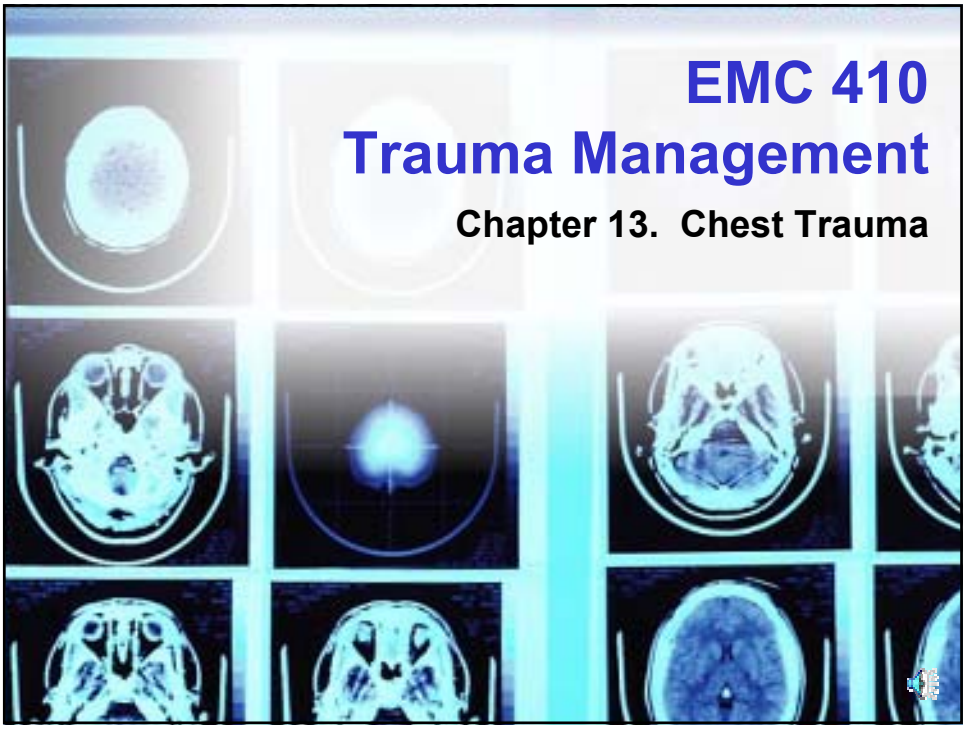


EMC 410
Trauma Management

Chapter 13. Chest Trauma

Unit Objectives

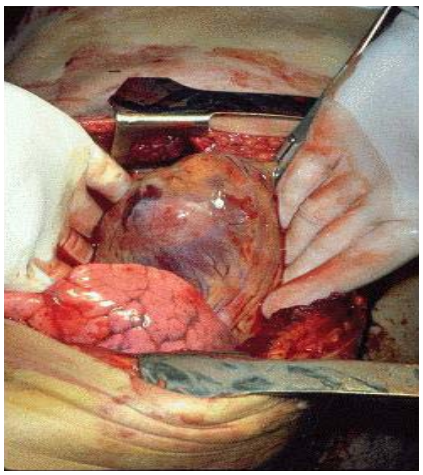
- **Upon completion of this chapter, you should be able to:**
  - Describe the incidence, morbidity, and mortality of thoracic injuries.
  - Provide an overview of the normal anatomy and physiology of the thorax.
  - Discuss the pathophysiology, assessment findings, and treatment of chest wall injuries.
  - Discuss the pathophysiology, assessment findings, and treatment of lung injuries.
  - Discuss the pathophysiology, assessment findings, and treatment of myocardial injuries.
  - Discuss the pathophysiology, assessment findings, and treatment of vascular injuries.

Unit Objectives continued

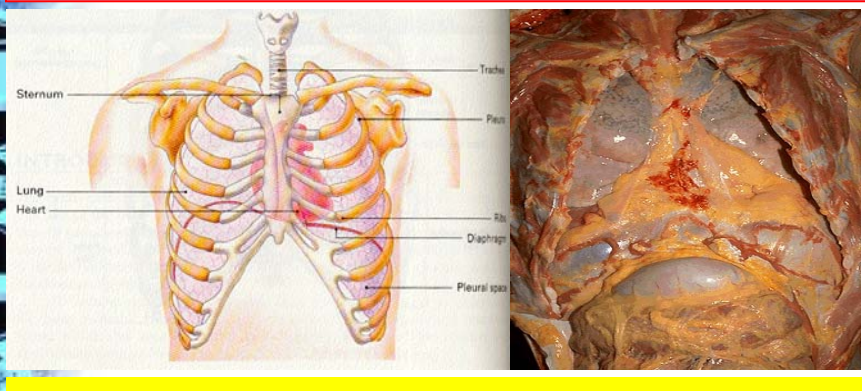
- Discuss the pathophysiology, assessment findings, and treatment of diaphragmatic injuries.
- Discuss the pathophysiology, assessment findings, and treatment of tracheal, bronchiolar, and esophageal injuries.
- Discuss the pathophysiology, assessment findings, and treatment of traumatic asphyxia.
- Acquire a systematic approach to the patient with chest trauma, taking into consideration the anatomy, pathophysiology, and possible life-threatening injuries that can occur.
- Describe the invasive procedures of pericardiocentesis, needle thoracentesis, and chest tube insertion.

Introduction

- Chest injuries are responsible for 25% of all trauma deaths.
- Less than 10% of blunt chest trauma requires surgery.
- 15% to 30% of penetrating chest trauma requires surgery.
- Most chest trauma patients can be managed with simple procedures as long as the proper diagnoses are made.



