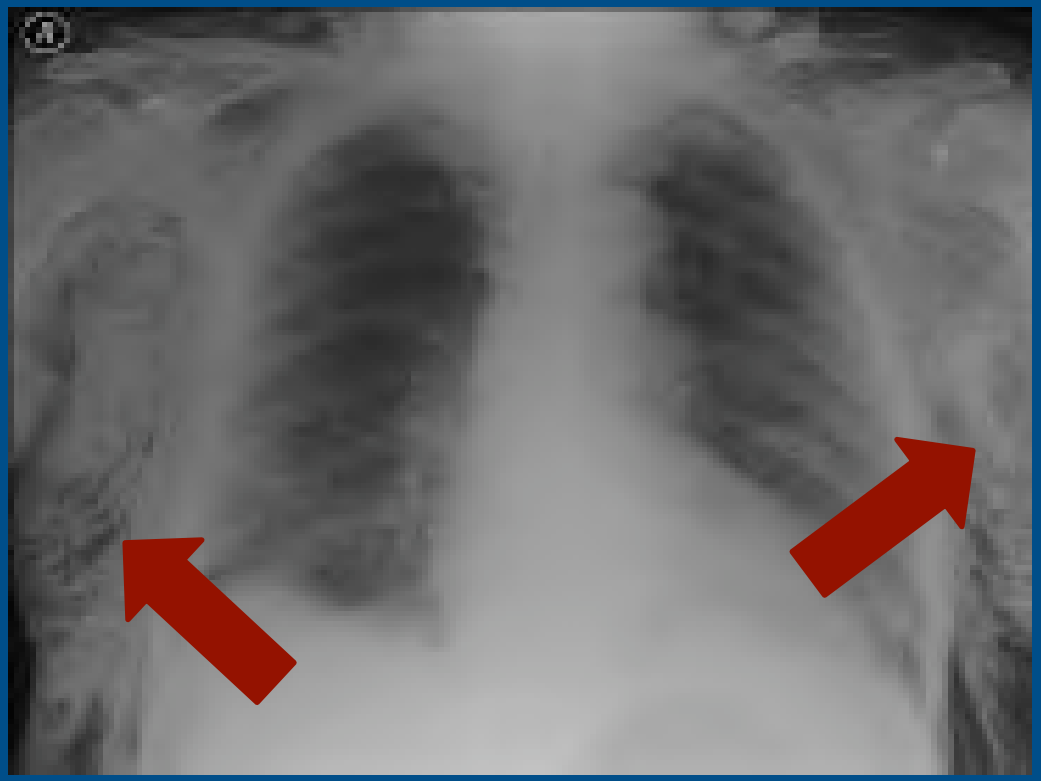
PD-INEL http://www.trauma.org/index.php/main/images/C11/



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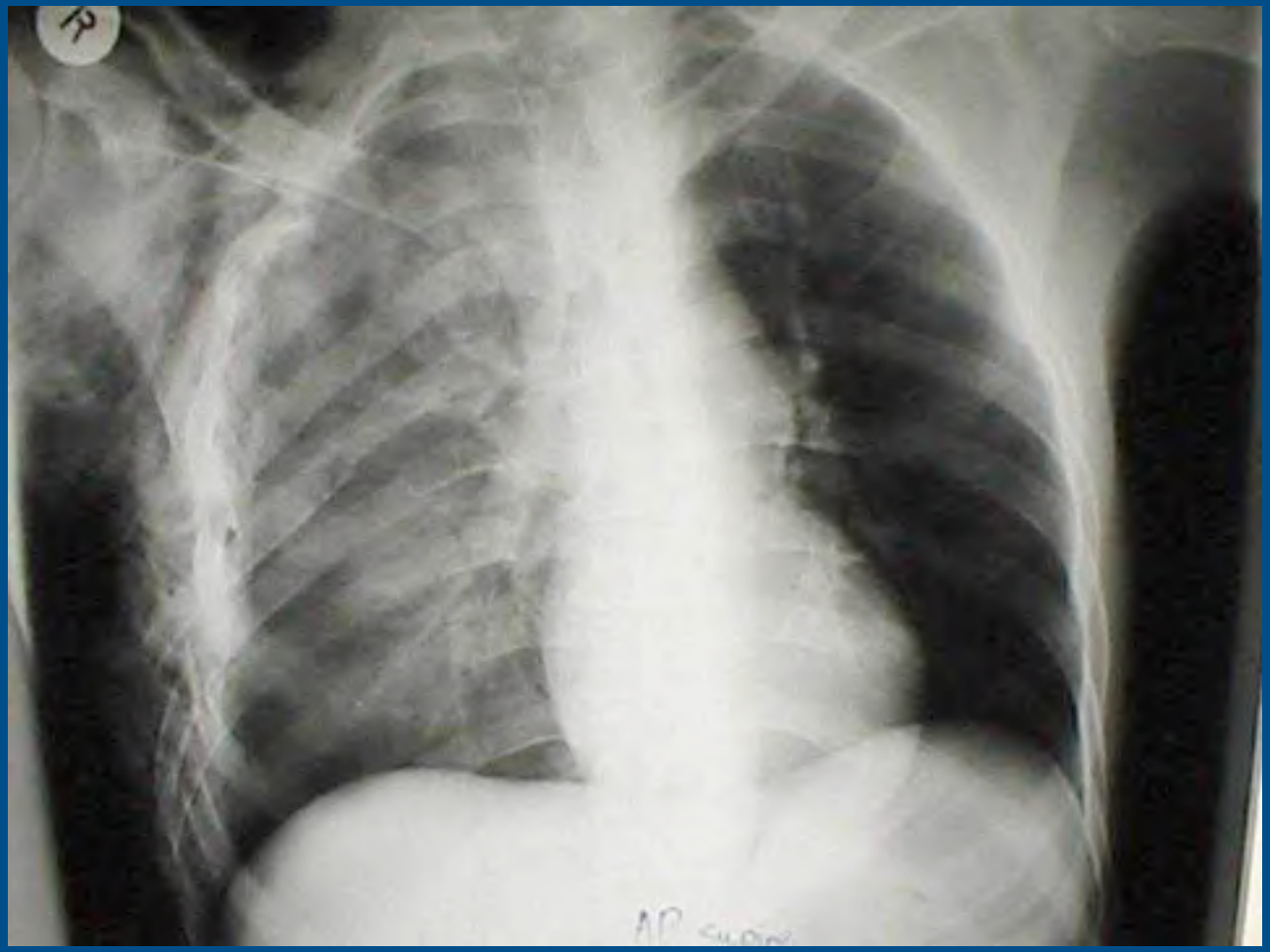
Pulmonary Contusion

