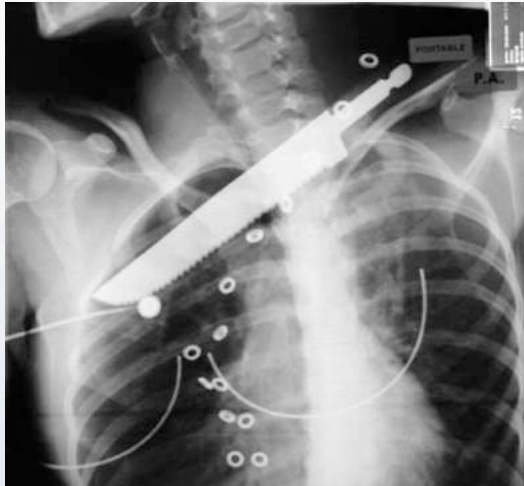


Blunt and penetrating injuries to the chest and abdomen

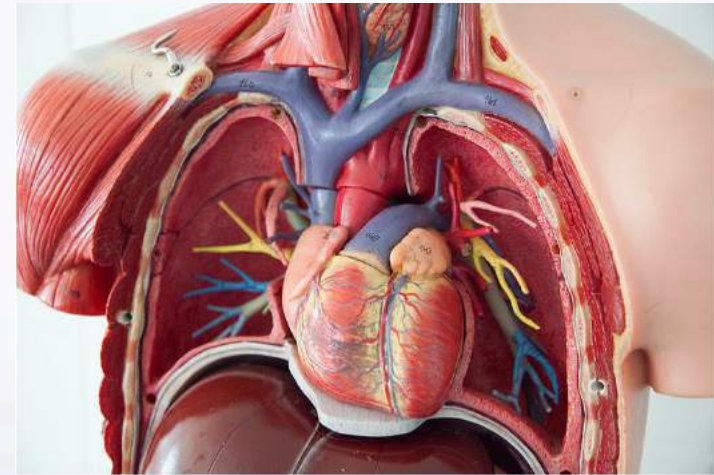


Sandor Mester

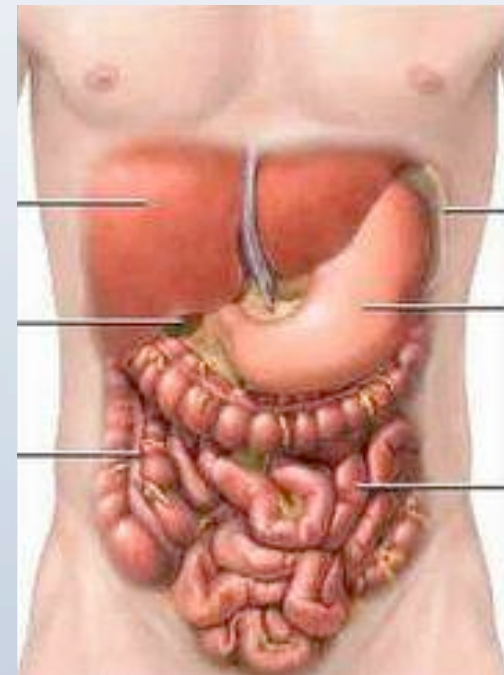


bony skeleton
ribs,
sternum

lungs and pleurae,
tracheobronchial tree,
esophagus,
heart,
great vessels of the chest,
diaphragm



spleen,
liver,
small bowel,
kidneys
bladder,
colorectum,
diaphragm,
pancreas



Broad range of injuries:

trivial contusion → life threatening emergencies

Blunt injuries ↔ Penetrating injuries



Pathophysiology - Etiology

Blunt – chest

Derangements in the flow of air, blood, or both in combination:

Chest-wall injuries (eg, rib fractures) → pain → difficult breathing → ventilatory compromise

Direct lung injuries (eg, pulmonary contusion) → shunting and dead-space ventilation → impaired oxygenation

Space-occupying lesions (eg, pneumothorax, hemothorax, and hemopneumothorax) → compression of otherwise healthy lung parenchyma → oxygenation and ventilation ↓

Tension pneumothorax mediastinal contents pushed toward the opposite hemithorax → distortion of SVC → decreased blood return to the heart, circulatory compromise, → shock

Significant cardiac injuries (eg, chamber rupture) or severe great vessel injuries (eg, thoracic aortic disruption): → exsanguination or loss of cardiac pump function, → hypovolemic or cardiogenic shock → death



Penetrating – chest

Eventually same pathologies as in blunt (e.g. PTX, HTX, etc.)

Blunt – abdomen

Deceleration (e.g. kidney)

Crushing (e.g. liver)

External compression (e.g. bowel)



Penetrating – abdomen

Depends on the causative factor
(e.g. GSW, knife)

and the organ affected (e.g.
solid, hollow, vessel)

Penetrating injuries

low,

impalement
(e.g. knife wounds)

only penetrating

medium,

bullet wounds from
handguns

penetrating + blast

high

velocity

rifles, military weapons
improvised explosive devices

penetrating, blast, and burn

GSW, urban violence (domestic violence), iatrogenic (DPL, tube thoracostomy)

Blunt injuries

MVAs : 70-80%, (Vehicles striking pedestrians,)

Falls

Acts of violence

Blast injuries

Industrial or recreational accidents



Workup

Laboratory Studies

complete blood count (CBC)
serum chemistries,
coagulation profile,
arterial blood gas (ABG)

serum amylase

serum troponin I

serum creatine kinase-MB

lactate

blood ethanol,

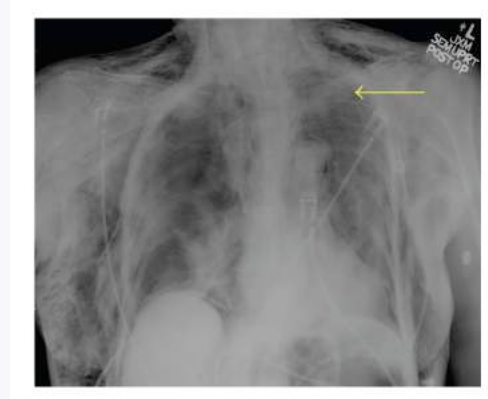
urine drug screens,

urine pregnancy test

type and crossmatch!!!



Plain and Contrast Radiography

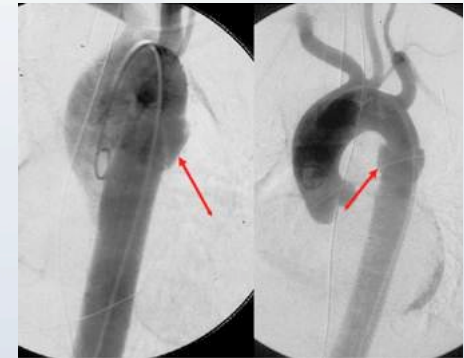


Chest radiography: chest x-ray (CXR)

initial radiographic study of choice except: tension pneumothorax

[Aortography ??? ⇔ spiral CT]

[Contrast esophagography: when esophagoscopy negative]



Computed Tomography

frequently performed (routine) in hemodynamically stable patient w/ significant trauma CT \approx 50 % pos in pts w/ neg CXR



