

# THORACIC TRAUMA

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# Thoracic trauma

## Definition

Chest trauma or (thoracic trauma ) is a serious injury of the chest and it is consider a significant cause of mortality.

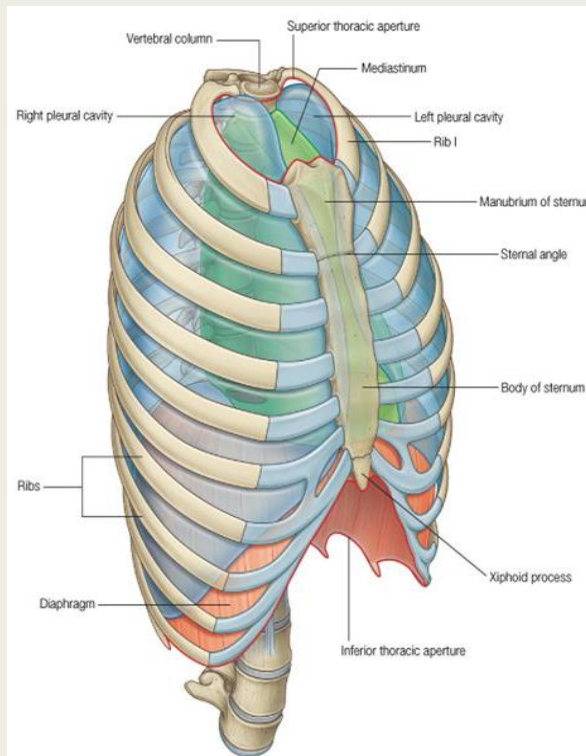
## Epidemiology

-25% of traumatic deaths are secondary to injuries to the thorax & 25% of all motor vehicle driver deaths are known to have a thoracic injury

-In patients presenting with penetrating trauma, 40% have a thoracic injury, whereas with blunt trauma, 33% have a thoracic injury

-Over 70% of thoracic injuries result from blunt trauma, and most occur in automobile accidents

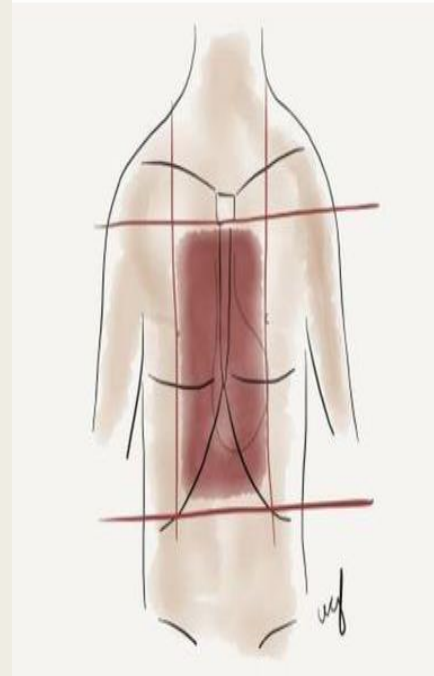
# Thoracic wall



The most common isolated mediastinal injury in blunt trauma is an **injury to the aorta**

In penetrating trauma all the mediastinal structures are equally susceptible

# Cardiac Box



- Superior = angle of Louis (sternomanubrial junction)
- Lateral = mid clavicular/nipple line
- Inferior = line drawn across the costal margin at the level of the mid clavicular line

Trauma in this region is associated with an increased risk of penetrating cardiac injury and the development of **cardiac tamponade** and rapid clinical decompensation.

# Types of Chest injury

## ■ Blunt Chest injury ( closed chest injury )

- Eg. RTA, Fall, Crush injury
- Associated with multiple injuries such as head, limb, abdomen



## ■ Penetrating Chest injury ( open chest injury)

- Mostly by assault
- Associated with chest wall damage, open pneumothorax, and organ injury



## Ventilation vs. Oxygenation

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- Ventilation is the movement of gas into and out of the lungs and does not necessarily provide oxygenation.

(e.g. a patient with no heart beat or circulatory support is not being oxygenated by simply blowing oxygen into their lungs.)

- Oxygenation is the delivery of oxygen to the blood and tissue level of the patient and does not necessarily require ventilation.

(e.g. a patient on heart-lung bypass is being oxygenated without any ventilation of the lungs)

# Primary survey

Is a systemic, rapid evaluation of the injured patient following the **ABCDE** system.

The goal : identify immediate, life-threatening injuries that could account for ventilation or hemodynamic instabilities such as :

**Tension pneumothorax, Massive Hemothorax, Flial chest**

**A**irway with c-spine protection

**B**reathing and ventilation

**C**irculation with hemorrhage control

**D**isability: Neuro status

**E**xposure / Environmental control

# Secondary survey

## The complete H&P

- Head to toe exam including rectal
- ABCDE reassessed
- Vital functions returning to normal
- Diagnostic studies simultaneously

## Patient History

## Physical examination

# Breathing interventions

Ventilate with 100% oxygen

Needle decompression tension pneumothorax

Chest tubes for pneumothorax / hemothorax

Occlusive dressing to sucking chest Wound



# Circulation

The goal of this portion of the primary survey is to identify and treat the presence of shock

Hypovolemic shock is the most common type of shock seen in trauma patients most commonly secondary to acute blood loss

	Class I	Class II	Class III	Class IV
Blood Loss	<750cc	750-1500	1500-2000	>2000
% Blood Vol	<15%	15-30%	30-40%	>40%
Pulse	<100	>100	>120	>140
BP	nl	nl	↓	↓
Pulse Pres.	nl	↓	↓	↓
RR	14-20	20-30	30-40	>35
UOP	>30cc/hr	20-30	5-15	negligible
CNS	nl	anxious	confused	lethargic
Fluid Choice	crystalloid	crystalloid	crystalloid & blood	crystalloid & blood

## Classical physical examination findings :

The size of the injury, and position of the patient will affect the clinical findings. For example, a small haemothorax may have no clinical signs at all. A moderate haemothorax will be dull to percussion with absent breath sounds at the bases in the erect patient, whereas signs will be posterior in the supine patient. This is also reflected in chest X-ray findings

	Trachea	Expansion	Breath Sounds	Percussion
<b>Tension Pneumothorax</b>	Away	Decreased. Chest may be fixed in hyper-expansion	Diminished or absent	Hyper-resonant
<b>Simple Pneumothorax</b>	Midline	Decreased	May be diminished	May be hyper-resonant. Usually normal
<b>Haemothorax</b>	Midline	Decreased	Diminished if large. Normal if small	Dull, especially posteriorly
<b>Pulmonary Contusion</b>	Midline	Normal	Normal. May have crackles	Normal
<b>Lung collapse</b>	Towards	Decreased	May be reduced	Normal



# Timing

The timing of intervention is oft debated but essentially takes place in one of three time periods mainly dictated by the patient's physiologic status upon arrival to the emergency room: immediate (emergency room thoracotomy), urgent (in the operating room, within 1–4 hours of arrival), and delayed (24 hours after admission) .

Once the need for intervention is apparent, the critical decision for an appropriate surgical approach is based on the location and nature of the

**Table 2**  
Thoracotomy in thoracic trauma

Thoracotomy	Immediate	Urgent	Delayed
Setting	Emergency room: upon arrival and assessment	Operating room: within 1–4 h	Operating room: > 24 h
Injury	Patients in extremis after penetrating chest injury	Cardiac, lung esophagus, tracheobronchial, great vessel injuries, aortic rupture	Retained hemothorax, posttraumatic empyema, delayed tracheobronchial injuries, intracardiac injuries

# Investigations

**Chest Radiography** : A systematic review of the film should reveal suspected and unsuspected injuries, and the presence of any foreign bodies. Fractures of the bony thorax, the mediastinum :widening, or shifting tracheobronchial or esophageal injuries

**Computerized tomography (CT)** it may reveal injuries not seen clearly on plain radiographs, It may be useful to screen all patients with blunt trauma CT of the chest has been shown to be more sensitive than plain radiography in detecting thoracic injuries such as pulmonary contusions, hemothorax, and pneumothorax.