- Epidemiology
  - Present in 30-75% of patients with significant blunt chest trauma
  - Most common significant chest injury in children
- Pathophysiology
  - Direct bruise of pulmonary parenchyma with associated alveolar edema and hemorrhage
- Clinical Features
  - Dyspnea, Tachypnea, Cyanosis, Tachycardia, Hypotension, Chest wall Bruising
  - Hemoptysis may be present in 50% of patients
  - Associated with flail chest
- Diagnosis
  - Radiographic findings appear within minutes of an injury
  - Patchy irregular alveolar infiltrates to frank consolidation
  - Always present within 6 hours of injury
  - CT is particularly sensitive at diagnosis
  - Differentiate from ARDS by time course
    - Pulmonary contusion < 6 hours present, resolves in 48-72 hours
    - ARDS onset is 24-72 hours after injury

Pulmonary Contusion

- Management
  - Restriction of IVF administration
  - Vigorous tracheopulmonary toilet, Suctioning
  - Pain Control
  - Judicious use of respiratory support with endotracheal intubation and mechanical ventilation
    - Consider double lumen ETT when only one lung damaged
    - Allows for compensation for differences in compliance between lungs
    - Avoid intubation if possible as increased mortality from intubation due to pneumonia, sepsis, pneumothorax, longer hospitalization
- Complication = Pneumonia
  - Prophylactic antibiotics are not recommended
- Prognosis
  - Mortality of isolated pulmonary contusion is 5-16%

Pulmonary Contusion



http://upload.wikimedia.org/wikipedia/commons/f/f2/Pulmonary_contusion.jpg

Pneumothorax

- Definition = Accumulation of air in the pleural space
- Epidemiology
  - 15-50% of patients with severe chest trauma
- Pathophysiology
  - Traumatic pneumothorax is caused by fractured rib that is driven inward resulting in laceration of pleura
  - Also occurs without a fractures when impact is delivered at full inspiration with the glottis closed, leasing to tremendous increase in intra-alveolar pressure and subsequent rupture of the alveoli
  - Penetrating trauma such as a gunshot wound or knife injury may cause direct trauma to the pleura

Pneumothorax

- Types of Pneumothorax
  - Simple Pneumothorax
    - No communication with the atmosphere or any shift of mediastinal structures or the hemi-diaphragm from accumulating air
    - Pneumothorax grading
      - Small Pneumothorax < 15%
      - Moderate Pneumothorax = 15-60%
      - Large Pneumothorax > 60%
  - Communicating Pneumothorax (Open Pneumothorax)
    - Pneumothorax associated with loss of integrity of chest wall
    - Often termed sucking chest wound
    - Results in large functional dead space for the normal lung and severe ventilatory disturbance

Tension Pneumothorax

- Tension Pneumothorax
  - Progressive accumulation of air under pressure within the chest cavity with shift of mediastinal structures to opposite hemithorax
  - Results in compression of contralateral lung and great vessel venous return
  - Results in decreased diastolic filling of the heart and subsequent decreased cardiac output
  - Leads to rapid onset of hypoxia, acidosis and shock
  - Cardinal Physical Exam Findings
    - Tachycardia, Jugular Venous Distension, Tachypnea
    - Absent Breath sounds on ipsilateral side
    - Hypoxia and Hypotension, followed by cardiac arrest

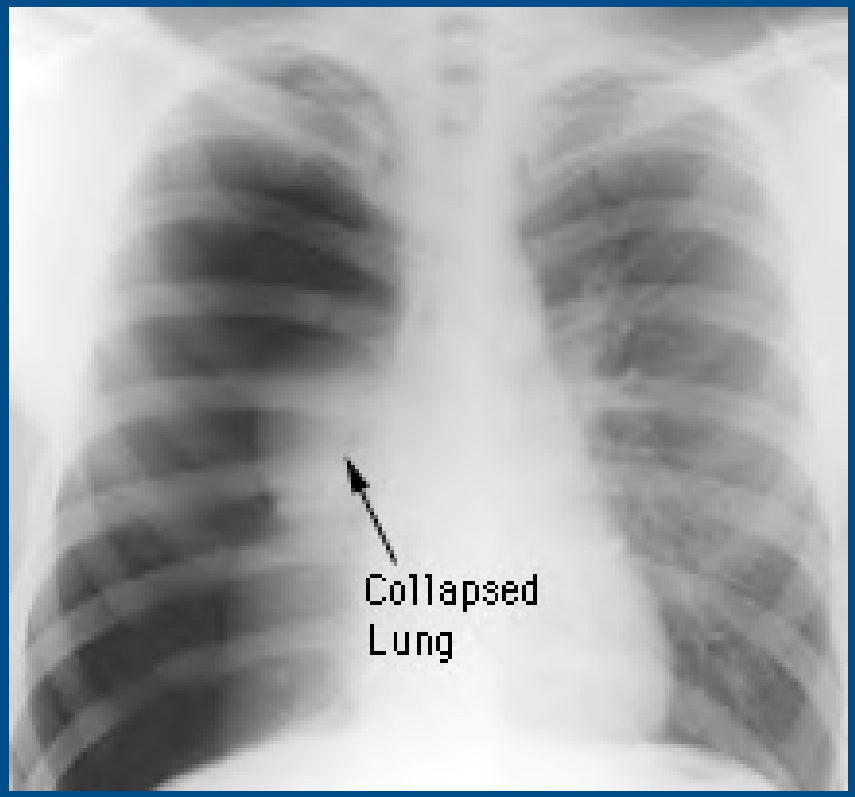
Pneumothorax

- Clinical Features
  - Chest pain and shortness of breath are most common symptoms
  - Spectrum of presentation
    - Small PTX = Absent clinically on exam
    - Tension PTX = Acutely ill in minutes with severe cardiovascular and respiratory distress
  - Signs and symptoms don't always correlate with size of pneumothorax
  - Physical exam
    - Absent breath sounds over affected side
    - Hyperesonance
    - Tachycardia
    - Tachypnea