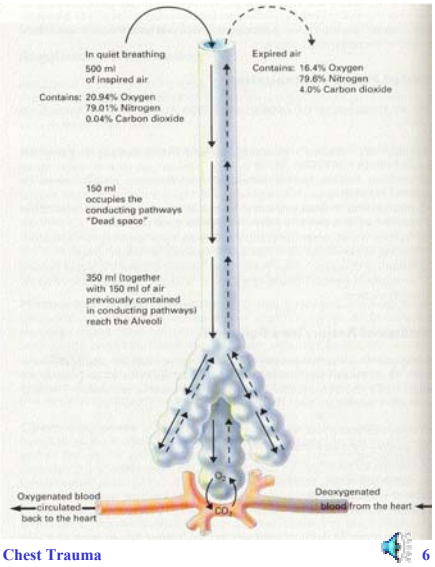
Anatomy and Physiology



- 12 pairs of ribs separated by 2 to 3 layers of intercostal muscles
- Costal groove containing neurovascular bundle lies along the inferior and internal surface of ribs.
- Contraction of intercostal muscles and flattening of the diaphragm increases intrathoracic volume and decreases intrathoracic pressure permitting inhalation.
- Intercostal muscles innervated by the intercostal nerves which branch from the spinal cord.
- The diaphragm is innervated by the phrenic nerve at C3,C 4, and C5.

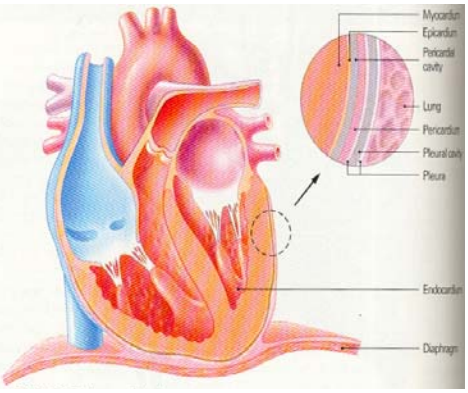
Anatomy and Physiology continued

- Parietal pleura lines the thoracic cavity
- Visceral pleura covers the lungs
- Small amount of fluid between the pleural layers which provide lubrication and keeps the lung adhered to the chest wall by high surface tension
- Tidal volume is 500 ml, of which 150 ml is dead space
- Carbon dioxide diffuses rapidly from the blood to the alveoli
- Oxygen does not diffuse as rapidly and is very dependent on the number of functional alveoli



Anatomy and Physiology continued

- Two ways of increasing oxygenation:
  - Increase FiO_2
  - Alveolar recruitment (manage injuries, PEEP)
- The heart is covered by the visceral and parietal pericardium.
- The pericardium is acutely non-distensible.
- Normally, 30 - 50 ml of pericardial fluid.
- The heart is positioned so that the most anterior portion is the right ventricle.
- Cardiac impulse is felt at 5th ICS along midclavicular line
- Average C.O. is 4 to 8 lpm



Anatomy and Physiology continued

- Trachea, superior vena cava, aortic arch, recurrent laryngeal nerves and esophagus are located in the superior mediastinum
- Recurrent laryngeal nerves are branches of the vagus and innervate the larynx
- The posterior mediastinum contains the descending aorta, esophagus, and lymphatic channels
- The descending aorta is firmly attached to the thoracic vertebrae by the ligamentum arteriosum.
- The aorta is composed of the tunica intima, tunica media, and tunica adventitia.

Initial Assessment and Stabilization

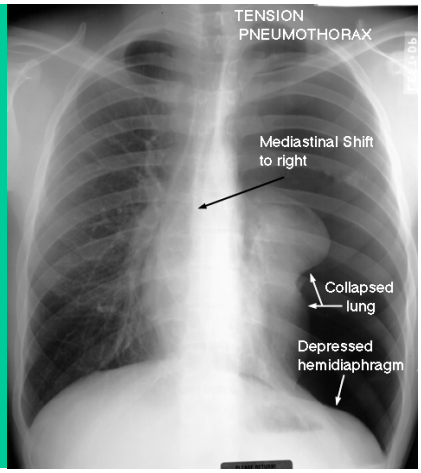
- **Airway**
  - Patency
  - Air exchange
  - FBAO
- **Breathing**
  - Rate, rhythm, and quality
  - Neck veins and trachea
  - Chest wall defects
  - Subcutaneous emphysema
  - Retractions
  - Hoarseness
  - BBS

Initial Assessment and Stabilization continued

- **Circulation**
  - Rate , rhythm, and quality of pulses
  - Blood pressure
  - Heart tones
  - Cardiac impulse (location and quality)
- **The goal of the initial assessment is to identify and treat all life-threatening injuries**

Initial Assessment and Stabilization continued

- **Tension pneumothorax**
  - One-way valve permits excessive increases in intrathoracic pressure
  - Pressure collapses lung and ultimately shifts the mediastinum
  - The life-threat of tension pneumothorax is mediastinal shift

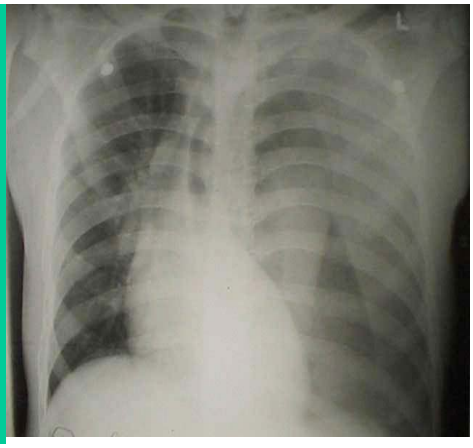


Initial Assessment and Stabilization continued

- **Tension pneumothorax continued**
  - S&S
    - Respiratory distress
    - JVD (absent with concomitant hypovolemia)
    - Tracheal deviation (late)
    - Shifted cardiac impulse
    - Tachycardia and narrowed pulse pressure
    - Asymmetry and diminished lung sounds
    - Hyperesonance
    - Pulsus paradoxus