## Ultrasonography

The focused assessment for the sonographic evaluation of the trauma patient, or FAST examination, four standard viewing ports are used to quickly access for abnormal fluid collection: right upper quadrant, left upper quadrant, pelvis, and subxiphoid.

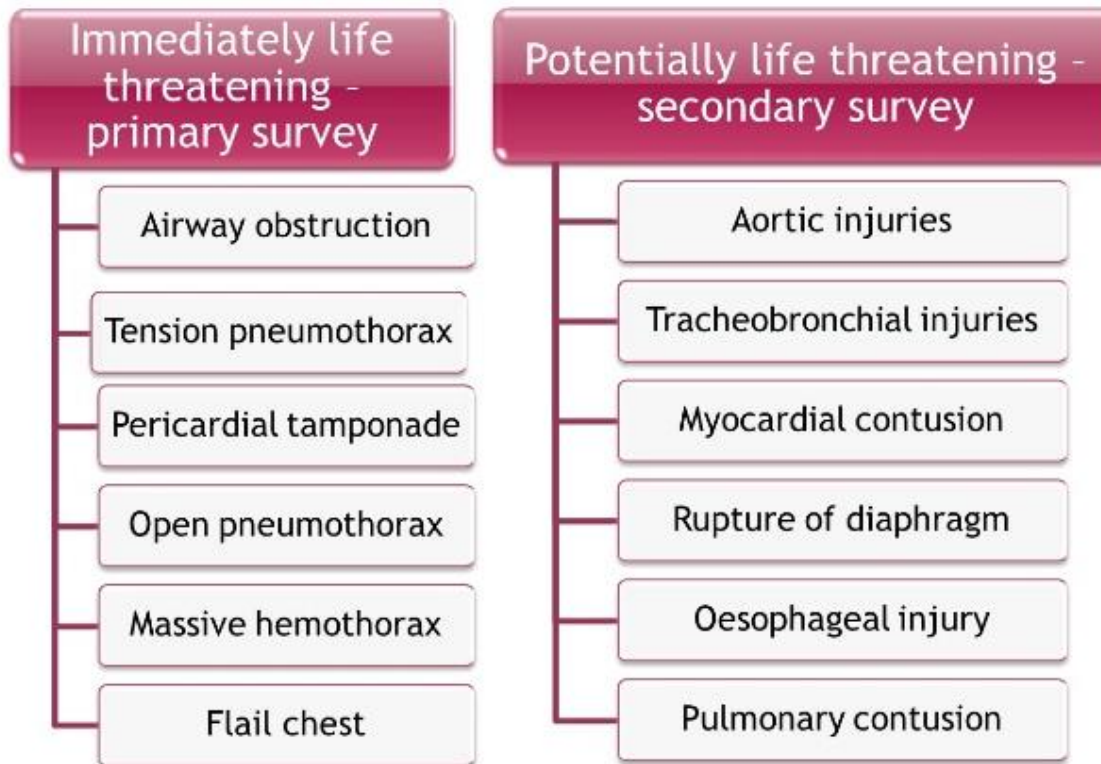
Of the four views, the subxiphoid view is the most accurate in the hands of surgeons for detecting abnormalities in the trauma setting.

## Echocardiography

Angiography Conventional angiography was once the gold standard in the diagnosis of aortic transection or injuries to the great vessels.

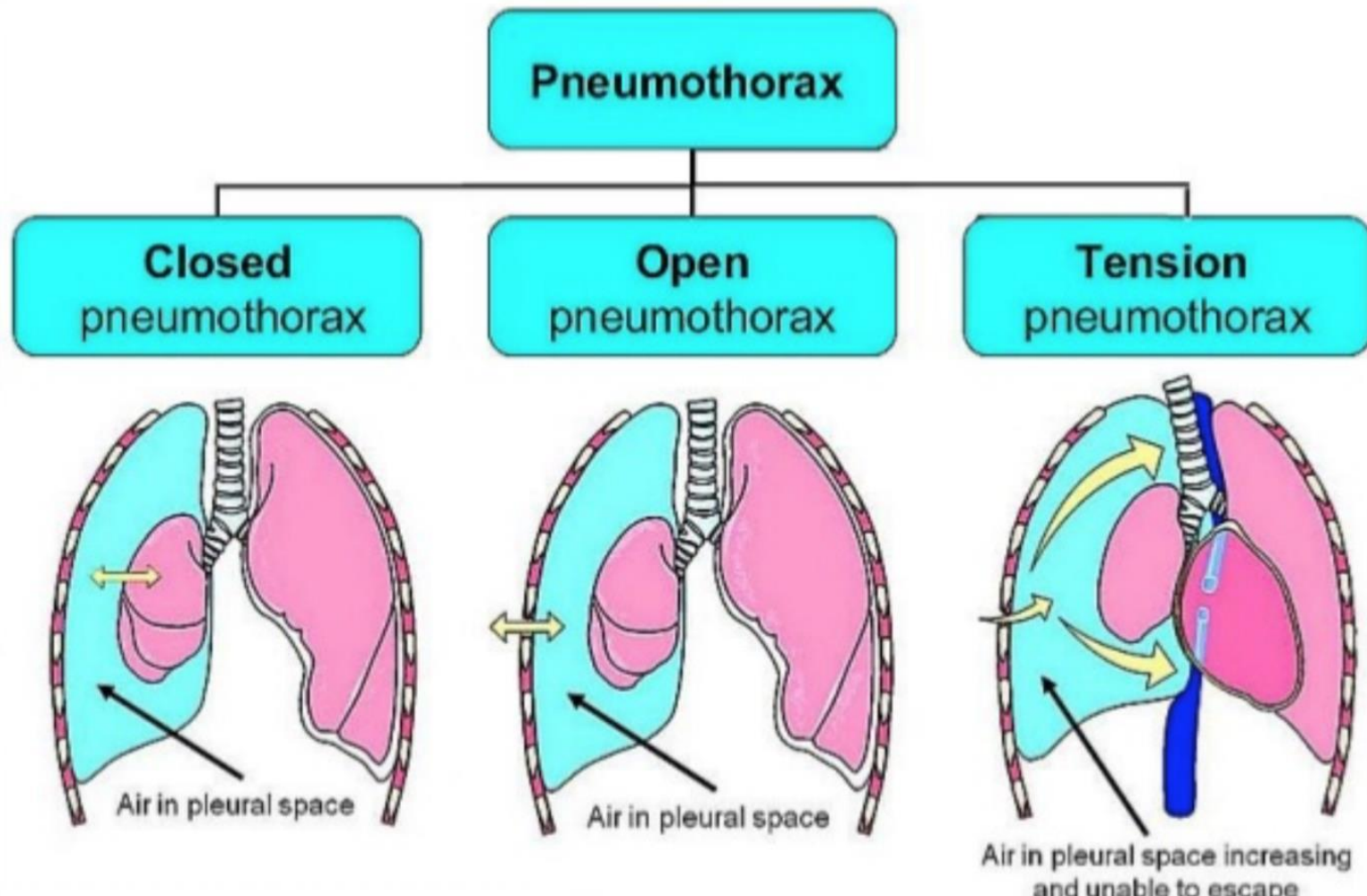
# Classification

## “DEADLY DOZEN” Threats to life from chest injury



# Pneumothorax

an abnormal collection of air in the pleural space between the lung and the chest wall



# Simple pneumothorax (closed)

is a non-expanding collection of air around the lung. The lung is collapsed, to a variable extent

**Diagnosis** on physical examination may be very difficult.

The classical signs of reduced air entry and resonance to percussion are often difficult or impossible to appreciate.