Pneumothorax

- Diagnostic Features
  - CXR is preferred initial study
  - Upright full inspiratory film provides best initial study
  - If non-diagnostic, expiratory film may make the pneumothorax more visible by decreasing the lung volume
  - CT is very sensitive at finding small pneumothoraces even in supine patient
  - Bedside ultrasound
    - Rapid minimally invasive way of evaluating for pneumothorax
    - Primarily used to exclude diagnosis
    - Findings suggesting the presence of a pneumothorax include
      - Absence of pleural line
      - Absence of pleural sliding
      - Presence of a lung point (exclusive horizontal lines)

Simple Pneumothorax



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http://www.daviddarling.info/images/pneumothorax_radiograph.gif

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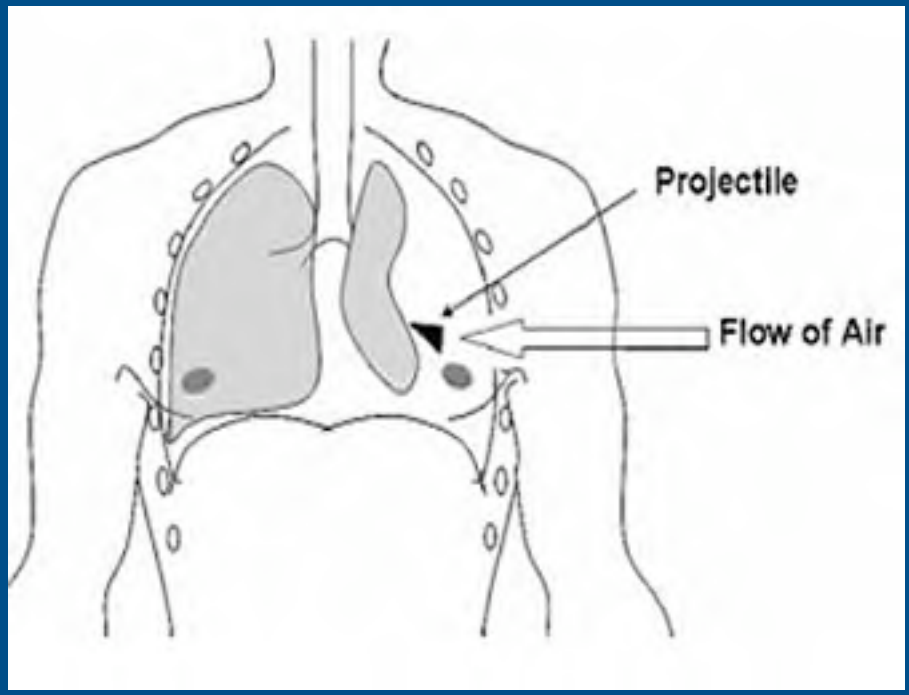
http://www.trauma.org/index.php/main/images/C11/

Open Pneumothorax

PD-INEL http://www.trauma.org/index.php/main/images/C11/



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Tension Pneumothorax

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http://www.trauma.org/index.php/main/images/C11/

Pneumothorax

- Management
  - Penetrating Trauma/No Pneumothorax
    - If CXR is negative, Observation x 3 hrs, Repeat CXR prior to D/c
  - Simple Pneumothorax
    - Some authors advocate chest tube for all traumatic pneumothoracies
    - Small Pneumothorax
      - Some people advocate careful observation if patient is symptoms free and does not need anesthesia or positive pressure ventilation
      - Small apical pneumothorax < 25% may also be observed closely
      - Occult CT diagnosed PTX is also suggested to be amenable to conservative treatment
      - If patient is to receive positive pressure ventilation or has evidence of multi-system trauma, chest tube should be placed
    - Moderate/Large Pneumothorax = Chest tube

Pneumothorax

- Management – Open Pneumothorax
  - Pre-hospital setting – Three sided occlusive dressing
    - Avoid conversion to tension pneumothorax
  - ED setting – Placement of Chest tube at site remote from wall deficit
    - Dressing can be occlusive dressing of petroleum gauze if chest tube is in place
    - Never pack the wound – dressing can be sucked into chest cavity
    - Endotracheal intubation for respiratory support
  - Definitive surgical repair of deficit

Pneumothorax

- Management – Tension Pneumothorax
  - Needle Thoracostomy
    - 2nd Intercostal Space – Mid-clavicular Line
  - Tube Thoracostomy
    - 5th Intercostal Space – Anterior Axillary Line

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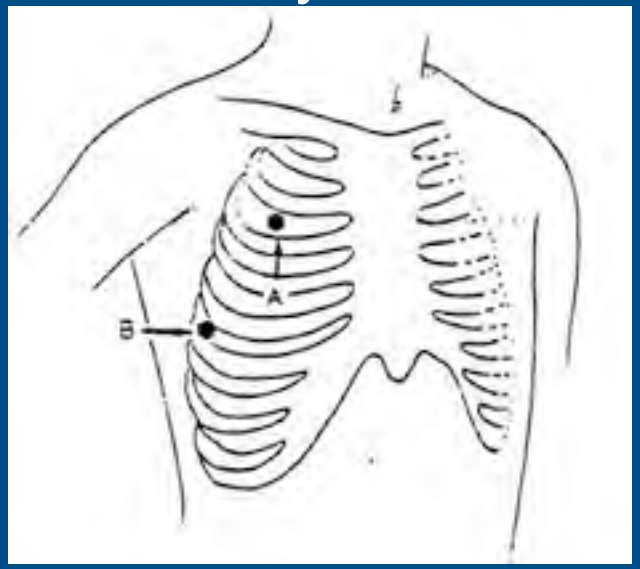
www.trauma.org/index.php/main/article/199/index.php?main/image/95/