Ultrasonography

Thoracic ultrasonography

Pericardial effusions or tamponade
Hemothorax

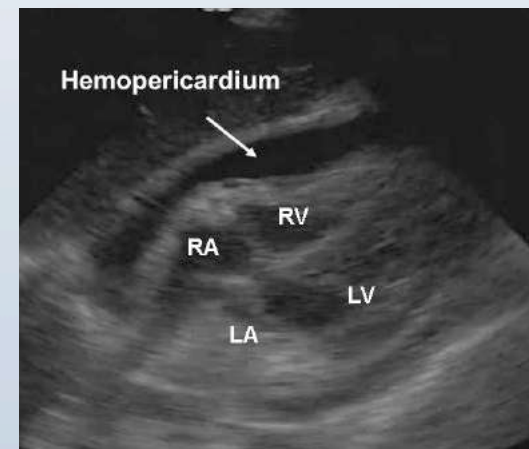
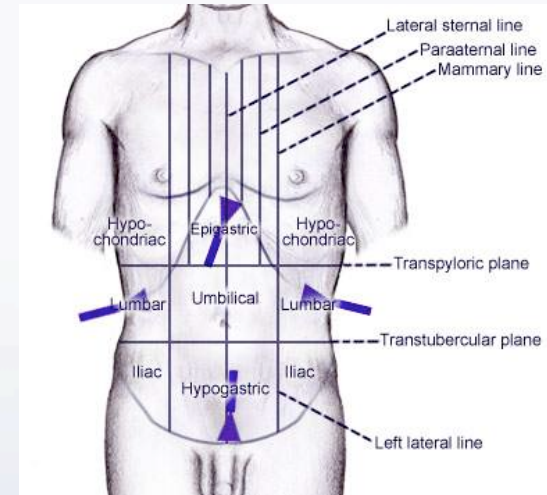
Focused assessment with sonography for trauma (FAST)
accurate, repeatable

Echocardiography

Transesophageal echocardiography (TEE)
blunt rupture of the thoracic aorta (93-96%)

Transthoracic echocardiography (TTE)
pericardial effusions and tamponade
valvular abnormalities
disturbances in cardiac wall motion

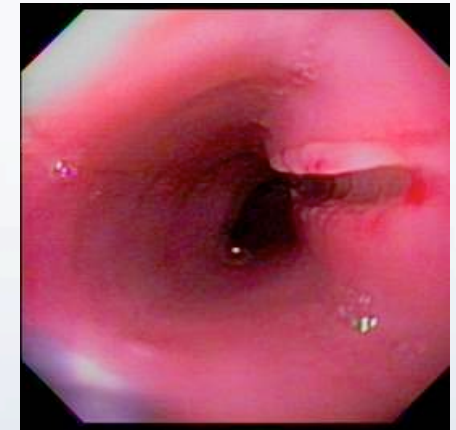
In cases of blunt myocardial injuries and abnormal ECG



Endoscopy

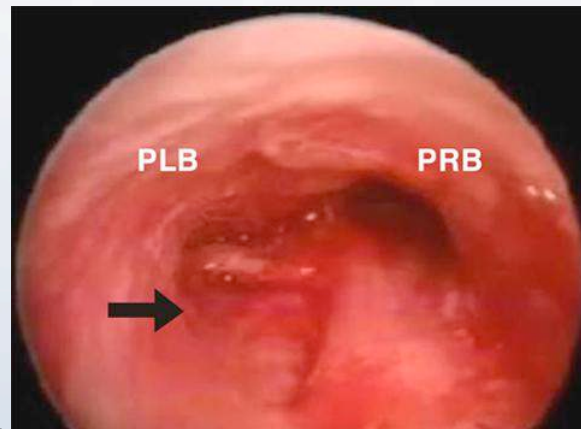
Esophagoscopy

initial diagnostic procedure of choice in patients with possible esophageal injuries



Bronchoscopy

in patients with possible tracheobronchial injuries

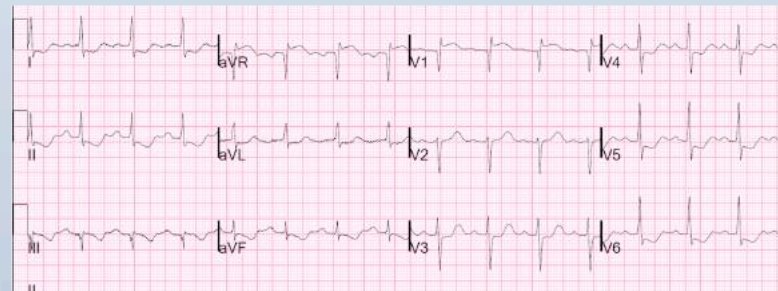


Electrocardiography

12-lead ECG: standard test to rule out blunt cardiac injuries

findings: tachyarrhythmias and conduction disturbances, such as first-degree heart block and bundle-branch blocks

Only w/ normal troponin I level !!!



(Diagnostic Laparoscopy)

major limitations; mostly in penetrating thoracoabdominal injuries



Diagnostic Peritoneal Lavage (DPL) (declining role)

In blunt abdominal trauma:

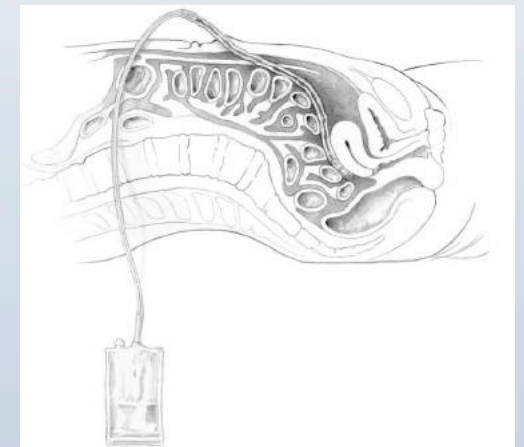
Patients with a spinal cord injury

Those with multiple injuries and unexplained shock

Obtunded patients with a possible abdominal injury

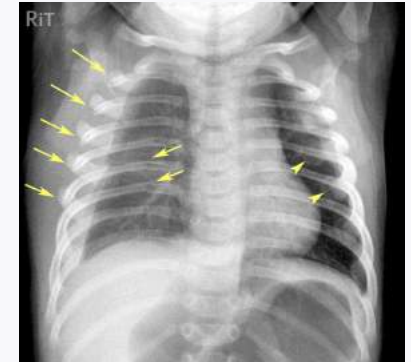
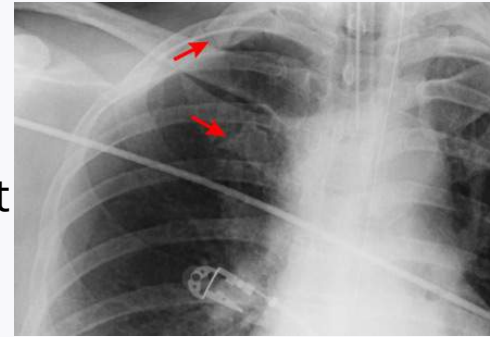
Intoxicated patients in whom abdominal injury is suggested

Patients with potential intra-abdominal injury who will undergo prolonged anesthesia for another procedure



Rib fractures

4th-10th most frequently involved
inspiratory chest pain and discomfort
local tenderness and crepitus



marker for other associated significant injury

elderly w/ three or more rib fractures: 5x ↑ mortality, 4x ↑ pneumonia

Dg:

x-ray, (CT)



Treatment:

Effective pain control

- oral or parenteral analgesic agents
- intercostal nerve blocks (long acting, eg, bupivacaine)
- epidural anesthesia

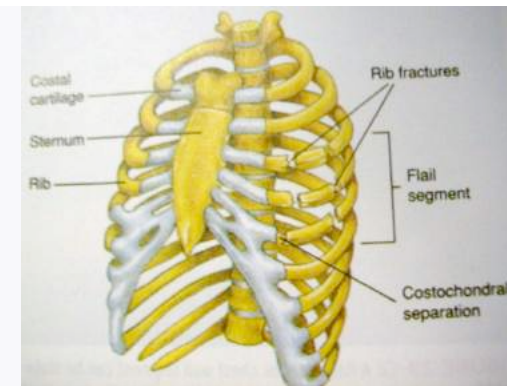
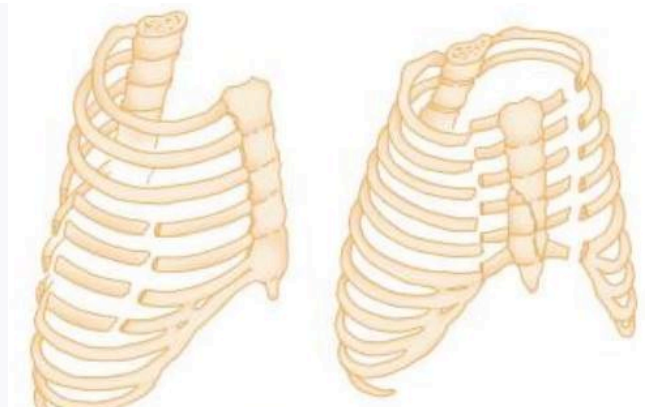
Early mobilization