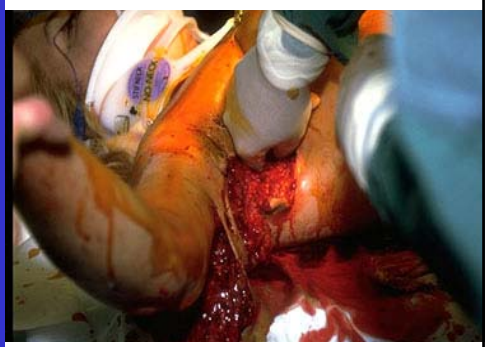
Initial Assessment and Stabilization continued

- **Tension pneumothorax continued**
  - Treatment
    - Immediate decompression
    - Reopening of penetrating wound
    - Tube thoracotomy
    - 100% oxygen



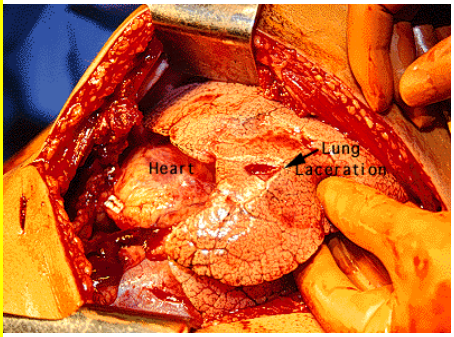
Initial Assessment and Stabilization continued

- **Open pneumothorax**
  - Chest wall defect resulting from usually penetrating trauma, but also blunt trauma
  - GSW and knife wounds most common penetrating mechanisms
  - MVC most common blunt mechanism
  - Small wounds are self-sealing
  - If defect greater than 2/3 diameter of trachea, air will preferentially enter through the defect, creating the “sucking” sound
  - Standard treatment is sealing defect with a gloved hand followed by an occlusive dressing sealed on 3 sides
  - If a chest tube is required, it should not be inserted through the defect



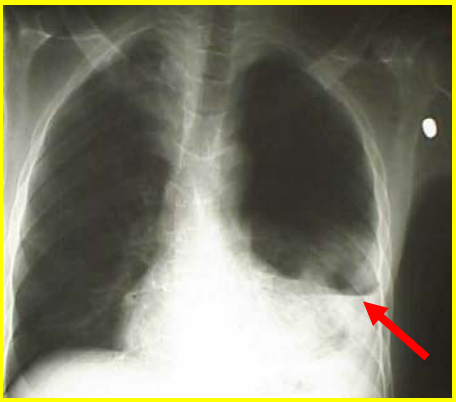
Initial Assessment and Stabilization continued

- **Massive hemothorax**
  - Occurs in 25% of chest trauma patients
  - Usually caused by tears in lung paryncheme, but may also result from injury to the heart or major vessels
  - Intercostal and internal mammary arteries more likely to be injured than hilar or great vessels
  - Greater than 300 ml of blood may form large clots that release fibrinolysins and fibrinogenolysins from their surface, increasing hemorrhage



Initial Assessment and Stabilization continued

- **Massive hemothorax continued**
  - Clinical presentation is one of shock and respiratory distress, diminished lung sounds, dull percussive note, and flat neck veins
  - Blood in the pleural space tends to keep lung inflated more so than air



Initial Assessment and Stabilization continued

- **Hemothorax continued**
  - Differential diagnosis

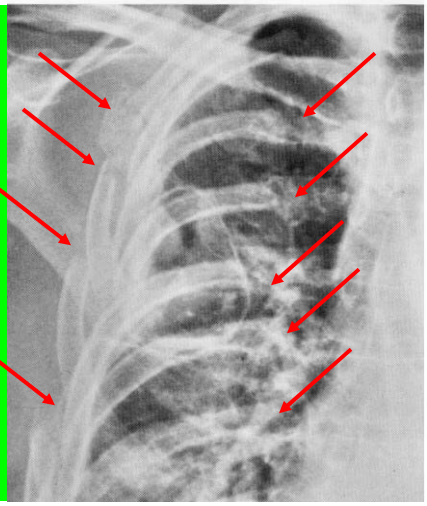
Assessment	Massive Hemothorax	Tension Pneumothorax	Cardiac Tamponade
Pulse	Rapid	Rapid	Rapid
Blood Pressure	Low	Low	Low
Pulsus Paradoxus	No	Yes	Possibly
Heart Sounds	Audible	Audible	Muffled
Neck Veins	Flat	Distended	Distended
Percussion	Dull	Hyperresonant	Normal
Trachea	Midline/Deviated	Deviated	Midline
Chest Symmetry	Normal/asymmetrical	Asymmetrical	Normal
Breath Sounds	Absent/Rhonchi/Rales	Absent	Present

Initial Assessment and Stabilization continued

- **Hemothorax continued**
  - Treatment
    - 100% oxygen
    - Crystalloid fluid replacement
    - PASG?
    - No needle decompression
    - Chest tube
    - Blood transfusion
    - Autotransfusion

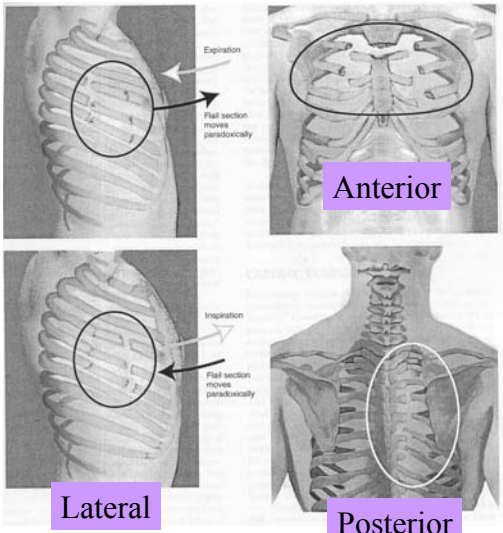
Initial Assessment and Stabilization continued