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http://www.hcmc.org/manualHCMC/Procedure_Lab/thoracostomy_tube_files/image004.jpg

Hemothorax

- Definition = accumulation of blood in the pleural space after blunt or penetrating traumatic injury
- Pathophysiology
  - Hemorrhage from injured lung parenchyma is most common cause but is usually self-limiting
  - Other vessels may be site of injury including intercostal and internal mammary arteries
  - Less commonly, major vessels or hilar vessels are site of bleeding
- Clinical Features
  - Depending on rate and quantity of hemorrhage, varying levels of hemorrhagic shock are encountered
  - Diminished or absent breath sounds on affected side

Hemothorax

- Diagnosis
  - Clinical Diagnosis – often enough to initiate treatment
  - CXR – initial diagnostic test
    - 200-300 cc Blood required to cause costophrenic blunting
    - Supine film – typically blood will layer posteriorly and generate diffuse haziness that can be subtle
  - CT – most sensitive test but often not able to be obtained if patient unstable
- Management
  - Tube thoracosomy for drainage of accumulated blood
    - Large bore chest tube = 36-40 French
    - Failure to evaluate blood may lead to pleural adhesions
  - Urgent thoracotomy is indicated with more than 1500 cc of blood output on initial placement of chest tube or more than 200 cc/hr for 3 hours
  - Restoration of circulating volume
  - Auto-transfusion is option for patients with brisk bleeding and requirement of transfusion to maintain circulating volume

Hemothorax

http://www.trauma.org/index.php/main/images/C11/

Tracheobronchial Injury

- Epidemiology
  - Occur with either blunt of penetrating trauma to the chest or neck
  - More than half are result of MVC
  - Rare entity - occurring in < 3% of patients with significant chest trauma
  - Mortality = 10%
- Pathophysiology
  - Knife wounds = Injury in cervical trachea with transection of tracheal rings or cricoid cartilage
  - GSW = Injury to tracheobronchial tree at any point
  - MVC/Blunt Injury = Sudden deceleration of thoracic cage, puts traction on trachea at the carina as lungs are pulled away
    - As elasticity of tracheobronchial tree is exceeded, it ruptures
    - 80% of these injuries occur within 2 cm of the carina

Tracheobronchial Injury

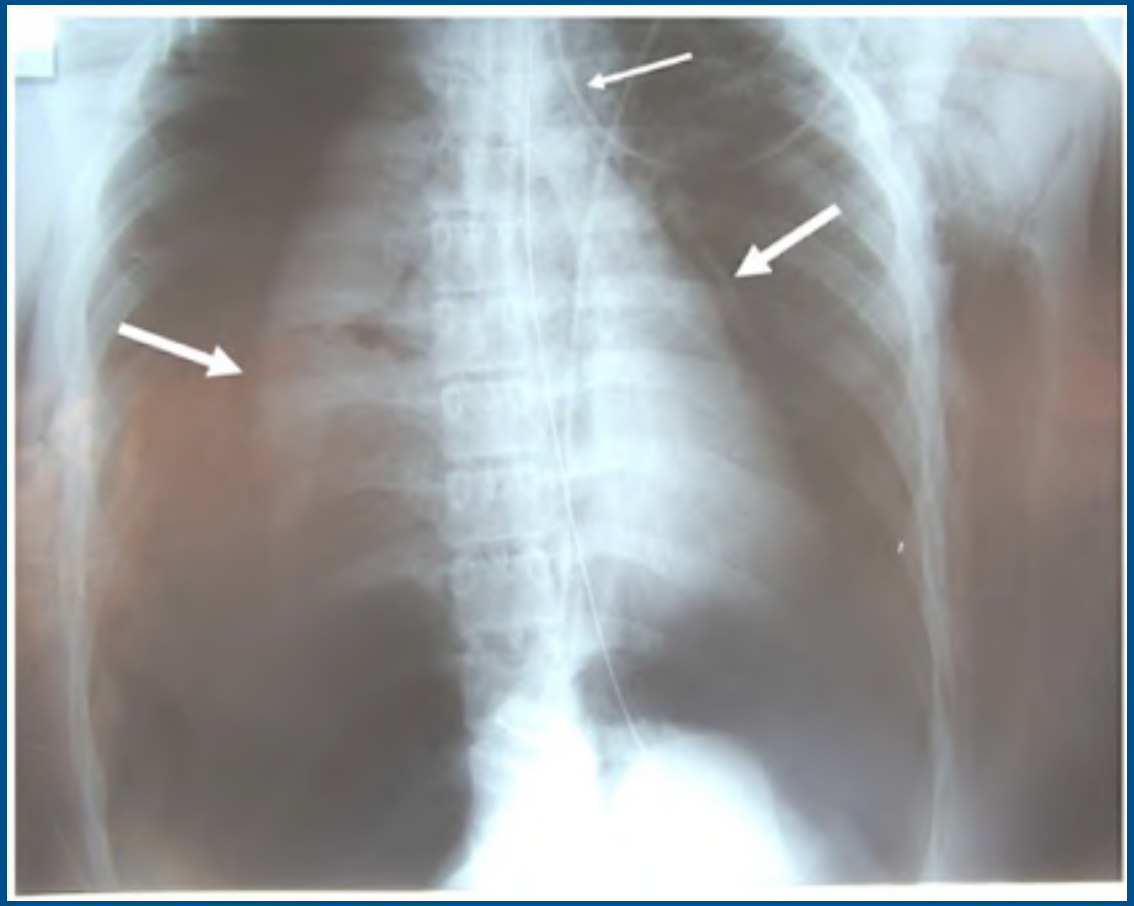
- Clinical Features
  - Symptoms
    - Massive Air Leak, Hemoptysis and Subcutaneous Emphysema
  - Two clinical Presentations
    - Wound opens into pleural space – Large PTX
      - Chest tube fails to evacuate the space and re-expand the lung characterized by bronchopleural fistula or persistent air leak
    - Complete transection of the tracheobronchial tree but little communication with the pleural space
      - Present with unexplained atelectasis or pneumonia days to weeks after injury