Aggressive pulmonary toilet

chest physiotherapy, incentive spirometry



Flail chest



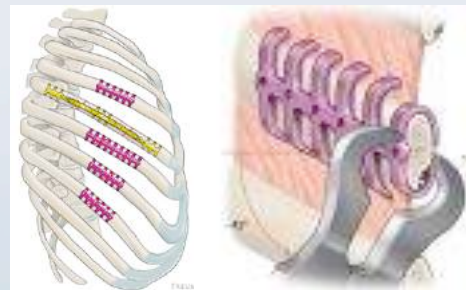
Three or more consecutive rib fractures in two or more places → free-floating, unstable segment of chest wall

Costochondral separation can also be involved

pain, frequently dyspnea, tachypnea, and tachycardia, labored respiration

paradoxical motion of the flail segment: chest wall moves inward with inspiration and outward with expiration

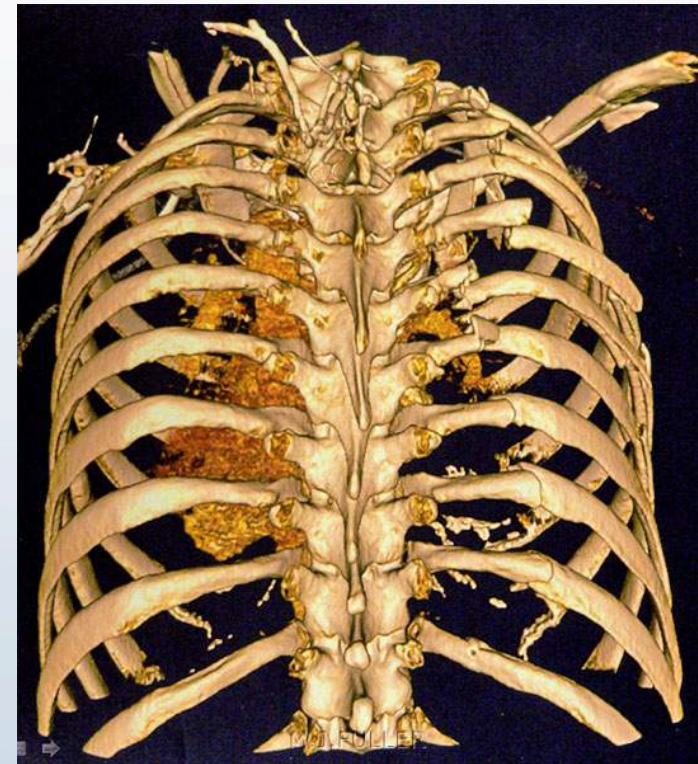
associated injuries aggressively sought



Treatment

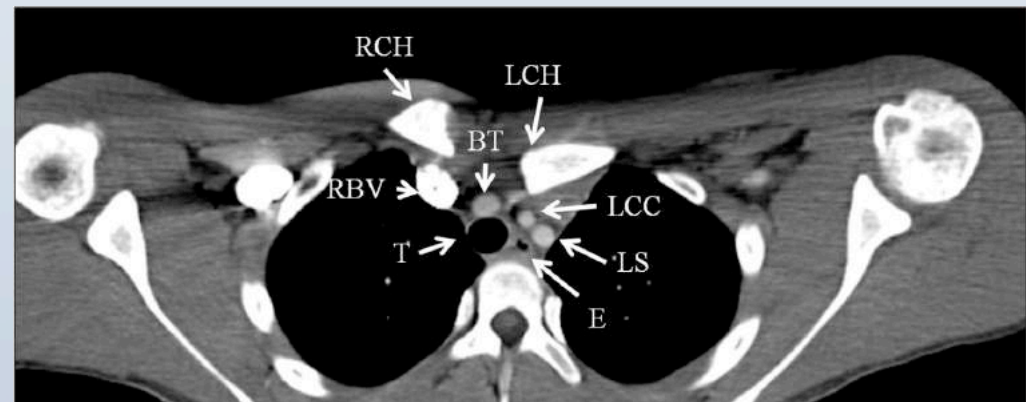
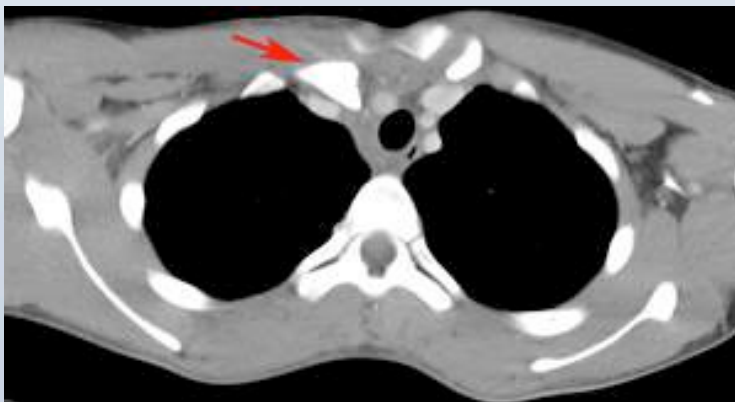
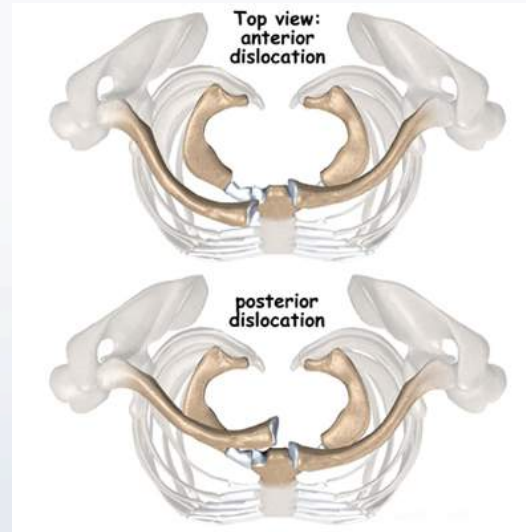
- as for rib fractures +
- endotracheal intubation and positive-pressure mechanical ventilation if respiratory distress or insufficiency develops
- ± surgical stabilization of chest wall (esp. if thoracotomy for other reason)

Flail chest



Sternoclavicular joint dislocations

Posterior dislocations: rule out associated injuries to the trachea, subclavian vessels, or brachial plexus



Sternal fractures

Usually MVAs, usually transverse, upper and middle third
Local tenderness and swelling, ecchymosis

Common associated injuries: rib fractures, long-bone fractures, closed head injuries

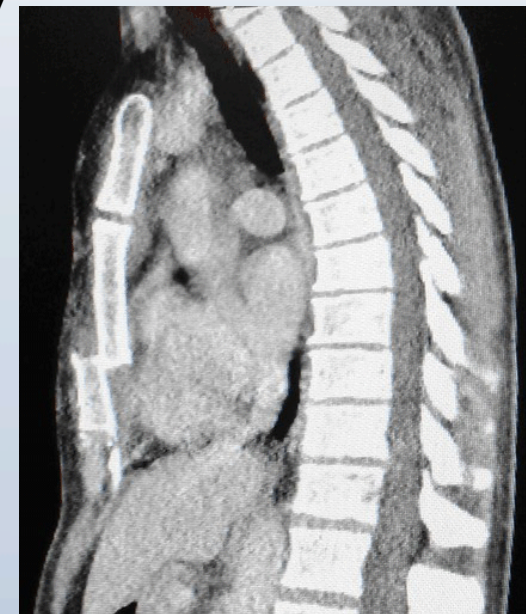
Blunt cardiac injuries in fewer than 20%

workup: ECG, echocardiography, troponin I level, observation

Treatment:

Analgesics

ORIF (plate fixation): severe pain, major displacement only

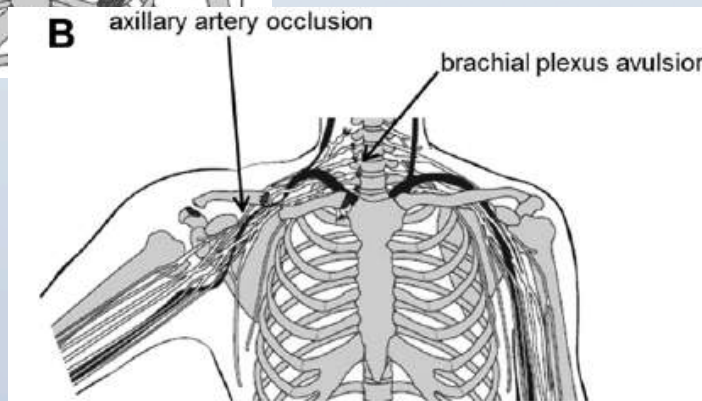
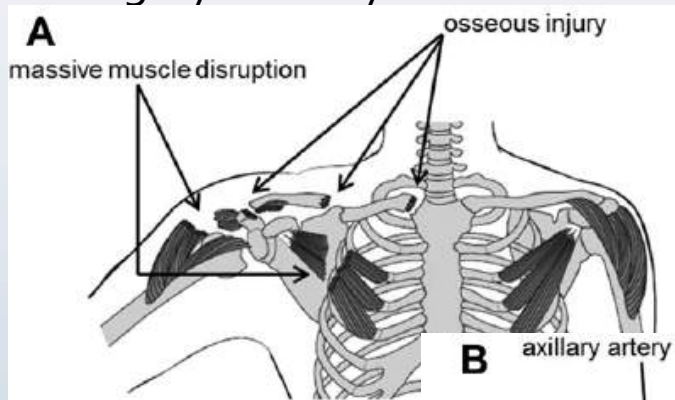
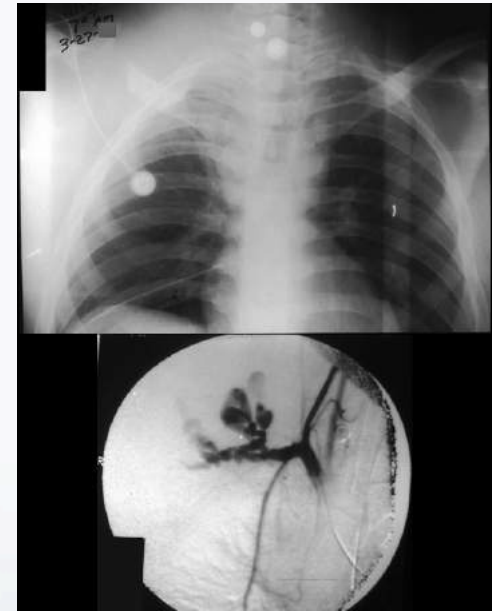


Scapulothoracic dissociation

Shoulder girdle pulled away from the thorax
muscular, vascular, and nervous components compromised

Hematoma, edema,
± loss of sensory and motor function
± distal pulses

Surgery: acutely: restoration of circulation, stabilization of shoulder girdle



Blunt diaphragmatic injuries

Relatively uncommon

MVAs in 33 %

Blow to the abdomen, dyspnea or respiratory distress

Associated injuries → ≈ hypovolemic shock

Dg:

Sometime incidentally diagnosed during laparotomy for associated injuries

Initial chest x-ray might be normal

nasogastric tube in the chest

ipsilateral hemidiaphragm elevation

abdominal visceral herniation into the chest

CT ± (accuracy?)

MRI (??? acute setting!)

US - gaining popularity

Thoracoscopy, laparoscopy

Treatment

Surgery (eg, suture) via laparotomy or thoracotomy



Penetrating diaphragmatic injury

In the USA 15% of stab wounds and in 46% of GSWs.

A high index of suspicion is usually required.

Acute injuries approached with laparoscopy or laparotomy because of associated injuries

Chronic injuries approached with thoracoscopy because of dense adhesions that arise between the abdominal contents and the lung.

Up to 13% of injuries missed in emergent settings

may present years later

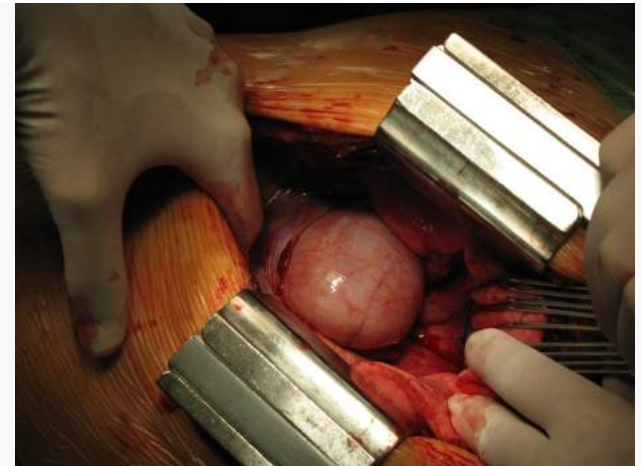
visceral herniation occurs (85% within 3 y)

decreased cardiopulmonary reserve,

obstruction,

frank sepsis.

Bowel strangulation and gangrene → high mortality rate.



Pneumothorax (PTX)

Most frequently caused by fractured rib

Can result from deceleration or barotrauma

Inspiratory pain or dyspnea and pain at the sites of the rib fractures



Physical examination: decreased breath sounds and hyperresonance to percussion.

Dg:

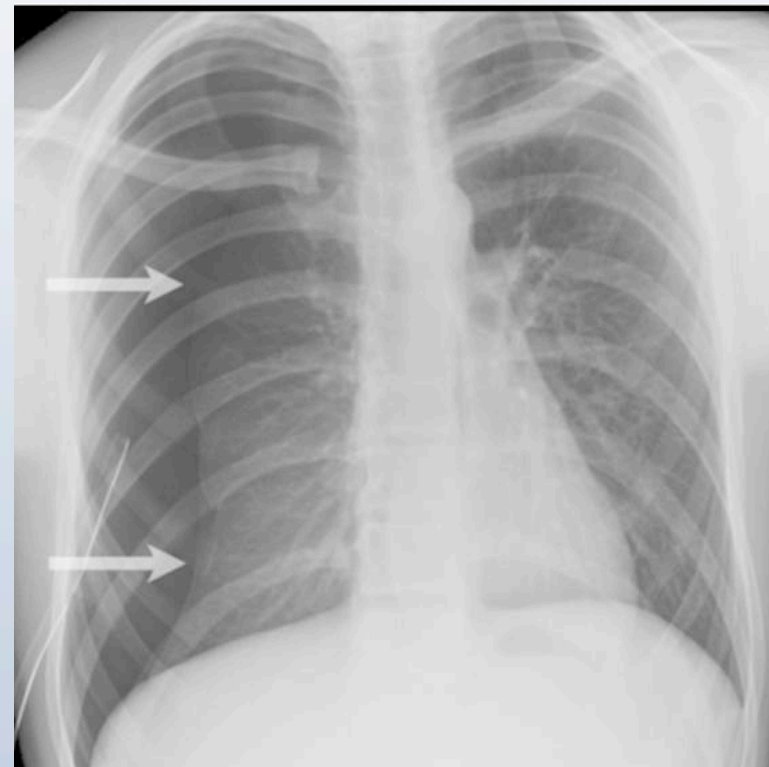
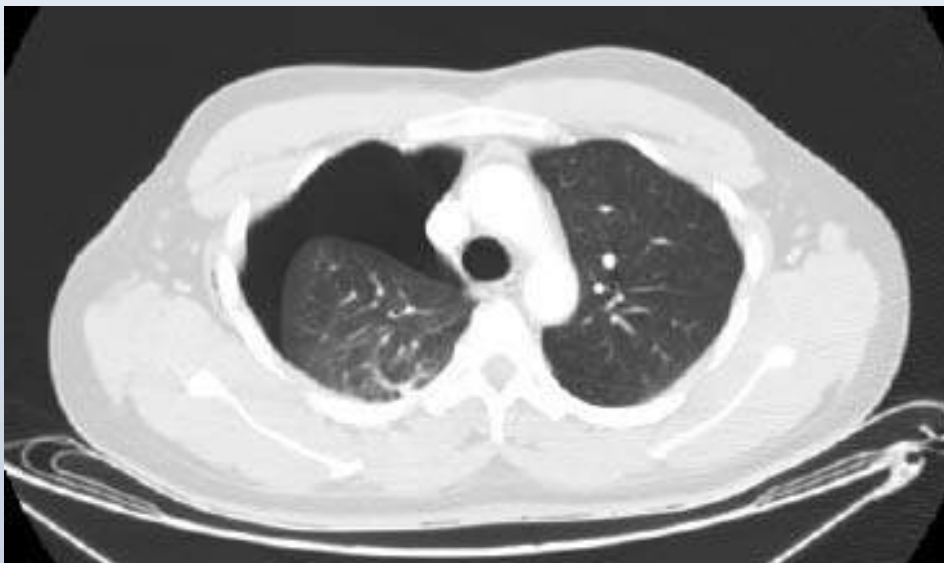
Chest x-ray (CXR): "air inside the thoracic cavity but outside the lung"

[CT]

Therapy:

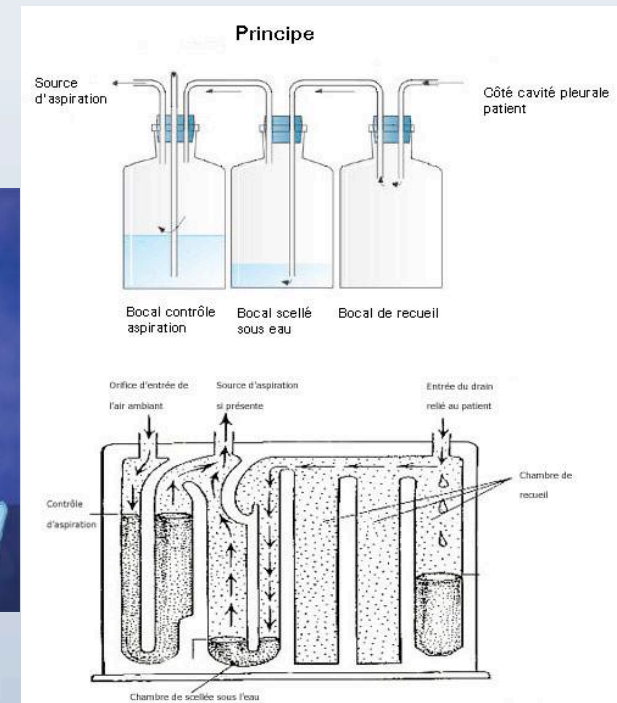
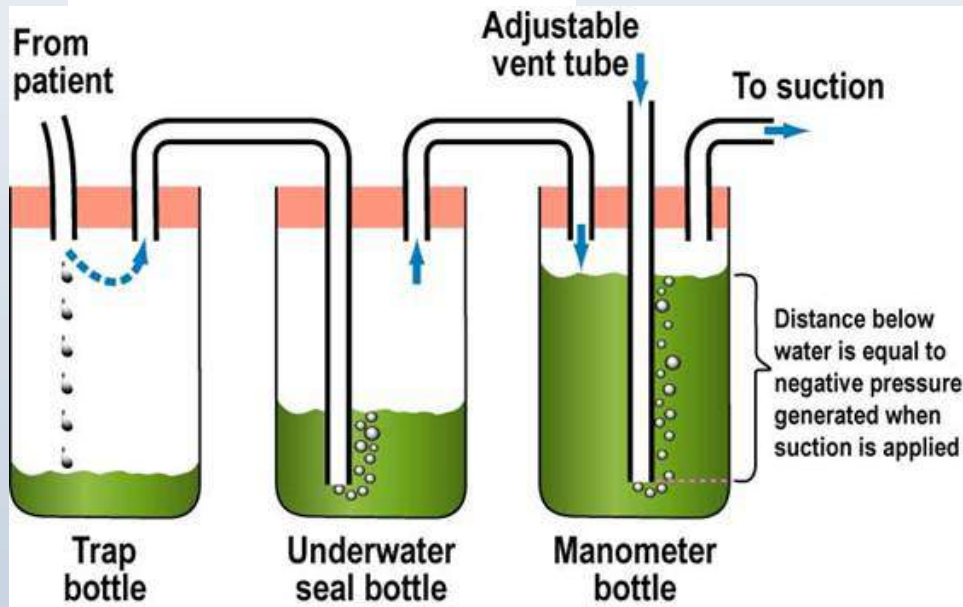
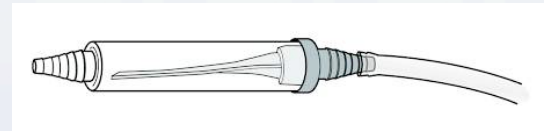
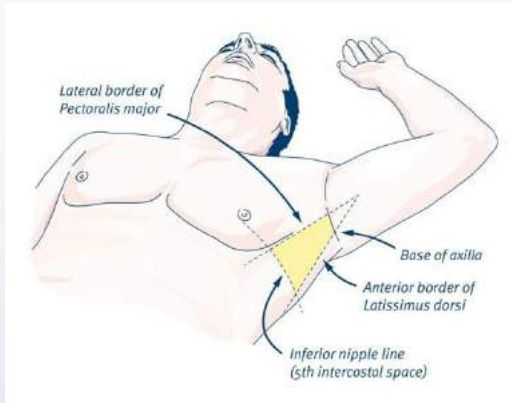
- tube thoracostomy