- **Flail chest**
  - Fracture of two or more adjacent ribs in two or more places
  - Occurs in up to 20% of admitted trauma patients
  - Mortality rate up to 50% and related to underlying injuries
  - Pulmonary contusion and hemothorax occurs in 50% of cases
  - Primary cause of hypoxia is not the flail but the underlying pulmonary contusion
  - Rarely seen in children



Initial Assessment and Stabilization continued

- **Flail chest continued**
  - May be located anteriorly, laterally, or posteriorly



Initial Assessment and Stabilization continued

- **Flail chest continued**
  - S&S
    - Paradoxical movement (rarely seen initially)
    - Splinting
    - Asymmetric chest wall movement
    - Pain
    - No paradoxical movement during PPV
  - Treatment
    - Manual stabilization
    - Bulky dressings (no sandbags)
    - Ventilatory support
    - 100% oxygen
    - Cautious use of fluids

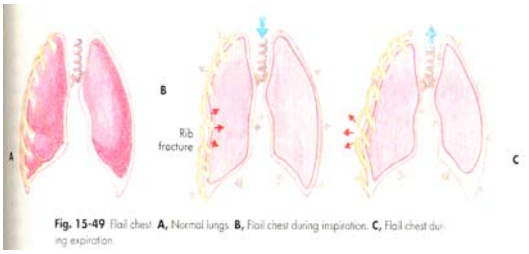
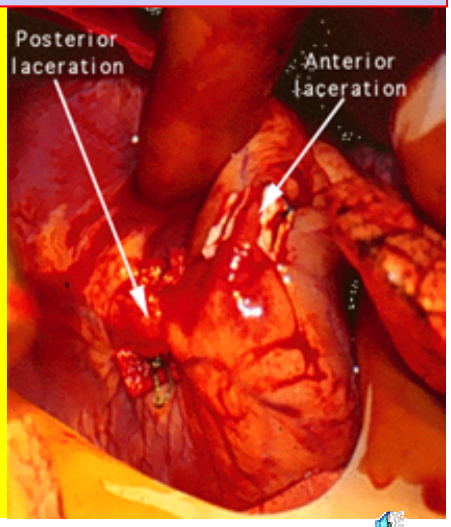


Fig. 15-49 Flail chest. **A,** Normal lungs. **B,** Flail chest during inspiration. **C,** Flail chest during expiration.

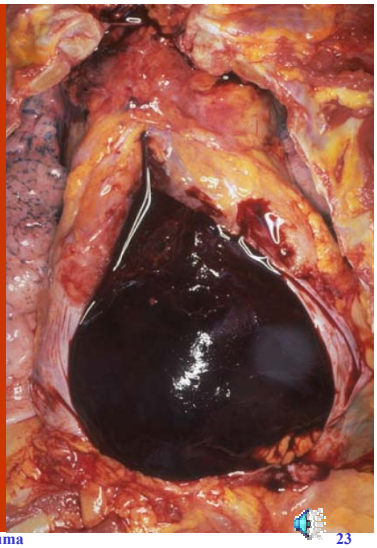
Initial Assessment and Stabilization continued

- **Cardiac tamponade**
  - Occurs in about 2% of penetrating injuries and rarely in the setting of blunt trauma
  - Right ventricle most frequently involved
  - Injury to intrapericardial or coronary vessels is rare
  - Should be suspected with any penetrating injury of the thorax, especially those overlying the precordium or epigastrium
  - Stab wounds generally seal setting the stage for tamponade
  - 80% - 90% of stab wounds to the heart develop tamponade
  - Only 20% of GSW to the heart develop tamponade
  - As little as 50cc of blood can create tamponade



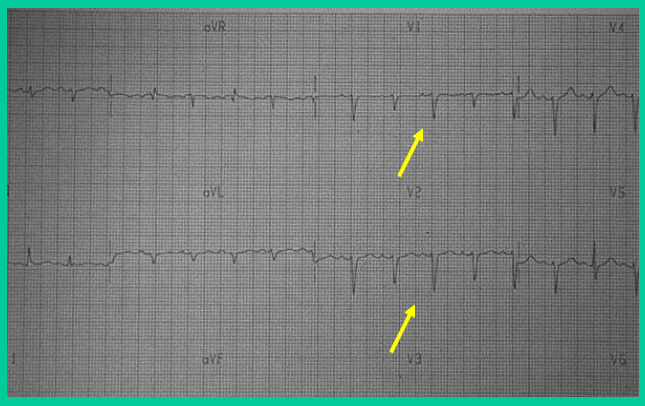
Initial Assessment and Stabilization continued

- **Cardiac tamponade continued**
  - S&S
    - Elevated CVP (>15 cm H_2O) (JVD, narrow pulse pressure, elevated diastolic pressure)
    - Beck's triad (10%-40% of cases)
      - Hypotension, muffled heart tones, JVD
    - Pericardial knock (early diastolic click from blood entering a non-distensible ventricle)
    - Kussmaul's sign (increased JVD with inspiration)
    - Pulsus paradoxus
    - Electrical alternans
    - Bradycardia, ST and T wave changes
    - PEA (potentially reversible)



Initial Assessment and Stabilization continued

- **Cardiac tamponade continued**
  - S&S
    - Electrical alternans



Initial Assessment and Stabilization continued

- **Cardiac tamponade continued**
  - Treatment
    - Airway and ventilatory management
    - Rapid infusion of IV crystalloid fluid
    - Pericardiocentesis
    - Dobutamine as temporizing measure