Careful palpation of the chest wall and apices may reveal subcutaneous emphysema and rib fractures as the only sign of an underlying pneumothorax.

# Open Pneumothorx

Sucking chest wounds in communication with a defect in the chest wall

## Pathophysiology

lung collapse and atelectasis (collapse of alveoli) which decreases gas exchange and Ventilation/Perfusion Mismatch  
→ hypoxia

Symptoms include dyspnea, tachypnea and chest pain

Signs hyperresonance to percussion and decreased breath sounds

## Management

Chest tube is inserted away from the wound site  
+ Dressing over the wound

# Tension Pneumothorax

**an Immediately fatal condition** in which an accumulation of air under pressure in the pleural space in which the defect in the visceral pleura acts like a one-way valve, allowing air to enter the pleural space but not to exit from it, causing collapse of the ipsilateral lung, mediastinal and tracheal shift and compression of the contralateral lung and great vessels, resulting in decreased cardiac filling(preload), decreased cardiac output, fatal hypotension and severe respiratory compromise  
**( totally collapse ,, severe dysfunction of CVS )**

**Findings** may include:

dyspnea, agitation, cyanosis, tachypnea,  
subcutaneous emphysema,  
hypotension(and Hypovolemia)→ tachycardia,

Increased jugular venous pressure

absent breath sounds

hyperresonance

tracheal shift to the uninvolved side and

increased resistance to ventilation

**a clinical diagnosis and treatment should never be  
delayed by waiting for radiological confirmation**



# Management

**needle**

**decompression**

5cm angiocatheter

2<sup>nd</sup> intercostal space at the  
mid clavicular line



**Insertion of a chest tube**

through the fifth intercostal space in the  
anterior axillary line.

24–28 French chest tube is placed for  
pneumothoraces,



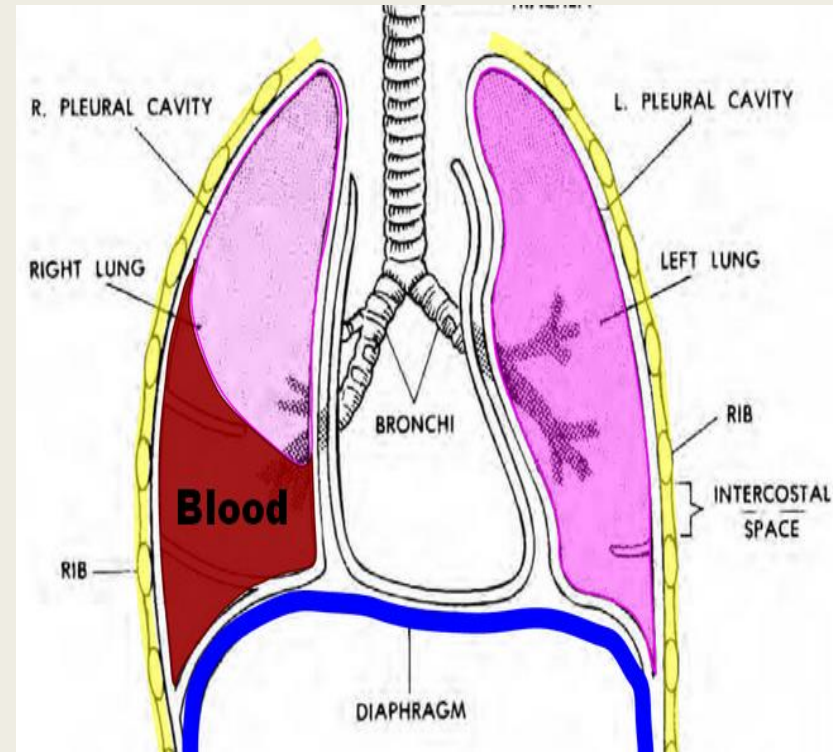
# Hemothorax

**Accumulation of blood in the pleural space** caused by injury to:

- 1- Pulmonary parenchyma or hilar vessels
- 2- intercostal vessels or internal thoracic vessels
- 3- great vessels with an opening in the pleura
- 4- heart with a communicating defect in the pericardium and pleura

Typically accompanies pneumothorax

– **Hemopneumothorax**



Each thorax may hold up to 3,000 mL

Considered **Massive Hemothorax** when blood loss is **greater than 1500** mL into the chest cavity or **persistent >200** cc of blood via chest tube per hour \*4 hours  
\* is a serious condition with mortality rate **of 75%**

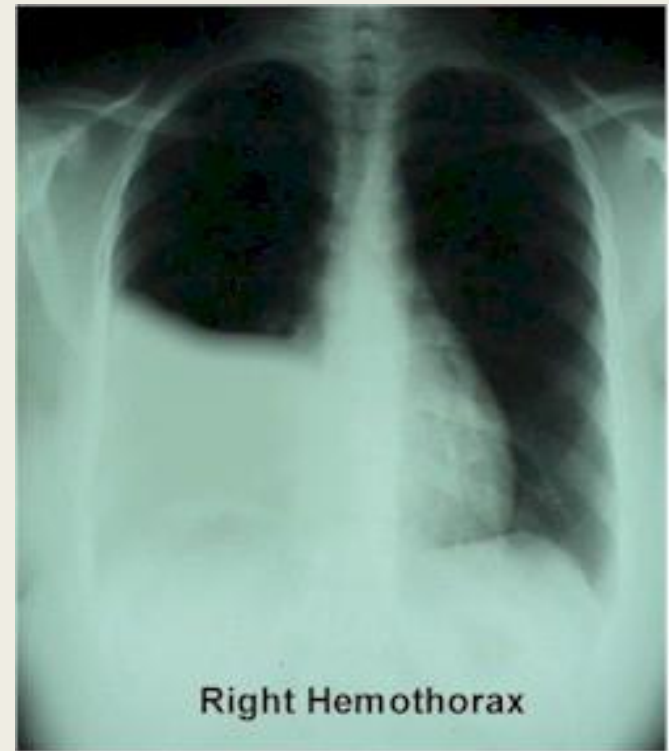
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-Accumulation of blood in a hemothorax can significantly **compromise respiratory efforts**, compressing the lung and preventing adequate ventilation in addition to hemorrhagic shock.

-Lung parenchymal **bleeding usually ceases spontaneously** as a result of the low pressure in the pulmonary vessels, the compressive effect of the shed blood in a closed space, and a high concentration of thromboplastin in the lung

-Bleeding from any of the major vessels or an intercostal artery or from the internal thoracic arteries, however, may require prompt operative intervention

Blunting of the costophrenic angles on an upright chest radiograph when more than 250 mL of blood is lost



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## Presentation :

### haemorrhagic shock

Hypotension / Tachycardia / Dyspnea / Tachypnea  
flat neck veins / unilateral absence of breath sounds  
dullness to percussion

# Treatment

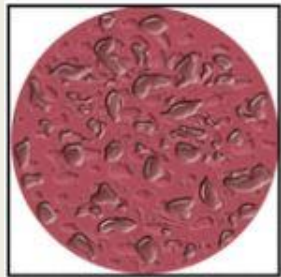
consists of:

- ✓ correcting the hypovolemic shock
- ✓ insertion of an intercostal drain, chest tube is placed for hemothoraces
- ✓ in some cases, intubation;
- ✓ urgent thoracotomy if

Initial blood loss through the chest tube of 1500 mL

Or Ongoing blood loss of approximately 250 mL per hour for 3 consecutive hours after its placement