suction ≈ -20 cm H₂O, water seal





Heimlich -valve



Open pneumothorax

may rarely occur with blunt thoracic trauma, more common w/ penetrating trauma

collapse of lung

chest-wall defect

significant-to-complete loss of breath sounds

contents of the mediastinum can shift to the opposite side

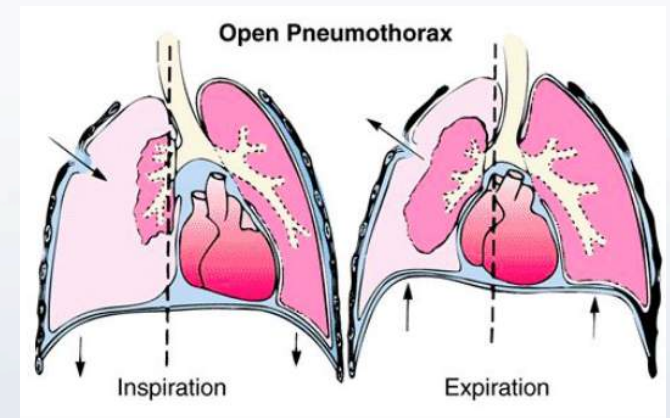
return of blood to the heart decreasing

hemodynamic instability

Initial treatment: three-way occlusive dressing

Tube thoracostomy

After initial stabilization: operative wound debridement and closure



Tension pneumothorax

Increasing pressure within the affected hemithorax

Patient in respiratory distress

Breath sounds severely diminished to absent

Hemithorax is hyperresonant to percussion

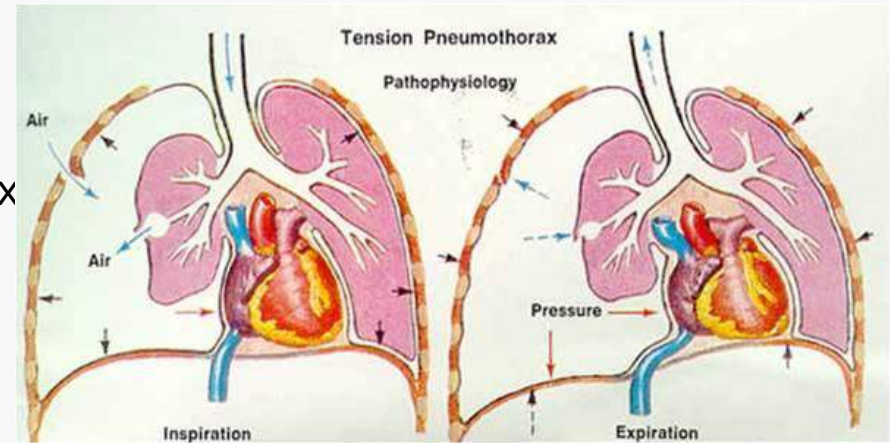
Trachea is deviated away from the side of the injury

Mediastinal contents are shifted away from the affected side

Results in decreased venous return of blood to the heart

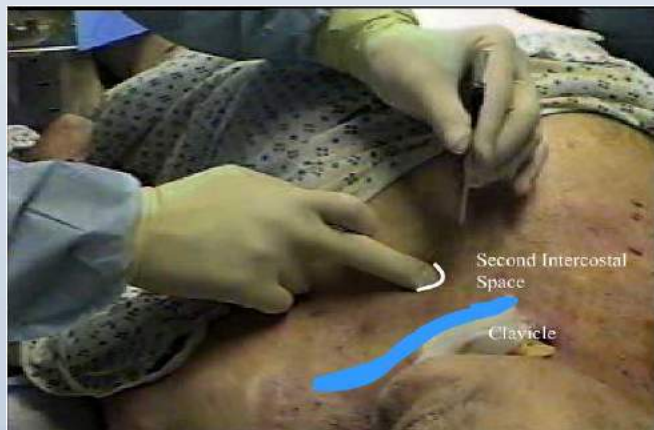
Signs of hemodynamic instability: hypotension

Complete cardiovascular collapse.



Immediate therapy: needle thoracostomy

Definitive therapy: tube thoracostomy



Hemothorax

Accumulation of blood within the pleural space

bleeding from the chest wall (eg, lacerations of the intercostal or internal mammary)

hemorrhage from the lung parenchyma or major thoracic vessels

Pain and dyspnea

Physical - vary with the extent of the hemothorax

decrease in breath sounds

dullness to percussion

± hemodynamic instability

Dg:

Chest x-ray (CXR)

(Upright: ≈ 200-300 ml, supine: ≈ 1000 ml blood depicted)

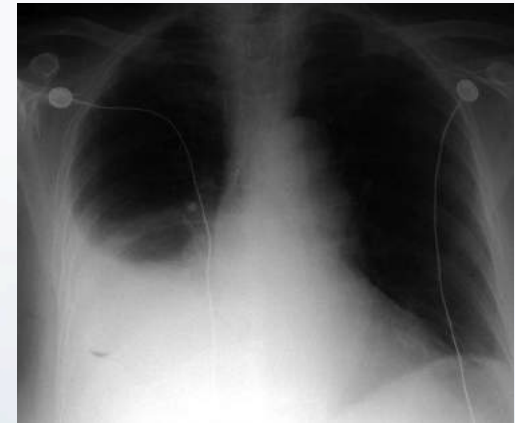
[CT]

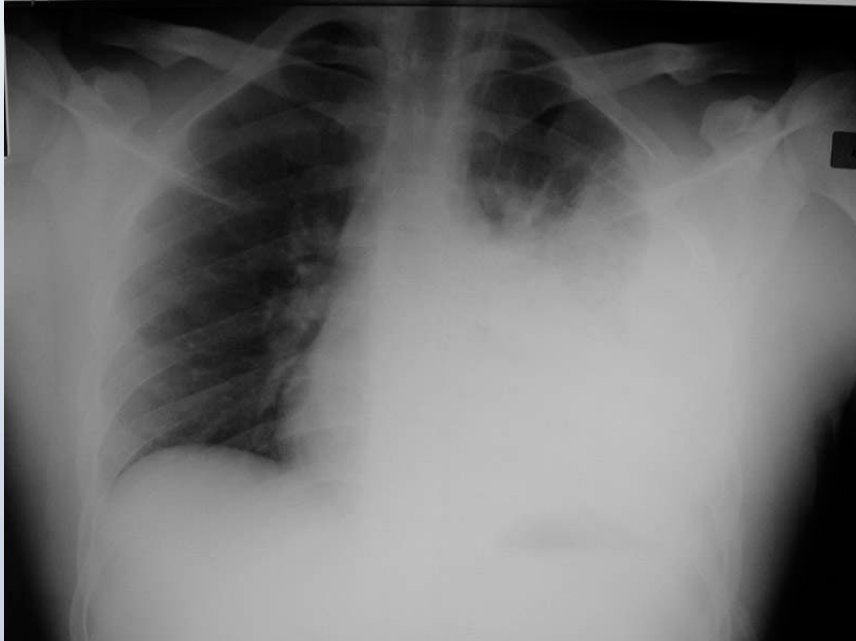
Therapy:

- tube thoracostomy

- thoracotomy (1500 mL immediately or 250 mL/hr for 3 hours)

- Large, clotted hemothorax: evacuation by thoracotomy or thoracoscopy to prevent fibrothorax and empyema.





Tracheal injuries

most patients die before reaching the hospital – immediately life-threatening

fractures, lacerations, disruptions by severe rapid deceleration
or penetrating object

respiratory distress
cannot phonate
stridor

associated pneumothorax
massive subcutaneous emphysema



Dg:
Bronchoscopy

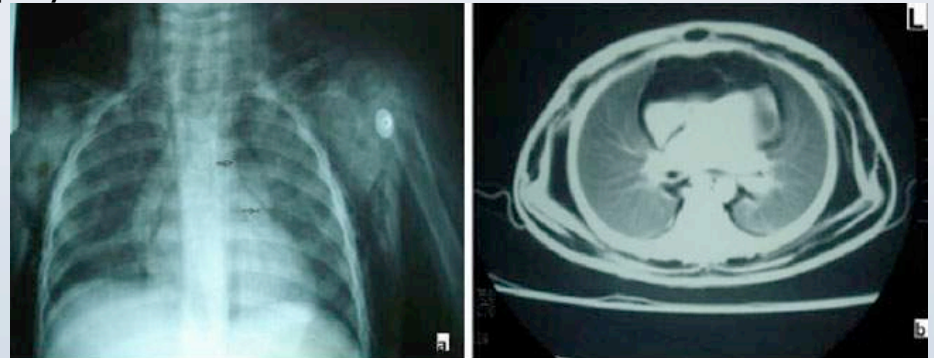
Therapy:

establishment of an adequate airway

endotracheal intubation if feasible (flexible bronchoscope, tube
placed distal to the site of injury)

emergency tracheotomy or cricothyroidotomy

debridement of fracture site and restoration of airway continuity
with end-to-end anastomosis