Tracheobronchial Injury

- Diagnosis
  - CXR may demonstrate secondary findings
    - i.e. Pneumothorax, Pneumomediastinum, etc
  - Definitive diagnosis is made with bronchoscopy
- Management
  - Endotracheal Intubation
    - Preferable if done with bronchoscope to allow visualization of tube passing beyond site of injury
    - Blind intubation risks placing endotracheal tube into transected airway, false passage or convert partial tear into full tear
  - Surgical Repair (Thoracotomy)

Tracheobronchial Injury

- Tracheobronchial injury resulting in bilateral pneumothorax, pneumomediastinum and subcutaneous air



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http://commons.wikimedia.org/wiki/File:Bilateral_pneumothorax_pneumomediastinum.jpg

Cardiovascular Injuries

- Blunt Cardiac Trauma
  - Myocardial Concussion
  - Myocardial Contusion
  - Myocardial Rupture
- Penetrating Cardiac Injury
- Acute Pericardial Tamponade
- Blunt Aortic Injury

Blunt Cardiac Trauma

- Epidemiology
  - Typically results from high speed MVC where chest wall strikes steering wheel
  - First characterized as significant traumatic entity in 1930's by Bright and Beck
  - Diagnosis is difficult because of lack of gold standard testing for making diagnosis
- Clinical Spectrum
  - Myocardial Concussion
  - Myocardial Contusion
  - Traumatic Myocardial Infarction
  - Myocardial Rupture

Myocardial Concussion

- Definition
  - Commotio Cordis
  - Blunt injury to chest produces a stunning to the myocardium and dysrhythmia
  - No permanent cellular injury occurs but transient clinical effects result
- Mechanism = Sharp direct blow to the mid-anterior chest
  - Results in a brief dysrhythmia, hypotension and loss of consciousness
- If patient survives initial dysrhythmia, no lasting pathologic changes and difficult to make diagnosis
- Myocardial concussion = cases of sudden death after a blow to chest with no changes on autopsy
- Treatment = Case reports of successful treatment with rapid application of CPR and automated defibrillator

Myocardial Contusion

- Epidemiology
  - Poorly understood and nebulous condition
  - Reported incidence = 3-55% in reports of severe closed chest trauma
- Pathophysiology
  - Direct blow to the chest transmits energy through the ribs to the spine and compresses the heart between the sternum and vertebrae, resulting in cardiac injury
  - The severity of the injury is thought to relate to the phase of the systolic/diastolic cycle during which the trauma occurs
  - Injuries occurring during the more rigid stages of later diastole and early systole (when the heart is filled with blood, less elastic) are more damaging.

Myocardial Contusion

- Pathophysiology (Continued)
  - Range of microcellular damage is seen from mild disruption of myofibrils to complete loss of structure and necrosis
  - Edema and cellular infiltrates accumulate in the wall of the heart and results in decreased ventricular compliance
  - Acute thrombus may form and result in coronary artery occlusion and myocardial infarction
  - Small pericardial effusions occur in more than 50% of all contusions (not indicative of significant cardiac injury or increased risk of tamponade)
  - Fibrous reaction may occur at the site of the myocardial injury and site is at risk for delayed rupture (typically 2nd week after injury)
  - Most myocardial contusions heal spontaneously with resolution of cellular infiltrate and hemorrhage leading to scar formation.

Myocardial Contusion

- Clinical Features
  - Most patients with myocardial contusion will have external signs of thoracic trauma including contusions, abrasions, rib fractures, etc.
  - Absence of thoracic lesions decreases suspicion but does not exclude cardiac injury
  - Most sensitive but least specific sign of myocardial contusion = sinus tachycardia
    - Present in 70% of patients with documented myocardial effusion
  - Conduction blocks may occur but is rarely clinically significant

Myocardial Contusion

- Diagnostic Strategies
  - Controversy
    - Significant controversy exists regarding the importance of making the diagnosis in otherwise hemodynamically normal patients
    - Cannot be definitively identified short of a biopsy performed at biopsy
    - The point of diagnostic testing is not to diagnose the presence of myocardial contusion but to define a low risk population that can be safely discharged from the emergency department
  - EKG
    - EKG may be normal or may demonstrate nonspecific abnormalities such as sinus tachycardia, RBBB (with injury of RV), AV Block, Arrhythmias
    - Most frequently seen abnormalities include sinus tachycardia and atrial extra systolic beats

Myocardial Contusion

- Diagnostic Strategies (Continued)
  - Cardiac Enzymes
    - CK/CK-MB are of little diagnostic utility because it will be non-specifically increased in trauma patients as a result of skeletal muscle injury
    - Serum troponin levels are highly specific for myocardial injury and some authors recommend two sets of troponin measurements 6 hours apart if negative is indicative of a low risk status
  - Echocardiography
    - Echocardiography is useful to identify wall motion abnormalities and identifying associated lesions such as thrombi, pericardial effusion and valvular disruption
  - Radionucleotide studies
    - Rarely available in the ED and of limited benefit but will identify underperfused areas of the heart due to contusion

Myocardial Contusion

- Management
  - There is little value to admitting and carefully monitoring patients with suspected mild cardiac contusions
  - Troponin is suggested as a means of risk stratification of patients suspected of having a myocardial contusion
  - Increased troponin levels suggest a higher risk of developing cardiac complications and warrants further monitoring with echocardiography, serial EKG's and serial troponin levels
  - Normal EKG and Troponin level at 4-6 hours after the injury correlates with minimal risk of developing cardiac complications
  - Elevated troponin levels should be treated with oxygen, cardiac monitoring and analgesia
    - Thrombolytic agents and aspirin are contraindicated in the setting of acute trauma