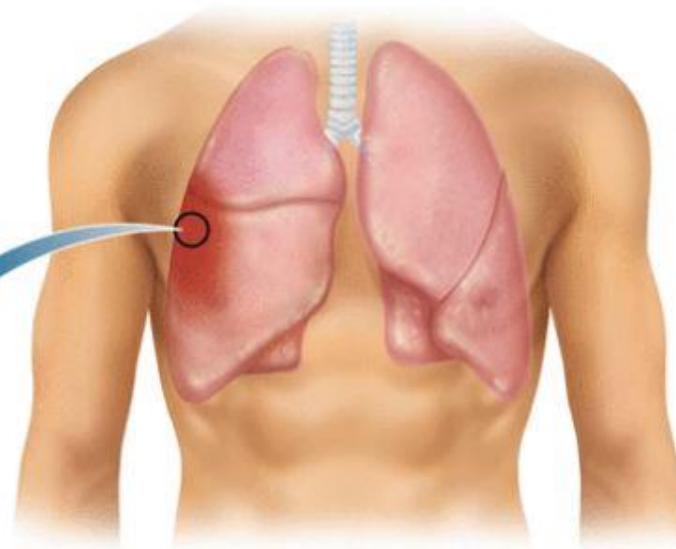
# Pulmonary Contusion



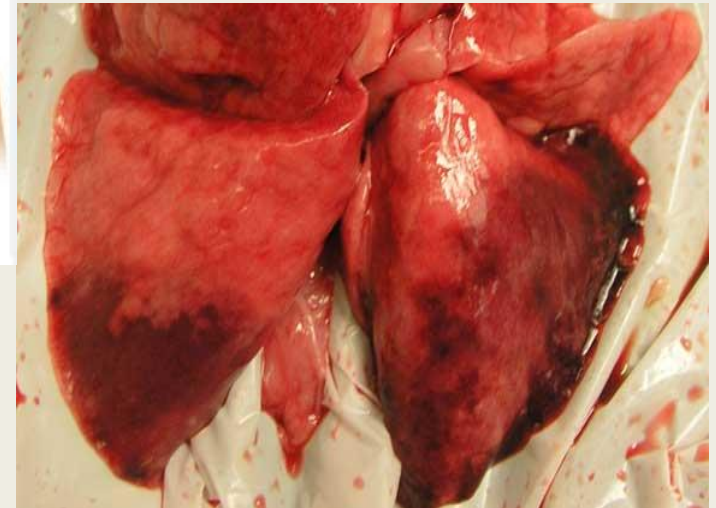
Normal lung tissue



Pulmonary contusion



Pulmonary contusion



# Pulmonary Contusion

Is an injury to lung parenchyma, leading to edema and blood collecting in alveolar spaces and loss of normal lung structure and function and the presence of gross bruises and ecchymosis

- Any chest trauma can lead to pulmonary contusions
- May not be evident initially on examination but develops in post traumatic period
- The most common potentially **lethal** chest injury.
- pulmonary **contusion and ribs fracture** are the most common injury in blunt chest trauma

Patients may present with :

chest-wall bruising

Hemoptysis

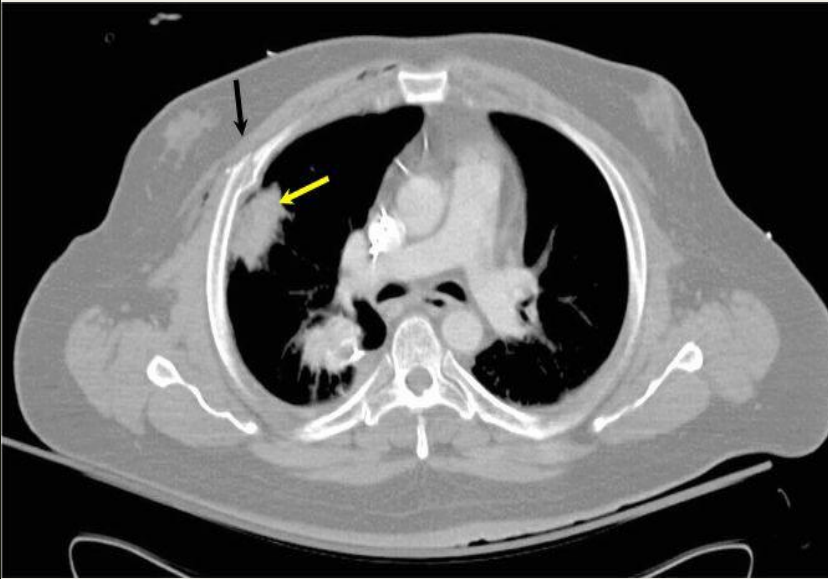
hypoxia ,tachypnea ,dyspnea, tachycardia,

Pain on breathing →Hypoventilation

The natural progression of pulmonary contusion is worsening **hypoxemia** for the first 24–48 hour

**Hemoptysis** or blood in the endotracheal tube is a sign of pulmonary contusion.





**CT** is the study of choice and has been found to be more sensitive than radiography in detecting a pulmonary contusion

**Contrast CT** scanning can be confirmatory.



The **chest radiography** findings are typically delayed  
If abnormalities are seen on **the admission** chest radiograph, the pulmonary contusion is **severe**.  
**Opacifications** (focal or diffused) may be seen immediately on chest radiograph and always within 6 hours. If opacifications persist on the chest radiograph for longer than 48 hours, pulmonary laceration should be suspected.

patients with pulmonary contusions are at a high risk of respiratory insufficiency and adult respiratory distress syndrome (**ARDS**)

and **secondary pneumonia** because of the parenchymal damage and large **systemic inflammatory response** that accompanies this injury

The mortality rate from an isolated pulmonary contusion is low, but when combined with other severe injuries, it rises to as high as 50%.

Clinical factors predisposing to mortality after a pulmonary contusion include patient age, resuscitation volume, and severity of the pulmonary parenchymal injury .

# Treatment

## oxygen administration

aggressive pulmonary hygiene

## adequate analgesia

In more severe cases, **mechanical ventilation** is necessary.