Initial Assessment and Stabilization continued

- **Myocardial rupture**
  - Acute perforation of the ventricles, atria, intraventricular septum, intra-atrial septum, chordae, papillary muscles, or valves.
  - Almost universally and immediately fatal and accounts for 15% of fatal chest injuries
  - Overall incidence from blunt chest trauma is 0.5% to 2%
  - Most commonly results from MVC, but forces need not be that high
  - Ventricles more prone during diastole or early systole when they are maximally distended with blood
  - In contrast, the atria are more prone during late systole

Initial Assessment and Stabilization continued

- **Myocardial rupture continued**
  - S&S
    - Most patients present with either tamponade or hemorrhage
    - If there is also a rent in the pericardial sac, the patient promptly exsanguinates
    - If there is no pericardial rent, tamponade develops which may be protective
    - Harsh, holosystolic murmur with septal defects

Initial Assessment and Stabilization continued

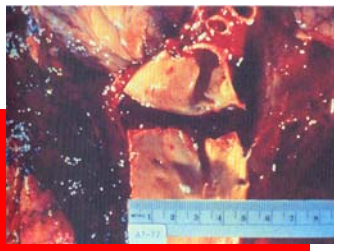
- **Arrhythmias**
  - Injured heart tissue can be electrically unstable
  - Arrhythmias include unexplained sinus tachycardia, PVC, atrial fibrillation, AV blocks, ventricular tachycardia, and ventricular fibrillation
  - Arrhythmias should be treated according to ACLS protocols
  - Commotio Cordis

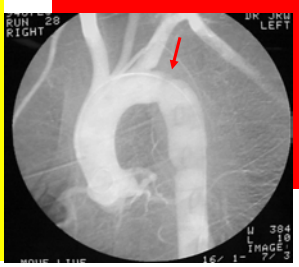
Continued Assessment

- **The continued assessment should identify or lead the paramedic to suspect potentially life-threatening injuries that were not obviously apparent during the initial assessment.**

Continued Assessment continued

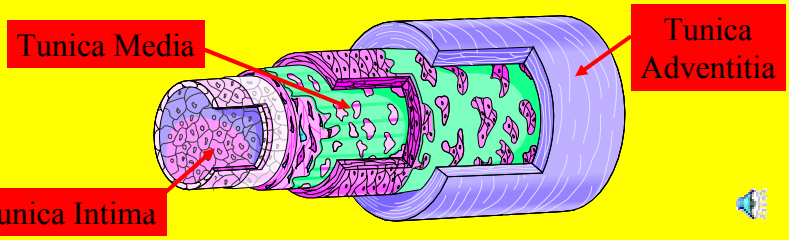
- **Aortic disruption**
  - Typically the result of shearing forces sustained during MVC or fall from great height
  - If the tear is complete, the patient promptly exsanguinates into the left pleural cavity (occurs in 80%-90% of patients with injuries to the great vessels)
  - If the tear is partial, patient salvage is possible if the diagnosis is made promptly followed by surgical intervention
  - Shearing of the aorta across the ligamentum arteriosum is the typical MOI, although acute lengthening of the aorta during falls has been implicated
  - The most common site of rupture is the descending aorta at the isthmus





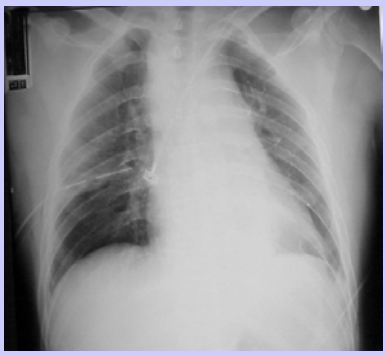
Continued Assessment continued

- **Aortic disruption continued**
  - Dissecting aneurysms may dissect down to the coronary arteries, resulting in myocardial ischemia
  - The injury is often occult, with no sign of chest trauma in 50% of cases
  - Suspicion based on MOI is essential for survival



Continued Assessment continued

- **Aortic disruption continued**
  - S&S
    - Chest wall trauma
    - Upper extremity hypertension
    - Lower extremity paralysis
    - Cardiac irritability
    - Asymmetry of blood pressures in the upper extremities
    - Compression of the esophagus or left recurrent laryngeal nerve, resulting in dysphagia, hoarseness, stridor, or dyspnea
    - Harsh, holosystolic murmur located over the precordium or posterior interscapular area
    - Hypotension

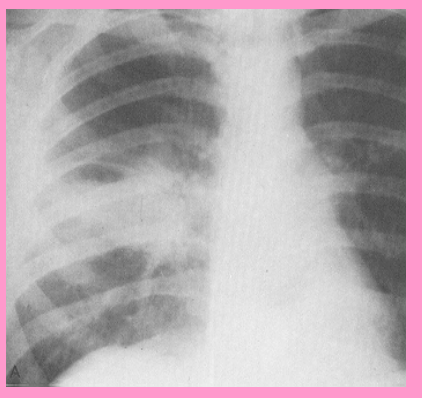


Continued Assessment continued

- **Aortic disruption continued**
  - S&S continued
    - Occasionally, swelling of the base of the neck or a pulsatile neck mass may appear
    - Definitive diagnosis requires angiography
  - Treatment
    - 100% oxygenation
    - Cautious hydration
    - Careful transport
    - Avoid overhydration as this causes shear forces
    - Maintaining systolic pressure between 100 mm Hg and 120 mm Hg with nitroprusside or beta blockers may be necessary to minimize the shearing effect

Continued Assessment continued

- **Pulmonary contusion**
  - Most common potentially lethal chest injury
  - 30% - 70% incidence among blunt chest trauma patients
  - MVC most common MOI
  - 87% of patients with pulmonary contusion have at least one other associated chest injury
  - Flail chest is almost invariably associated with a pulmonary contusion
  - The mortality rate is between 14% and 20%
  - Pulmonary interstitial edema and capillary leakage of blood into the alveoli can result after contusion.