Bronchial injuries

Rapid deceleration, penetrating trauma
respiratory distress, hemoptysis
(massive) pneumothorax



ipsilateral breath sounds are severely diminished to absent

hemithorax is hyperresonant to percussion

subcutaneous emphysema, may be massive

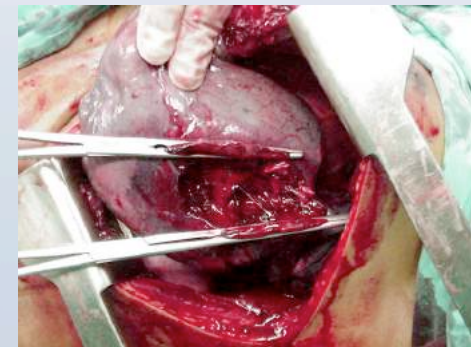
hemodynamic instability: tension pneumothorax or massive blood loss from associated injuries

Dg:

Bronchoscopy if possible

Therapy:

ipsilateral thoracotomy after single-lung ventilation is established on the uninjured side
debridement of the injury and end-to-end anastomosis



Lung injuries

tube thoracostomy – complication rate \approx 20%.

thoracotomy: 80-90% simple measures (eg, stapling, tractotomy, oversewing)

Esophageal injuries

Blunt rare: forceful blow, mostly in cervical region; penetrating more common

subcutaneous emphysema,
pneumomediastinum,
pneumothorax,
intraabdominal free air

Aggressive investigation, including radiography, endoscopy, and thoracoscopy (when warranted)

Late presentation: signs and symptoms of systemic sepsis

Fluid resuscitation

broad-spectrum intravenous antibiotics

surgery: within 24 hours debridement and primary closure + reinforcement +
drainage

with advanced mediastinitis esophageal exclusion and diversion

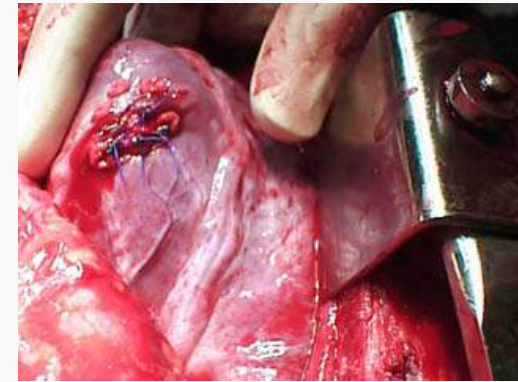
cervical esophagostomy + gastrostomy + feeding jejunostomy tube

wide mediastinal drainage

Blunt cardiac injuries

MVAs + falls, crush injuries, acts of violence, sport

Range from transient arrhythmias to rupture of the valve mechanisms, interventricular septum, or myocardium (cardiac chamber rupture)

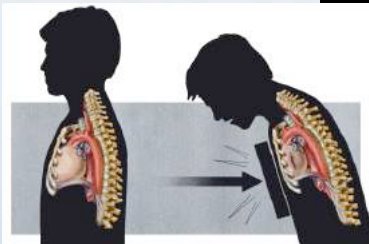


Patients can be asymptomatic or can manifest signs and symptoms ranging from chest pain to

cardiac tamponade (eg, muffled heart tones, jugular venous distention, hypotension) to

complete cardiovascular collapse and shock due to rapid

exsanguination



Many patients do not require specific therapy

Patients with severe blunt cardiac injuries may be stable initially, and diagnosis may be delayed as a result.

tamponade: rapid pericardiocentesis or surgical creation of a subxiphoid window
thoracotomy, cardiorrhaphy (cardiopulmonary bypass, intra-aortic counterpulsation
balloon pump)

Penetrating cardiac injuries

Highly lethal, 70-80%.

Right ventricle – 43%; Left ventricle - 34%; Right atrium - 16%; Left atrium - 7%

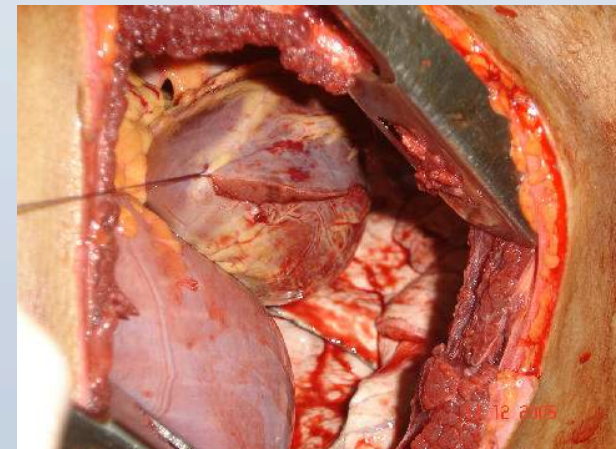
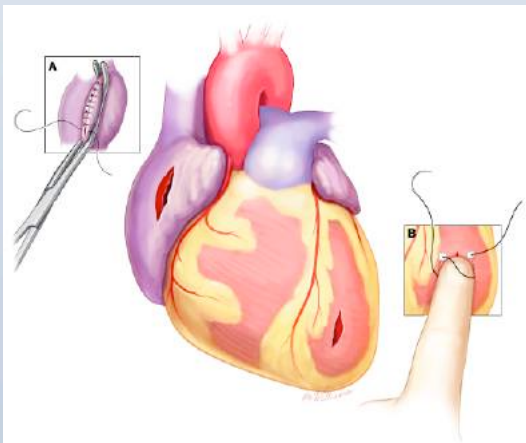
Beck triad (i.e., high venous pressure, low arterial pressure, muffled heart sounds) in only 10-30% of proven tamponade

Pericardiocentesis: diagnostic and therapeutic

Echocardiography: rapid, noninvasive, accurate

For patients with stab wounds or GSWs from low-caliber missiles who are apparently lifeless upon arrival, resuscitative thoracotomy is justified.

Bleeding controlled using finger occlusion, sutures, or staples.



Blunt injuries to thoracic great vessels

MVAs, falls from heights and MVAs involving a pedestrian

Deceleration; direct luminal compression; Many die at the scene.

Signs of significant chest-wall trauma (eg, steering wheel imprint),
hypotension,

upper extremity blood pressure differential,

loss of upper- or lower-extremity pulses,

thoracic spine fractures

signs of cardiac tamponade may be present

decreased breath sounds and dullness to percussion due to massive hemothorax

50% of patients: no overt external signs of injury!!! High index of suspicion!!!