By standard ATLS protocol, patients with significant hypoxia

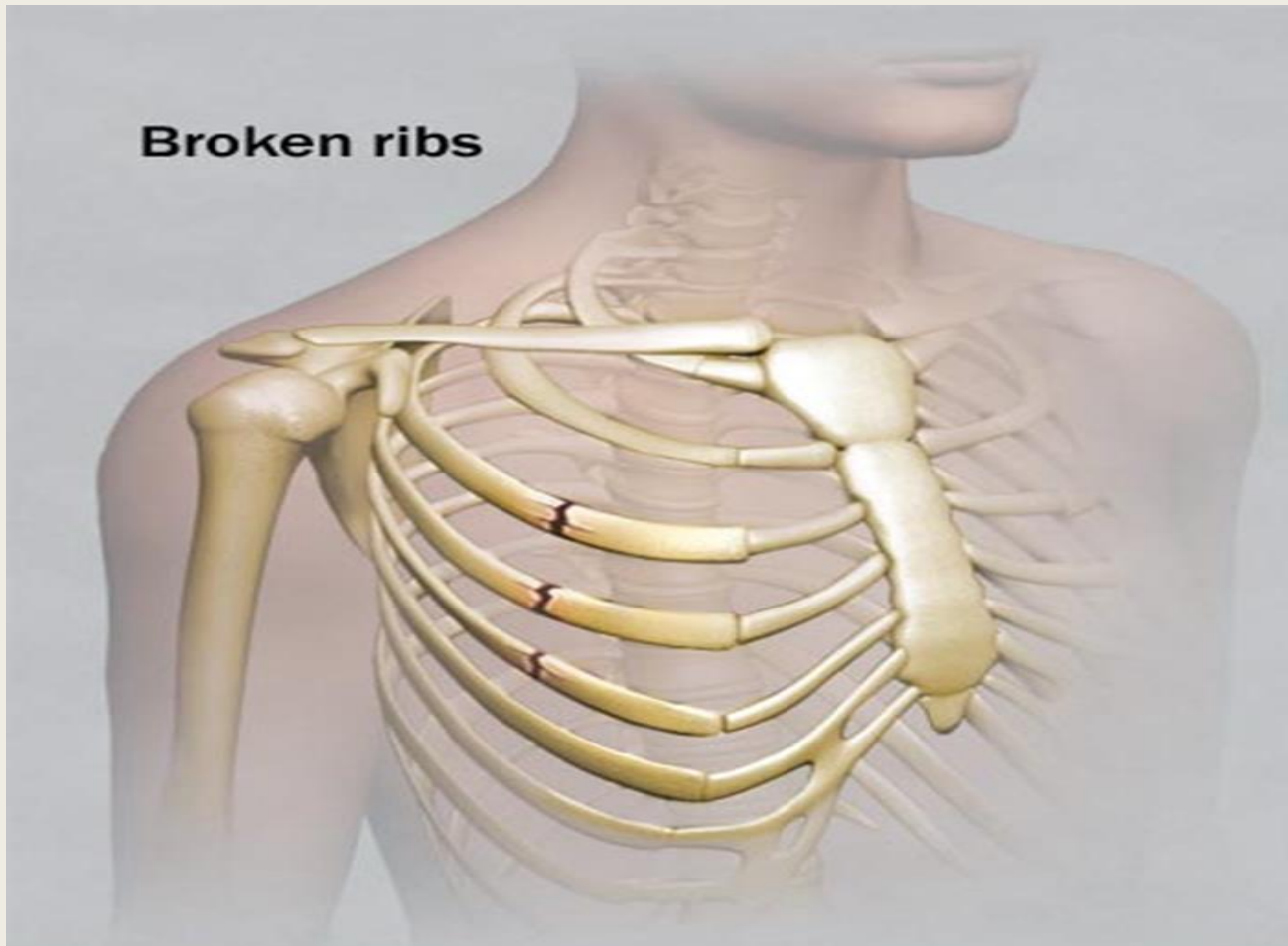
( $P_{aO_2} < 65$  mm Hg,  $S_{aO_2} < 90\%$ ) should be intubated and ventilated

within 1 hour after injury

Although we should be careful **not to overload these patients with fluids** (to avoid pulmonary edema), establishment of normovolaemia is critical.

If large volumes of fluid are necessary for resuscitation of associated extrathoracic injuries, a **pulmonary artery catheter should be placed**

# Rib fractures



**Rib fractures** are the most frequent injuries after TT, and they are considered an important indicator of severity, as they reflect a great quantity of energy absorbed by the chest wall.

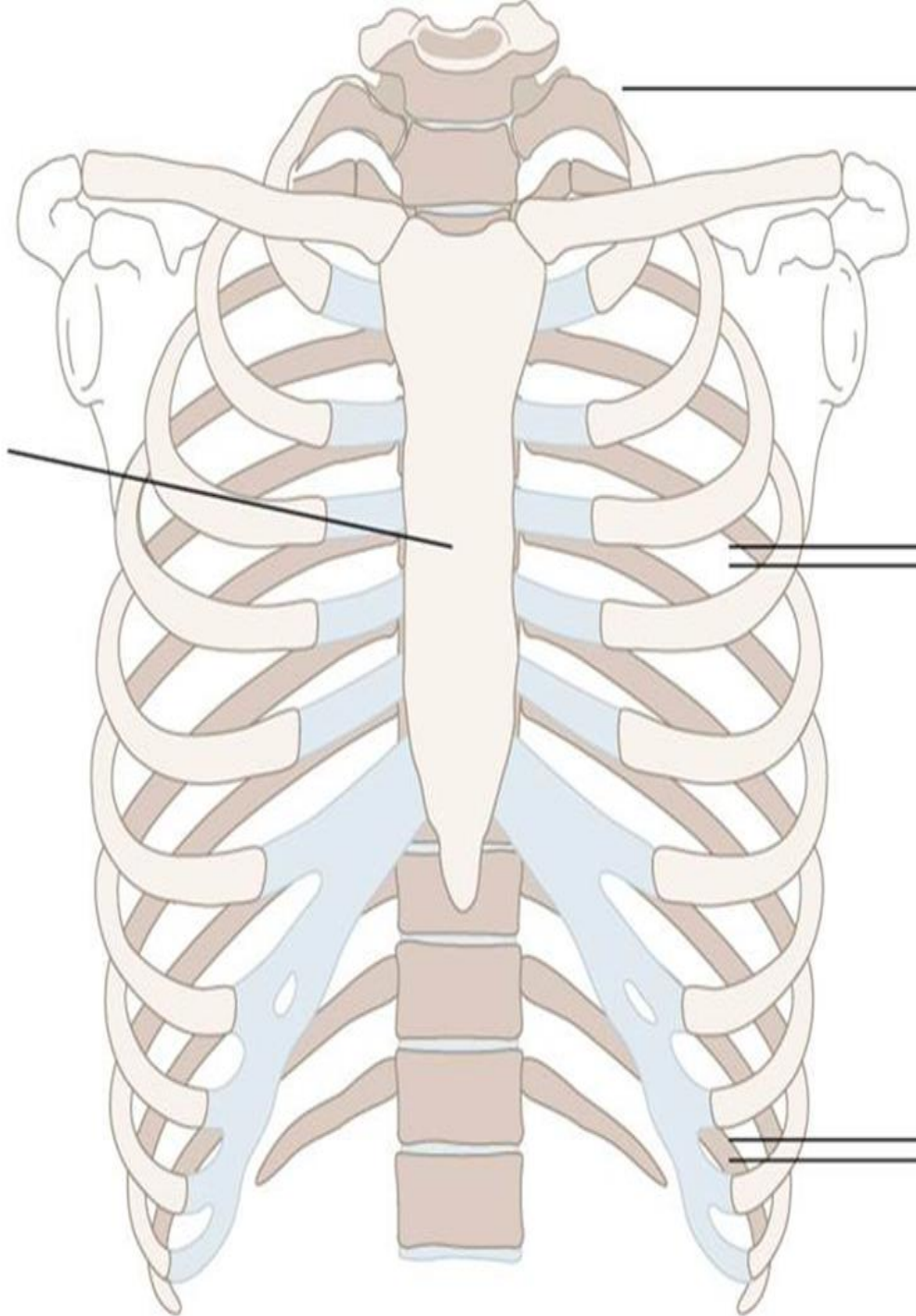
\*Most often caused by **blunt trauma**

\*More common in **adults** than children , Especially common in elderly.

\*Elderly patients and those with poor pulmonary reserve are at the highest risk.

\*All rib fractures should have associated **pneumothorax ruled out.**

Great force is required for sternal fractures.



Ribs 1–3 are well protected by shoulder bones and muscles.

Possible underlying lung injury

Ribs 4–9 are most frequently fractured.

Possible risk of puncturing the liver or spleen

Ribs 10–12 are relatively mobile and fracture less frequently.

Three determinant factors :

**1) Age** : A moderate TT in a senior can cause multiple fractures, and comorbidities increase with age, especially those of respiratory origin.

**2) Number of ribs injured** :With 3 RF or more, the associated extra thoracic lesions, the rate of complications and mortality increase significantly, therefore this number of lesions is considered an indicator for hospitalization

Elderly with 3 or more rib # to have a 5-fold increased mortality rate and a 4-fold increased incidence of pneumonia.