Continued Assessment continued

- **Pulmonary contusion continued**
  - Increased pulmonary fluid decreases lung compliance and prevents adequate gas exchange
  - S&S
    - Respiratory symptoms ranging from asymptomatic to frank respiratory failure
    - Tachypnea and dyspnea
    - Tachycardia
    - Hemoptysis
    - Chest pain
    - Cough
    - Bloody mucous secretions
    - Rales or rhonchi
    - Signs and symptoms of hypoxia

Continued Assessment continued

- **Pulmonary contusion continued**
  - Treatment
    - Ensure adequate ventilation and oxygenation
    - Intubate if unable to maintain PaO_2 of at least 60 mm Hg on 50% oxygen
    - Intubate if PaO_2/FiO_2 ratio is less than 300 (normal 500)
    - Judicious fluid administration
    - Bronchial toilet through tracheal suction, analgesia for chest wall pain, and chest physiotherapy
    - If ventilatory assistance is needed, IMV mode with PEEP
    - Patients who develop frank failure do poorly, therefore intubation and PPV should be initiated at first signs of respiratory distress

Continued Assessment continued

- **Myocardial concussion and contusion**
  - Myocardial concussion describes a sharp blow to the chest, resulting in a brief dysrhythmia, hypotension, or loss of consciousness, without histologic evidence of cellular injury
  - Myocardial contusion produces cellular injury with extravasation of erythrocytes into the muscle wall, along with necrotic areas of myocardial fibers, focal myocardial edema, interstitial hemorrhage, and subendocardial hemorrhage. Damage may include the conduction system or coronary arteries.
  - The significance of the injury depends on the extent of injury and the underlying health of the patient.

Continued Assessment continued

- **Myocardial concussion and contusion continued**
  - MVC most common cause and should be suspected in any MVC of 20 mph or greater
  - 20% of patients with steering wheel impacts sustain myocardial contusion, of which 16% are fatal
  - The clinical significance is related to associated injuries such as dysrhythmias, valvular lesions, cardiac output, CHF, ventricular aneurysm, coronary artery laceration, cardiac rupture, traumatic myocardial infarction, and constrictive pericarditis.
  - Without complications, there is complete recovery with minimal scarring in 3 to 6 weeks.

Continued Assessment continued

- **Myocardial concussion and contusion continued**
  - S&S
    - 25% will not have external signs of injury
    - Symptoms may be minor, transient, masked by other injuries, or totally absent
    - Sinus tachycardia is present in 70% of patients though it lacks specificity
    - Cardiac examination is usually normal but may reveal a friction rub or the murmur of valvular damage, septal rupture, of papillary muscle dysfunction
    - Chest pain, when present, is usually retrosternal, non-pleuritic, and anginal in character
    - Chest pain will be relieved by oxygen but not nitroglycerin

Continued Assessment continued

- **Myocardial concussion and contusion continued**
  - S&S continued
    - ECG changes include ST-T wave changes, bundle branch blocks, first and second degree heart block, IVC, sinus bradycardia, and prolonged QT interval, sinus tachycardia, PAC, PVC, atrial fib, and VT
    - Blows to the right chest result in atrial dysrhythmia, SA block, and AV block, owing to the position of the heart within the chest
    - Blows to the left chest result in predominantly ventricular dysrhythmias and BBB
    - ECG lacks sensitivity because right ventricle most commonly injured, but left ventricle is more massive and produces most of the ECG voltage potentials

Continued Assessment continued

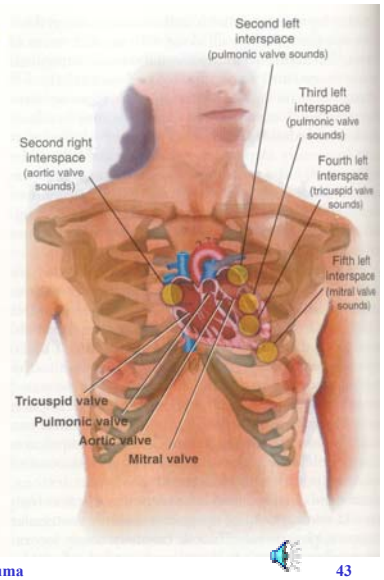
- **Myocardial concussion and contusion continued**
  - S&S continued
    - Serum enzymes (SGOT, LDH, and CPK) are usually elevated, but may be the result of trauma to the liver, brain, lung, or skeletal muscle
    - CK-MB will usually be markedly elevated and are more accurate
  - Treatment
    - ABCs
    - Oxygen
    - Continuous ECG monitoring
    - Manage dysrhythmias according to ACLS protocols
    - Judicious fluid administration if depressed C.O. due to contusion and, if ineffective, dobutamine
    - Use pressor agents cautiously

Continued Assessment continued

- **Valvular injury**
  - Unknown incidence
  - May involve chordae tendinea, leaflets, or papillary muscles
  - Mortality depends on valve involved
  - Most commonly affected valve is aortic followed by mitral
  - Complete rupture of aortic or mitral valve is usually fatal
  - Incomplete rupture of aortic valve produces a loud, harsh diastolic murmur heard at the right parasternal border of the second ICS, with frank left heart failure and cardiogenic shock. Thrills and murmurs of aortic insufficiency not appreciated in low output states.