Myocardial Rupture

- Definition – Acute traumatic perforation of the ventricles, atria but includes pericardial rupture, laceration or rupture of intraventicular septum, papillary muscles or valves
  - Delayed rupture may occur weeks after blunt trauma, probably resulting from necrosis of a contused or infarcted area of myocardium
- Epidemiology
  - Most commonly the result of high speed MVC
  - 15% of all fatal thoracic injuries
  - Incidence of cardiac rupture in cases of blunt chest trauma ranges from 0.5% - 2%
  - Autopsy review suggest 20% of patients will survive 30 minutes or more suggesting rapid diagnosis may have allowed this subset to reach the operating room

Myocardial Rupture

- Pathophysiology
  - Ventricles most commonly rupture
  - Multiple chamber rupture in 30% of patients
  - 20% of non-survivors also have aortic rupture
  - Proposed mechanisms of rupture
    - Deceleration shearing forces acting on fixed attachments (IVC/SVC and atrium)
    - Upward displacement of blood and abdominal viscera from blunt abdominal injury resulting in sudden increase in intrathoracic pressure
    - Direct compression of heart between sternum and vertebral bodies
    - Laceration from rib or sternal fracture
    - Complication of myocardial contusion with subsequent rupture
  - High association with multi-trauma – 70% of reported survivors had other associated major injuries
  - Immediate survival is related to the integrity of the pericardium
    - Intact pericardium with tamponade bleeding effect
    - Violated pericardium will result in immediate exsanguination

Myocardial Rupture

- Clinical Features
  - Patients will typically present with evidence of pericardial tamponade and subsequent rapid deterioration
  - Auscultation = “bruit de moulin” = harsh murmur = splashing mill wheel = hemopericardium
  - Findings suggestive of myocardial rupture
    - Hypotension disproportionate to suspected injury
    - Hypotension unresponsive to fluid resuscitation
    - Massive Hemothorax unresponsive to thoracotomy and fluid resuscitation
    - Persistent metabolic acidosis
    - Pericardial Effusion on echocardiography with hypotension
- Diagnosis
  - Emergency Department Ultrasound
  - CXR suggestive of associated traumatic injuries

Myocardial Rupture

- Management
  - Immediate Decompression of cardiac tamponade and hemorrhage control
  - Pericardiocentesis may be performed as temporizing measure or as a diagnostic evaluation tool
  - Emergency department thoracotomy may be required in patients with rapid deterioration and cardiac arrest
    - Hemorrhage control = Finger occlusion, Foley Catheter, Vascular clamp

Penetrating Cardiac Injury

- Penetrating cardiac injuries is one of leading causes of traumatic death in urban settings
- Right ventricle (43%) > Left ventricle (34%) due to anatomic location
- 1/3 affect multiple chambers
- 5% have an associated lacerated coronary artery
- Outcomes
  - Exsanguinating Hemorrhage
    - Frequently expire prior to reaching emergency medical care
    - E.g. Gunshot wound to the heart
  - Cardiac Tamponade
    - In cases of penetrating cardiac injury, actually offers some decree of protection by providing tamponade effect to massive exsanguination
    - In some patients, small pericardial wound can act as a way to relieve pressure from tamponade by also help tamponade severe exsanguination

Penetrating Cardiac Injury

- Penetrating Cardiac Injury
  - Knives = Lower Energy
  - Bullets = Higher Energy
  - RV closest to surface of chest

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http://www.trauma.org/index.php/main/images/C11/

Acute Pericardial Tamponade

- Epidemiology
  - Incidence in penetrating trauma to chest and upper abdomen = 2%
  - 60-80% of stab wounds to the heart will result in tamponade
- Pathophysiology
  - Tamponade results in increased intrapericardial pressure and volume
  - Increasing volume and pressure limits ability of atria and ventricles to fill with blood, eventually leading to decreased stroke volume and decreased cardiac output
  - Decreased stroke volume and cardiac output result in hypotension and decreased pulse pressure result
  - Heart attempts to compensate with increased HR and total peripheral resistance in an attempt to maintain adequate cardiac output and blood pressure
  - Clinical picture of tamponade may result from as little as 60-100 cc of blood and clots in the pericardium

Acute Pericardial Tamponade

- Clinical Features
  - Beck's Triad
    - Hypotension
    - Distended neck veins
    - Distant or muffled heart sounds
  - Three distinct clinical presentations
    - Normotensive, tachycardic patient with elevated CVP
      - Hemorrhage confined to pericardial sac
    - Hypovolemic shock with hypotension, tachycardia and low CVP
      - Significant hemorrhage outside of pericardial sac
    - Waxing and waning hemodynamic measures
      - Intermittently decompressing tamponade
- Diagnosis
  - Ultrasound = pericardial effusion + RV collapse
    - Ultrasound = 98.1% Sensitive, 99.9% specific
  - Electrocardiography = Electrical Alternans
  - Radiography
    - Not typically helpful, may see water bottle shaped heart or air fluid level

Acute Pericardial Tamponade

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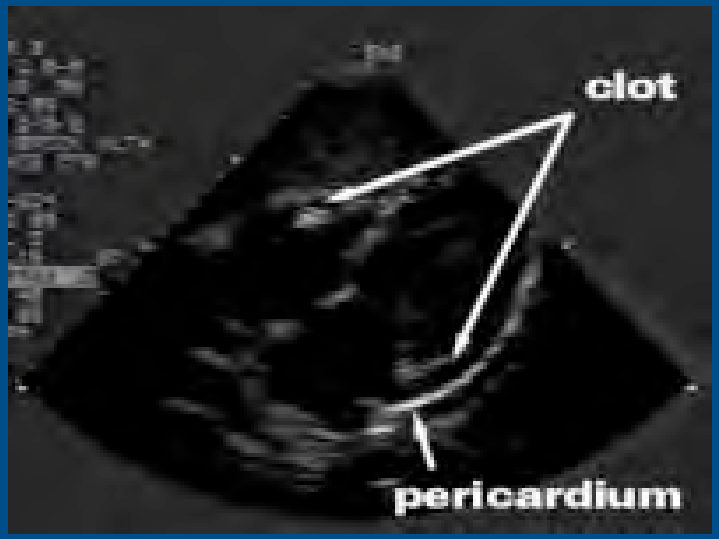