**3) Underlying pulmonary status.**

Immobilization of the chest wall impairs pulmonary toilet and increases the risk of atelectasis, compromised gas exchange, and eventually pneumonia to occur.

\*\* So multiple rib fracture can cause :

Atelectasis / Hypoventilation / Inadequate cough / Pneumonia

Associated **complications** of rib fractures :

- rupture of the aorta
- tracheobronchial tree injury
- vascular injury

The **Diagnosis** is often difficult

On physical examination  
occasionally identified by  
localized tenderness  
swelling, and hematoma  
formation over the fractured site





## Assessment findings :

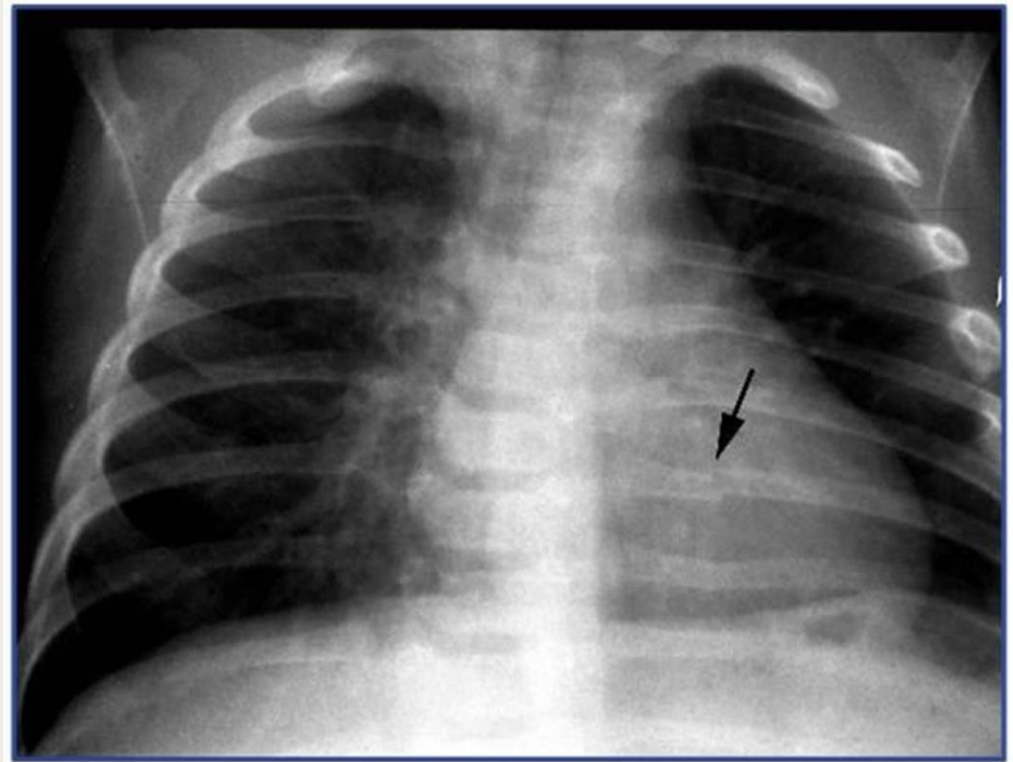
1. Localized pain
2. Increases on palpation or when patient: Coughs , Moves , Breathes deeply
3. Splinted Respirations
4. Point tenderness , most patients can localize the fracture by pointing to the area (confirmed by palpation) .
5. Crepitus or audible crunch

**Radiologic diagnosis** of isolated RF is done by simple chest radiograph.

The current availability of **CT** has promoted its routine use in patients with severe TT, as it has been demonstrated to be superior in the diagnosis of associated lesions and in the evolution of the RF themselves.

### **X-ray**

- confirm the diagnosis
- detects associated conditions :  
pneumothorax , hemothorax



## Indications for admission :

-Unable to cough and clear secretions adequately.

-Underlying pulmonary disease (COPD) .

-Age  $\geq 65$  years (high incidence of hypoventilation, hypercapnia, atelectasis, and pneumonia)

-Associations :

hemothorax, pneumothorax, 3 or more unilateral rib fractures, or pulmonary contusion.

-First and second rib fracture

\*Any rib fracture mandates a search for other injuries and are primarily of concern because of the structures that the ribs cover.

\*Consider obtaining urinalysis in cases of lower rib fractures, as hematuria may indicate associated renal injury

# Management

## Airway and ventilation

- High concentration oxygen
- Positive pressure ventilation
- Encourage coughing and deep breathing

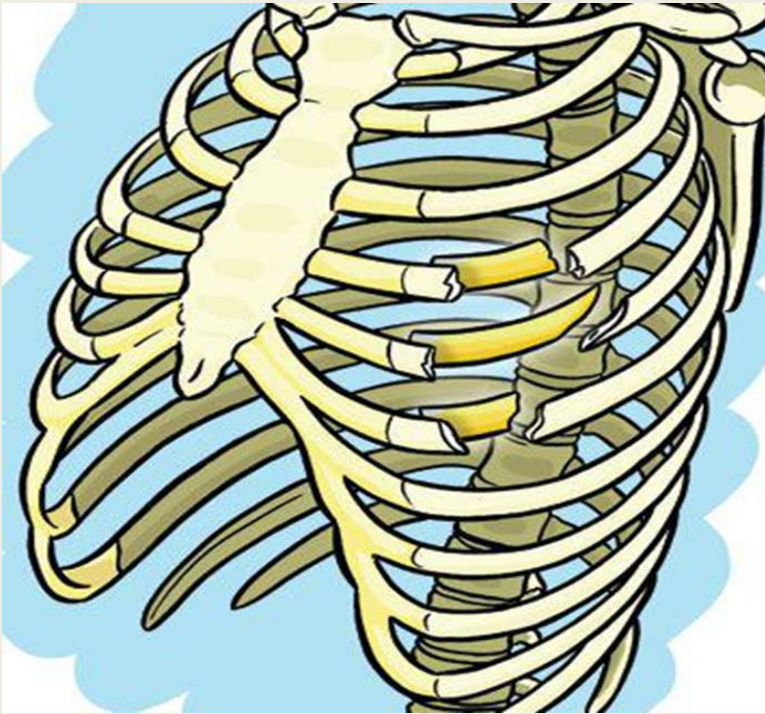
## pharmacological

Analgesics

## Non pharmacological

Non-circumferential splinting

# Flail chest



In flail chest , **three or more** ribs are involved in segmental fractures .

\*A segment of the rib cage breaks and becomes separated or detached from the chest wall.

\*The fractured segment will sink into the chest with inspiration and expand out of the chest wall with expiration opposite to the normal chest wall mechanics .

\*The fractured segment goes in while the rest of the chest goes out and this is called paradoxical breathing

This condition usually results from **blunt trauma** associated with **multiple** ribs fractures, i.e. three or more ribs fractured in two or more places.

The blunt force required to disrupt the integrity of the thoracic cage typically produces an underlying pulmonary contusion as well.

The **diagnosis** is made **clinically**, not by radiography.

- \*There may be a pulmonary contusion associated with the flail chest fracture segment

- \* The pulmonary contusion could be more significant than the flail segment .