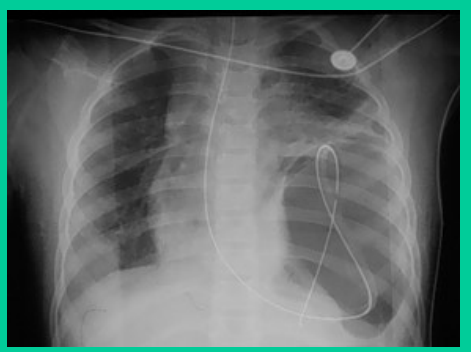
Continued Assessment continued

- **Valvular injury continued**
  - Mitral valve or papillary muscle ruptures are usually fatal within a few days if not repaired
  - Mitral injuries poorly tolerated due to high pressures of the left ventricle
  - S&S of mitral valve injury include pulmonary edema, harsh apical systolic murmur, S3 and S4 heart sounds, thrill at the apex, JVD, tachycardia, cardiogenic shock, cardiac arrest
  - Tricuspid valve rarely involved in blunt trauma and is usually well tolerated unless there is pre-existing pulmonary hypertension.
  - S&S of tricuspid injury is usually unremarkable and may reveal only a diastolic murmur and prominent jugular venous pulsations
  - Treatment is generally supportive with medical management of CHF and cardiogenic shock



Continued Assessment continued

- **Traumatic diaphragmatic rupture (TDH)**
  - Incidence of 1% - 3% in patients with blunt chest trauma; Usually the result of MVC
  - 53% of TDH are the result of penetrating trauma
  - TDH is 9 times more likely to occur on the left
  - Co-morbidity is very high
  - Mortality rate ranges between 17% - 28% and is related to the severity of the co-morbidity
  - Once a tear is created in the diaphragm, the positive pressure gradient between intraperitoneal and intrapleural pressure during inspiration encourages herniation of abdominal contents through the defect
  - The organs most often herniated through the diaphragm include the colon, spleen, stomach, and omentum

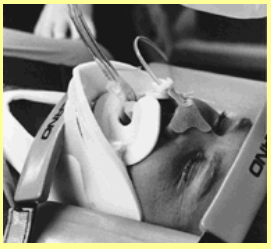


Continued Assessment continued

- **TDH continued**
  - Initial S&S
    - Often masked by other injuries
    - Mediastinal shift with decreased C.O.
    - Herniation into the pericardial sac with tamponade
    - Chest pain with radiation to the left shoulder
    - Respiratory distress
    - Cough and hiccough
    - Abdominal pain and scaphoid abdomen
    - Bowel sounds in the chest or paralytic ileus

Continued Assessment continued

- **TDH continued**
  - Initial S&S continued
    - Tension gastrothorax or viscerothorax
  - Treatment
    - Suspicion and MOI
    - ABCs
    - PPV negates intraperitoneal and intrapleural pressure gradient
    - NG tube
    - IV fluids
    - No PASG
    - Risk of lacerating abdominal viscera with needle decompression
    - Definitive treatment is surgical repair



Continued Assessment continued

- **Tracheobronchial disruption**
  - Rare injury that is often fatal
  - 3% incidence among patients with chest trauma
  - 30% mortality with most dying within the first hour
  - Survivors usually have cervical tracheal injury; Survival from lower tracheal injuries is rare
  - Associated with esophageal injury
  - Results from shearing, crushing, or “paper bag syndrome”
  - 80% of tears are within 2 cm of the carina
  - Because of the forces required to produce these injuries, patients usually succumb to other associated injuries

Continued Assessment continued

- **Tracheobronchial disruption continued**
  - S&S
    - Dyspnea
    - Cough and hemoptysis
    - Subcutaneous emphysema
    - Sternal tenderness
    - Hoarseness
    - Hamman’s sign (crunching sound during systole)
    - Mediastinal and/or cervical emphysema
    - Pneumothorax (distal mainstem bronchi and smaller airway injuries)
    - Injury to smaller airways may result in a persistent air leak

Continued Assessment continued

- **Tracheobronchial disruption continued**
  - Treatment
    - ABCs
    - Avoid intubation if possible to allow for endoscopy
    - If intubation is necessary, try to pass the balloon beyond the injury
    - Persistent air leak may require intubation of the uninvolved bronchus
    - Needle decompression and chest tube if needed
    - Definitive treatment is surgical repair

Continued Assessment continued

- **Simple pneumothorax/pneumomediastinum**
  - Most common cause is lacerated lung parenchyma
  - “Paper bag” syndrome
  - Patients with pre-existing asthma or COPD are prone to pneumothorax
  - Defect is usually in the apex in a partial pneumothorax
- **S&S**
  - Presentation varies with size of the defect
  - Pleuritic chest pain
  - Dyspnea
  - Decreased or absent breath sounds on the affected side
  - Hyper-resonance
  - Subcutaneous emphysema and/or Hamman’s sign

Continued Assessment continued

- **Simple pneumothorax/pneumomediastinum continued**
  - Treatment
    - ABC's
    - Oxygen
    - PPV exacerbates pneumothorax and may result in tension
    - Needle decompression and chest tube usually not required

Continued Assessment continued

- **Esophageal disruption**
  - 100% fatal when diagnosis is delayed
  - 30% mortality rate with prompt diagnosis and treatment
  - Incidence of 5% - 10% and usually the result of penetrating trauma
  - Cervical esophagus more commonly injured than the tracheal esophagus
  - Esophageal injuries secondary to blunt trauma are almost always cervical and usually associated with tracheal or laryngeal trauma
  - Disruption can occur from blunt trauma if gastric contents are rapidly forced up the esophagus
  - High mortality results from gastric contents entering the mediastinum and pleural space, forming an empyema

Continued Assessment continued

- **Esophageal disruption**
  - S&S
    - Symptoms are subtle, vague, and frequently missed
    - Pleuritic chest pain with radiation to the neck or shoulders
    - Pain along the course of the esophagus that is exacerbated by swallowing or neck flexion
    - Heart-burn type pain over epigastrium
    - Fever
    - Pneumothorax
    - Abdominal pain
    - Dyspnea
    - Dysphagia
    - Change in voice pitch
    - Subcutaneous emphysema, mediastinal air, Hamman's crunch