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Acute Pericardial Tamponade

- Management
  - Initial Resuscitation
    - Volume expansion with crystalloid via two large bore IV catheters
    - Bedside echocardiography for diagnosis
  - Pericardiocentesis
    - Controversial temporizing procedure
    - 5-10 cc aspiration of blood may result in dramatic improvement of clinical condition
    - Not benign procedure – laceration of coronary artery or lung, induction of cardiac arrhythmias
  - Surgical Repair (Thoracotomy)
    - Definitive treatment

Emergency Department Thoracotomy

- Drastic potentially life-saving procedure
- Indications
  - Penetrating Traumatic Cardiac Arrest
    - Cardiac arrest at any point with initial signs of life in the field
    - Blood pressure < 50 mmHg after resuscitation
    - Severe shock with clinical signs of cardiac tamponade
  - Blunt Trauma
    - Only if cardiac arrest in the emergency department
  - Suspected Air Embolus
- Goal = Determine if a life-threatening fixable lesion is present
  - Cardiac Tamponade, Cardiac Rupture
  - Vascular bleeding, Cross-Clamp Aorta
- Survival Rates
  - Cardiac arrest in the field = 0%
  - Cardiac arrest in emergency department = 30%
  - Agonal in the emergency department = 40%
  - Unresponsive shock in emergency department = 50%

Emergency Department Thoracotomy

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Blunt Traumatic Aortic Injury

- Epidemiology
  - Most common vessel injured by blunt trauma
  - Increasing mortality rate suggesting strong association with high speed MVC
    - < 1 % (1947), 15% (Current)
  - 10-20% of patients sustaining blunt aortic injury will survive temporarily
  - Mean age = 33 y/o, >70% are men
  - 85% will survive if diagnosis and surgical intervention are prompt

Blunt Traumatic Aortic Injury

- Pathophysiology
  - Site of Rupture
    - 80-90% occur in descending thoracic aorta just distal to the left subclavian artery
      - 25% incidence of associated lethal cardiac injuries
    - Other common areas of injury
      - Distal descending aorta at level of the diaphragm
      - Mid-thoracic descending aorta
      - Origin of left subclavian artery
    - Descending aorta > Ascending aorta
    - Ascending aorta rupture has high association (70-80%) with lethal cardiac injuries
      - Survival long enough to be evaluated in ED rare

Blunt Traumatic Aortic Injury

- Pathophysiology
  - Mechanism of Injury (Descending Aorta)
    - Descending aorta is fixed and immobile due to tethering effect of the intercostal arteries and ligamentous arteriosum
    - Sudden deceleration, more mobile aortic arch moves forward producing a shearing force on the aorta at the isthmus
    - Bending stress at the isthmus created by lateral oblique compression may also result in rupture by flexion of the aortic arch on the left main bronchus and pulmonary artery
    - Other authors suggest that these stresses are not enough to cause the injury and the injury results from inferior and posterior rotation of anterior thoracic osseous structures (e.g. manubrium, clavicles, first rib) that shear the aorta as it strikes the vertebral column

Blunt Traumatic Aortic Injury

- Pathophysiology
  - Ascending aorta mechanism
    - Rapid deceleration displaces the heart in to left chest causing a shearing stress above the aortic valve with a sudden increase in intra-aortic pressure (waterhammer effect)
  - Other mechanisms of Aortic Injury
    - Direct laceration by fractures of sternum, ribs, clavicle
    - Complication of external cardiac massage
    - Fracture dislocations of spine

Blunt Traumatic Aortic Injury

- Clinical Features
  - Consider in any patient with sudden deceleration injury
  - Clinical manifestations can be deceptive and subtle
  - Co-existing injuries can mask the signs and symptoms of aortic injury
  - Most common symptoms are intrascapular or retrosternal pain
  - Other symptoms
    - Dyspnea – tracheal compression and deviation
    - Stridor or hoarseness – compression of recurrent laryngeal nerve
    - Dsyphagia - compression of the esophagus
    - Extremity pain – decreased extremity perfusion
  - Signs – uncommon and non-specific
    - Hypertension (reflex response to stretching stimulus)
    - Harsh systolic murmur
    - Swelling at base of neck (rare)

Blunt Traumatic Aortic Injury

- Diagnosis
  - Chest radiography
    - Increased width of superior mediastinum
      - Seen in 50-92% of aortic ruptures
      - Specificity = 10%
    - Mediastinal width > 8 cm in AP film
    - Obscured aortic knob
    - Left apical pleural cap
    - Previous belief that negative CXR is highly predicative of normal aortogram has been recently challenged and patients with significant mechanisms are at increased risk

Blunt Traumatic Aortic Injury

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Blunt Traumatic Aortic Injury

- Diagnosis
  - Helical Chest CT
    - 100% sensitivity and specificity
    - Poor results with CT were previously related to conventional style CT scanners
  - Transesophageal Echocardiography
    - Fast, non-IV contrast study that can be performed in the ED (if available)
    - Allows identification of intimal flap and periaortic hematoma
    - Sensitivity = 87% - 100%
    - Specificity = 98-100%
  - Intravascular Ultrasound
    - Small ultrasound probe that can be inserted through femoral artery and guided up to the aorta to find subtle injuries
    - Very few centers have modality available
  - Aortography
    - Gold standard for establishing the diagnosis
    - Intra-arterial injection of IV contrast and was previously recommended for any patient with significant blunt chest trauma and abnormal CXR (before helical CT scans)
    - Risk of causing further damage if arterial catheter crosses site of injury