- \*There may also be a noticeable chest wall deformity with presence of air in the subcutaneous tissue (crepitus)

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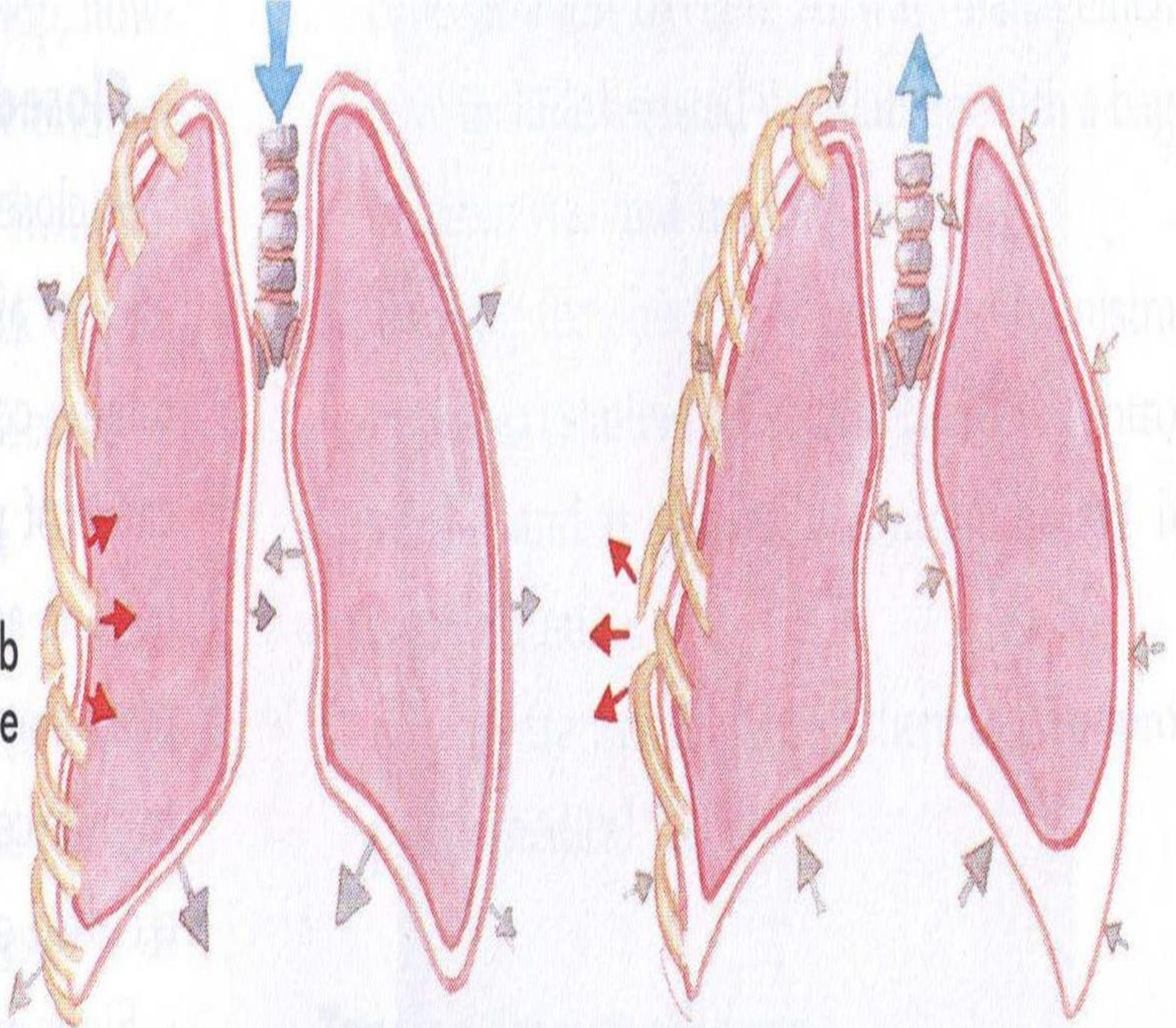
# Symptoms

- \*Patient will have chest pain and shortness of breath
- \*Paradoxical movement of the flail segment
- \*The constant movement of the rib is really painful , the broken rib may puncture the lung and cause pneumothorax

To confirm the diagnosis the chest wall can be observed for paradoxical motion of a chest wall segment for several respiratory cycles and during coughing.

Voluntary splinting as a result of pain, mechanically impaired chest wall movement and the associated lung contusion are all causes of the hypoxia.

Rib fracture





# Images

It is difficult to see if the fractures are displaced or nondisplaced

CT scan is probably better for visualizing these fractures

# Management

- Intubation

- Positive pressure ventilation

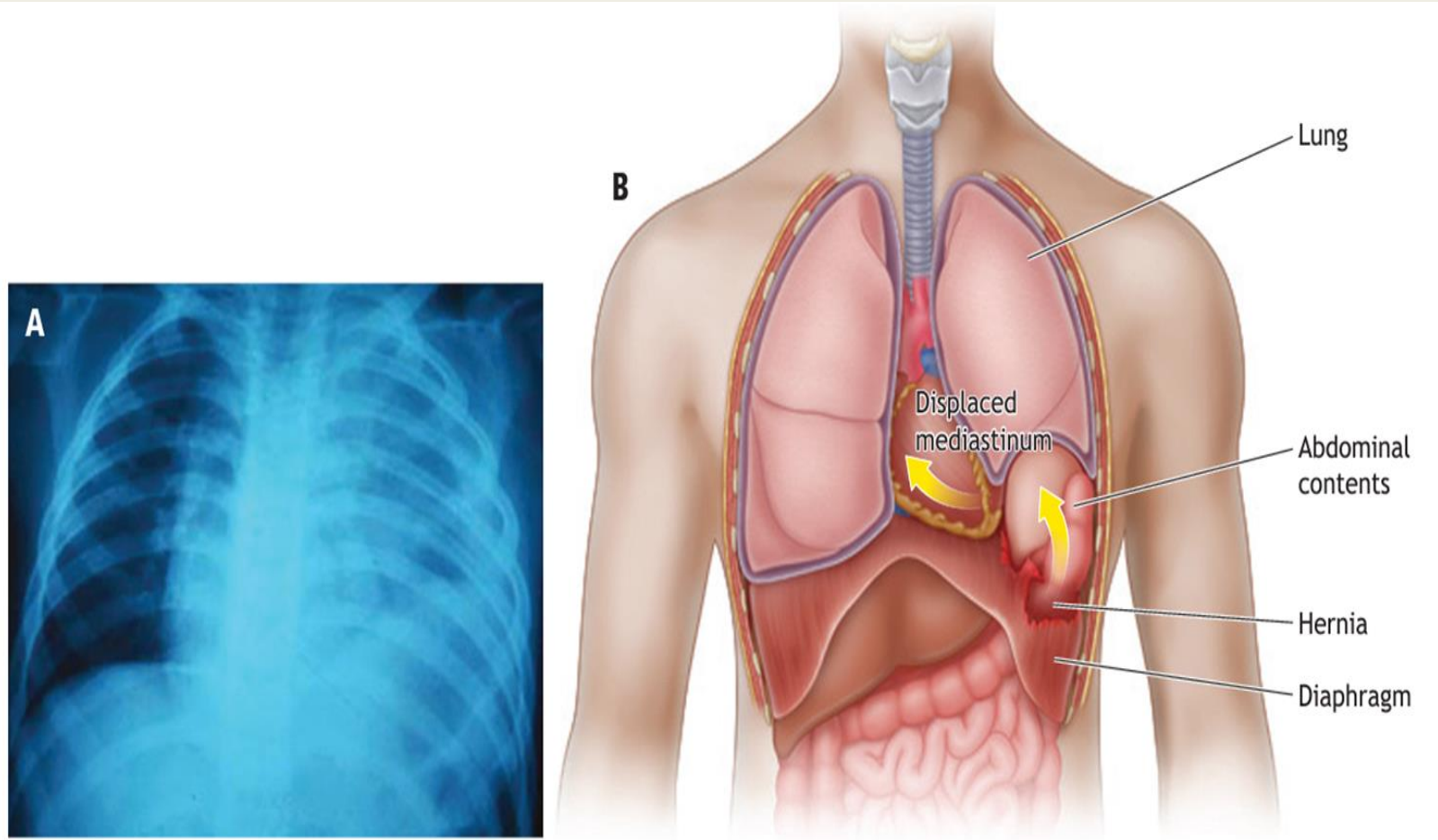
- Conservative therapy with emphasis on pain relief with thoracic epidural analgesia is the mainstay of therapy in most centers. In a minority of cases, however, patients require chest wall stabilization

# Bulky Dressing for splint of Flail Chest



- Use Trauma bandage and Triangular Bandages to splint ribs.