Continued Assessment continued

- **Esophageal disruption continued**
  - Supportive care
  - ABC's
  - NPO
  - NG tube
  - IV fluids and broad-spectrum antibiotic
  - Frequently accompanied by pneumothorax and hemothorax

Continued Assessment continued

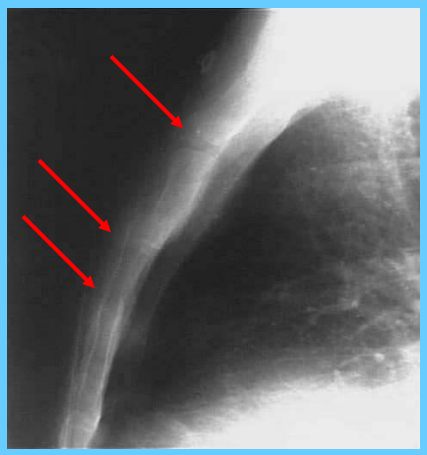
- **Traumatic asphyxia**
  - Sudden crushing of the chest causes retrograde blood flow from the right heart into the veins of the head and neck
  - Large veins of the head and neck lack valves allowing the neck and facial capillaries to become engorged with blood
  - Patients present with facial and upper extremity cyanosis, edema, swollen tongue, subconjunctival hemorrhage or petechiae, and vascular engorgement
  - Venous congestion results and cranial blood flow becomes sluggish
  - Transient hypoxia, seizures, cerebral edema and CVA may result
  - Intracranial hemorrhage is rare
  - Treatment is supportive and prognosis is good in the absence of other injuries

Continued Assessment continued

- **Chest wall injuries**
  - Soft tissue injuries
    - Bleeding can be significant
    - Avoid probing
    - Occlusive dressing if open pneumothorax
  - Bony injuries
    - Clavicular fractures are generally benign, but may injure adjacent subclavian vessels and brachial plexus
    - Claviculosternal dislocations frequently associated with manubrial fracture that may be displaced posteriorly injuring the trachea or innominate vessels
    - Scapular fractures are the result of large forces and may be associated with thoracic trauma

Continued Assessment continued

- **Chest wall injuries continued**
  - Bony injuries continued
    - Sternal fractures usually the result of steering wheel strikes
    - Most common sites of fracture are transversely throughout the sternal body and at the sternomanubrial junction
    - Frequently associated with flail segments and myocardial contusion
    - Sternal fracture easily identified by palpable "step-off"
    - Treatment generally supportive but should be alert for associated injuries



Continued Assessment continued

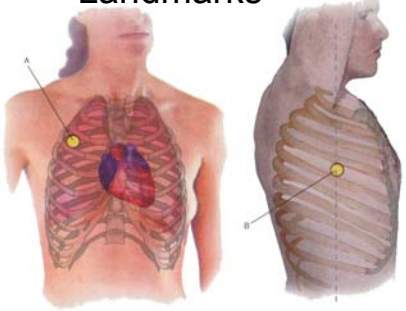
- **Chest wall injuries continued**
  - Bony injuries continued
    - Rib fractures are the most common injuries of the thoracic cage
    - 4th through 9th ribs most commonly involved
    - Ribs 1 - 3 are relatively protected and ribs 9 - 12 are relatively mobile at the anterior end
    - Isolated rib fractures are usually benign but may rarely cause pneumothorax or hemothorax
    - Pain, point tenderness, crepitus, echymosis, palpable discontinuity and deformity may be present
    - Only 50% of rib fractures are identified on x-ray
    - Treatment is generally supportive with attention to pain control and pulmonary toilet

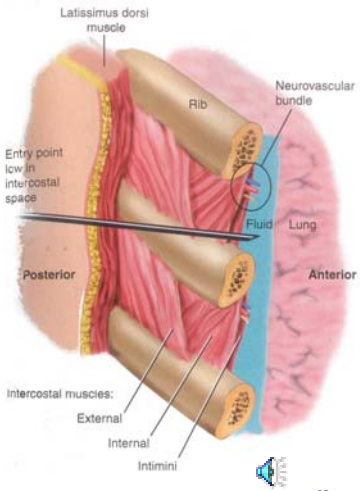
Continued Assessment continued

- **Chest wall injuries continued**
  - Bony injuries continued
    - Multiple rib fractures occur most commonly in ribs 4-9 from anteroposterior compression
    - Fractures of 2 or more ribs associated with internal injuries
    - Fractures of ribs 9, 10, 11 suggest an associated intra-abdominal injury
    - Fractures of ribs 1 and 2 are associated with myocardial contusion, tracheobronchial disruption, major vascular injury and head injury

Procedures

- **Needle thoracentesis**
  - Landmarks





Procedures

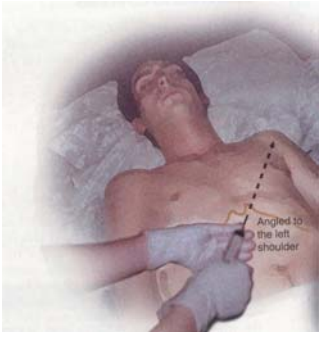
- **Needle thoracentesis**
  - Equipment

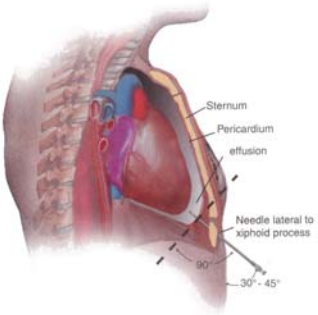
Procedures

- **Needle thoracentesis**
  - Water seal

Procedures

- **Pericardiocentesis**
  - Landmarks





Procedures

- **Pericardiocentesis**
  - Current of Injury Pattern