Blunt Traumatic Aortic Injury

- Helical CT Imaging
  - Aortic arch disruption

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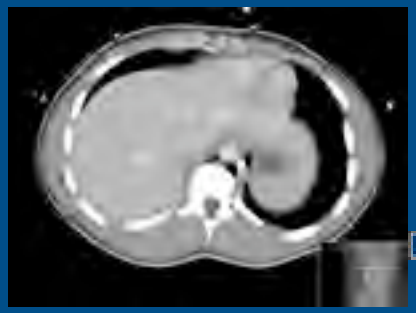
Source Undetermined



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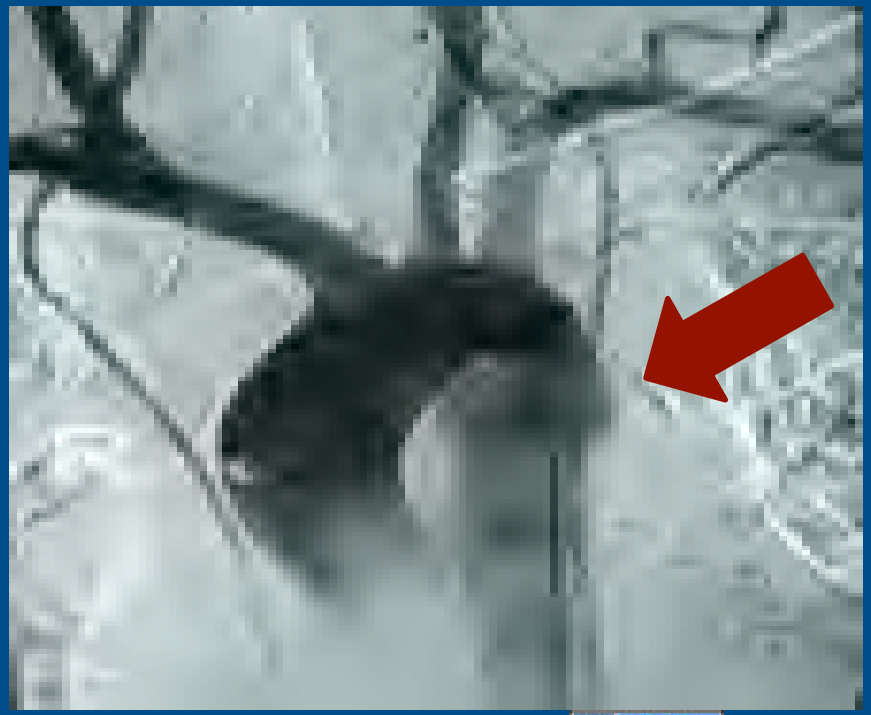
Source Undetermined

- Aortogram
  - Pseudoaneuyrsm of descending aorta at the isthmus



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Source Undetermined

Blunt Traumatic Aortic Injury

- Management
  - Emergency Department
    - Fix life threatening injuries first (ABCDE)
    - Make the diagnosis
    - Careful regulation of blood pressure (SBP = 100-120 mmHg)
      - Decrease the shearing effect of elevated pulse pressure
      - IV Beta blocker (Esmolol)
  - Surgical Intervention
    - Definitive therapy
    - Incidence of mortality during surgery = 20-30%
    - Incidence of paraplegia = 5-7%
    - Endovascular repair is developing as tool for management and initial literature is promising

Esophageal Perforation

- Epidemiology
  - Most rapidly fatal perforation of the GI tract because death is nearly 100% if diagnosis is delayed past 24 hours
  - Classic description was by Boerhaave in 1724
  - Between 1724 – 1940 – Boerhaave syndrome was nearly 100% fatal
  - With improved surgical techniques, mortality has now been decreased to 30%
- Pathophysiology
  - Esophageal perforation is associated with high mortality because of the lack of any serosal covering to the esophagus which allows direct access to mediastinum
  - Upper or cervical perforations – extend into retropharyngeal space
  - Mid or Lower esophageal perforations – extend directly into the mediastinum
  - Drainage of esophageal contents results in chemical and bacterial mediastinitis

Esophageal Perforation

- Etiology
  - Iatrogenic
    - Complication of Rigid or Flexible Endoscopy
    - Esophageal Dilatation
    - Nasotracheal intubation or Nasogastric tube placement
    - Difficult Endotracheal Intubations
  - Foreign Bodies
    - Foreign bodies cause esophageal perforation through direct laceration or pressure necrosis or as complication of endoscopic removal
  - Caustic Burns
    - Intentional or accidental ingestion of acid or alkali
    - Perforation typically occurs 4-14 days after ingestion
    - Strong alkali burns = Liquefaction necrosis = Higher potential of perforation
    - Strong acid burns = Coagulation necrosis = Lower potential of perforation

Esophageal Perforation

- Etiology (continued)
  - Penetrating and Blunt Trauma
    - Esophageal Trauma occurs in 5% of patients with injuries to the neck but only 1% of blunt trauma due to posterior location of esophagus
    - Blunt esophageal trauma < Penetrating esophageal trauma
  - Spontaneous Rupture
    - Boerhaave's Syndrome
    - More than 80% are middle aged men who have ingested large meals and alcohol

Esophageal Perforation

- Diagnosis
  - CXR – Classic Features
    - Mediastinal Air with or without subcutaneous air
    - Left-sided pleural effusion
    - Pneumothorax
    - Widened mediastinum
  - Radiographic evidence may not be present in early phase of disease
  - Gastrografin esophagram (Gold Standard)
  - Endoscopy
- Management
  - Early diagnosis is key
  - Broad spectrum antibiotics
  - Surgical Repair

http://www.ispub.com/ispub/ijtcvs/volume_13_number_1_2/spontaneous_esophageal_perforation_presenting_as_pneumothorax_a_case_report/pneumo-fig1.jpg

Questions?

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