# Diaphragmatic Rupture



■ **FIGURE 4-10** Diaphragmatic Rupture. (A) Radiograph view. (B) Blunt trauma produces large radial tears that lead to herniation, whereas penetrating trauma produces small perforations that can take time, sometimes even years, to develop into diaphragmatic hernias.

## Definition

**A tear in the Diaphragm that allows the abdominal organs enter the chest cavity**

- \* More common on Left side due to liver helps protect the right side of diaphragm
- \* Associated with multiple injury patients
- \* Blunt > Penetrating
- \* These injuries do not heal spontaneously and can produce herniation ,so need operative repair when diagnosed

## Signs & Symptoms

Decreased breath sounds on side of rupture

Bowel sounds heard in the chest cavity

Breathlessness (dyspnea)

Abdominal pain

**Diagnosis** can be difficult; therefore, have a high index of suspicion based on mechanism :

Rapid deceleration or direct crush to the upper abdomen

Severe chest trauma, lower rib fractures

Penetrating injuries to the chest and upper abdomen

\***CXR** is diagnostic in only 25% to 50% of cases of blunt trauma.

Possible findings include:

Hemi diaphragmatic elevation.

Stomach, colon, or small bowel in chest.

\***CT** scan may miss diaphragmatic injury in the absence of gross hollow visceral herniation.

\***Direct visualization** of the injury by laparotomy, laparoscopy, or thoracoscopy remains the gold standard for diagnosis.



# The Diaphragm

A small injury to the diaphragm may go undiagnosed initially and present years later as a diaphragmatic hernia.

**Diaphragmatic hernias** classically present in one of three phases:

**1. Acute phase:** Occurs shortly after injury with signs and symptoms related to the intra-thoracic and intra-abdominal structures

**2. Interval phase:** Symptomatically silent for

days to years, during which time there is progressive herniation from the abdomen to the chest because of the differential pressure during the respiratory cycle

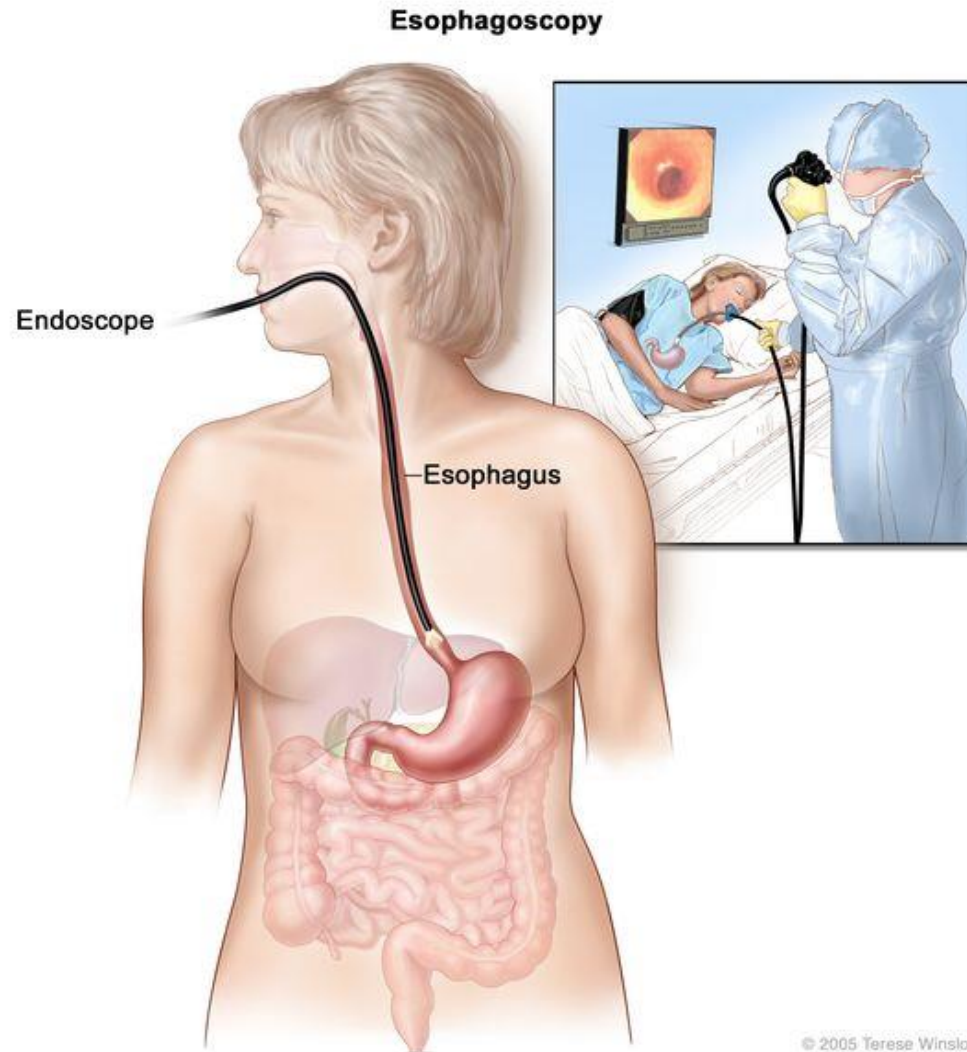
**3. Late phase:** Symptoms occur as a result of complications of herniated viscera, namely intestinal obstruction or gangrene in addition to respiratory or cardiac compression

# Management

- \*ABC's with c-spine control as indicated
- \*High Flow oxygen
- \*Treat Associated Injuries
- \*Definitive treatment is surgery



# Esophageal Injury



\*Most injuries to the esophagus as a result of **penetrating trauma** occur in the neck. thoracic and abdominal esophageal penetrating ! injuries to adjacent vital structures

\*Blunt injury to the esophagus is relatively rare, but can result in a rupture of the esophagus from anteroposterior compression against closed upper and lower esophageal sphincters, usually occurs at the level of the carina where the esophagus may be tethered by subcarinal lymph nodes

\*An injury to the esophagus can lead to **mediastinitis** if left untreated

\*An injury to the **cervical esophagus** typically drains into the deep cervical fascia, which is in continuity with the mediastinum

\*An injury to the **proximal two thirds** of the esophagus often drains into the right pleural space and results in a right-sided effusion. Conversely , injury to the distal third of the esophagus typically drains into the left pleural space.

\*Injury to the very **distal esophagus** may present as free intra-abdominal air, peritonitis, or as a sub phrenic abscess if diagnosis is delayed.

## On physical examination

\*Subcutaneous air and pleural effusions are the hallmarks of esophageal injury. As opposed to tracheobronchial injuries, which create a large amount of air in abnormal locations, the resultant air from an esophageal injury can be very subtle and a challenge to diagnose

\*Mediastinal emphysema may be appreciated on physical examination as a “crunch” with each heartbeat, known as Hamman’s sign

## Other diagnostic methods

Esophagoscopy

barium swallow

**Management** of these injuries can be difficult but primary repair is preferred when possible, although resection and diversion may be required



**THANK YOU**