Immediate repair ⇔ Delayed repair

associated injuries requiring urgent correction

short-acting beta-blockers

mean arterial pressure to ≈ 60 mmHg

Endovascular stent grafts

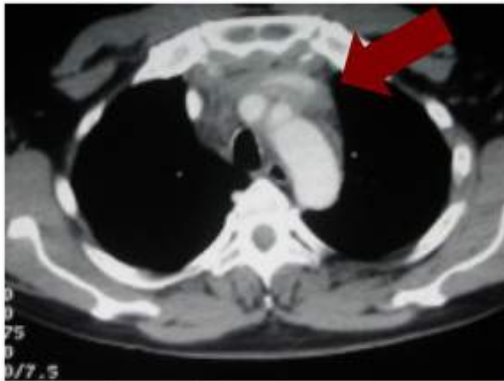
Cardiopulmonary bypass techniques

Repair of major thoracic vessels – see Surgery curriculum

Blunt Traumatic Aortic Injury

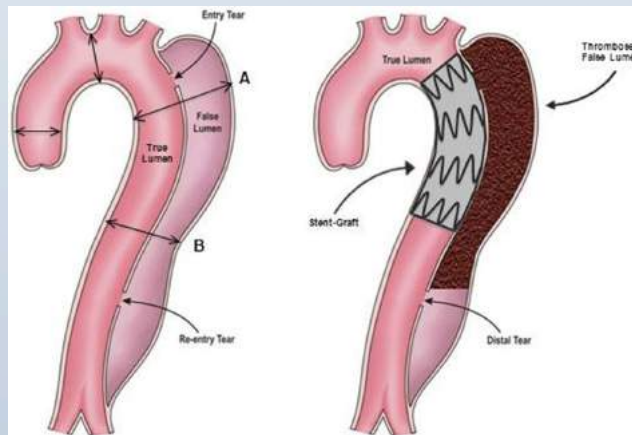
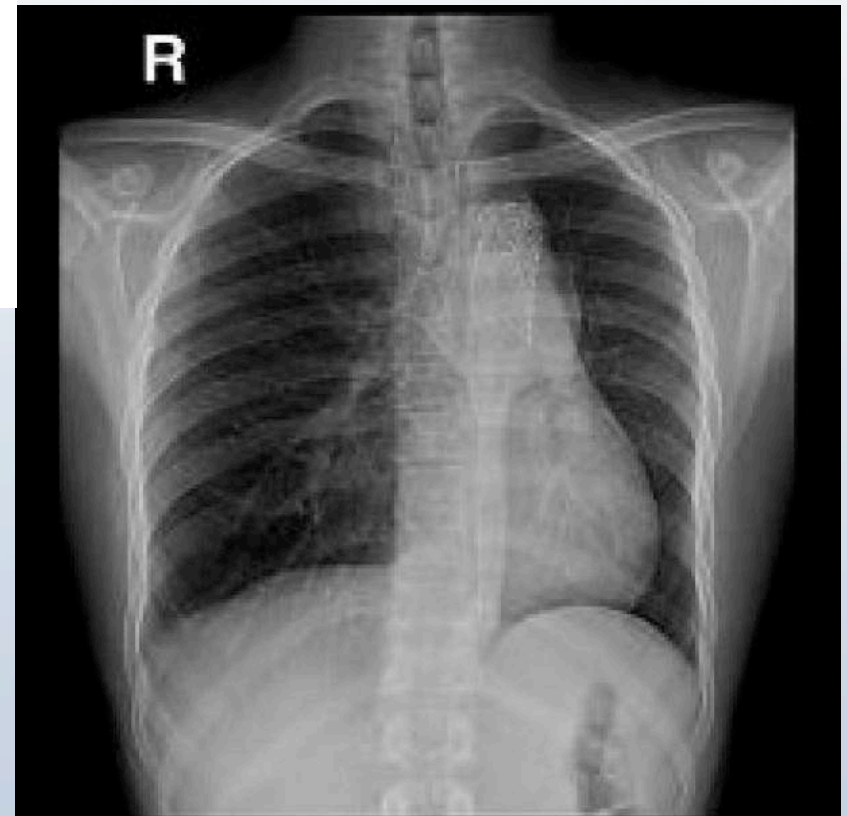
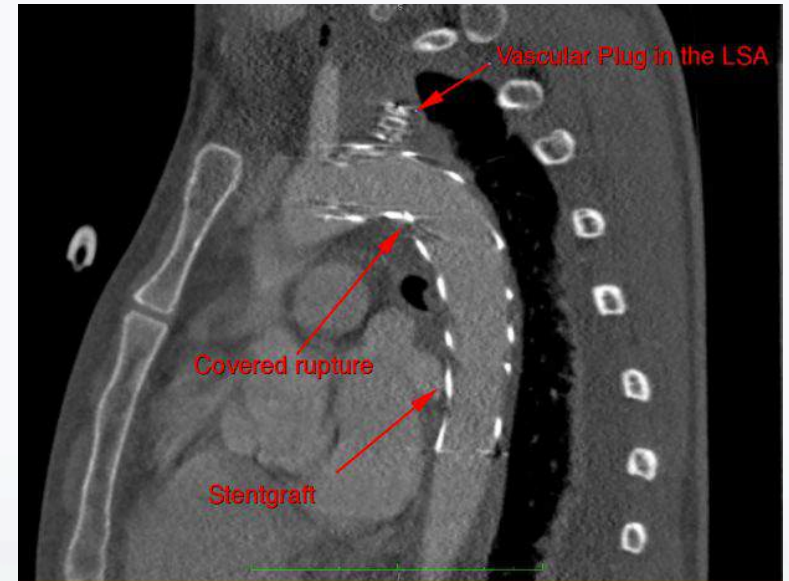
- Helical CT Imaging

- Aortic arch disruption



- Aortogram

- Pseudoaneurysm of descending aorta at the isthmus



Thoracic great vessel injury due to penetrating trauma

Gunshot, shrapnel, stab wounds, therapeutic misadventures

Managing dictated by patient's hemodynamic stability

stable after initial resuscitation → further diagnostic workup
helical CT, CT angiography, transesophageal echocardiography

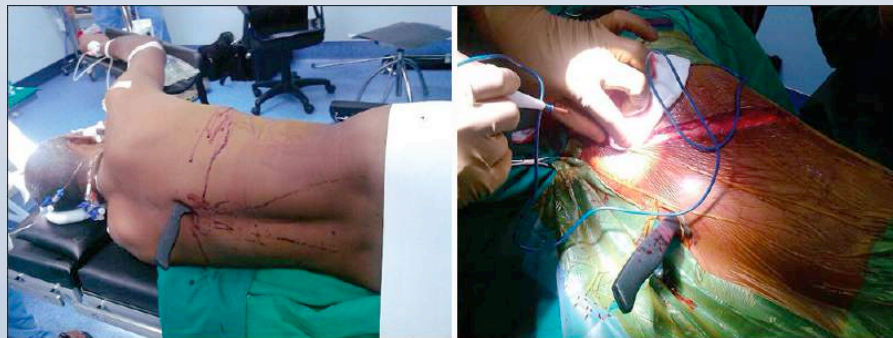
remaining unstable or hemodynamic deterioration → emergency thoracotomy

Surgical approaches:

median sternotomy (to the subclavian vessels)

posterolateral thoracotomy

to the descending thoracic aorta)



Blunt Abdominal Trauma

Signs and symptoms

In alert patient:

Pain

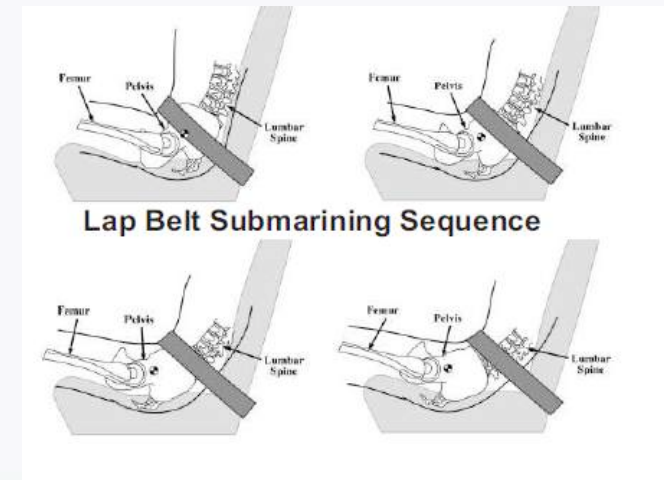
Tenderness

Gastrointestinal hemorrhage

Hypovolemia

Evidence of peritoneal irritation

However!!! large amounts of blood – no significant or early changes in the physical
Bradycardia



Injury patterns:

Lap belt marks: ? small intestine rupture

Steering wheel-shaped contusions

Ecchymosis involving the flanks (Grey Turner sign) or the umbilicus (Cullen sign):

Indicates retroperitoneal hemorrhage, but is usually delayed for several hours to days

Abdominal distention

Auscultation of bowel sounds in the thorax: May indicate a diaphragmatic injury

Abdominal bruit: May indicate underlying vascular disease or traumatic arteriovenous fistula

Local or generalized tenderness, guarding, rigidity, or rebound tenderness: Suggests peritoneal injury

Fullness and doughy consistency on palpation: May indicate intra-abdominal hemorrhage

Crepitation or instability of the lower thoracic cage: Indicates the potential for splenic or hepatic injuries

Diagnosis

Assessment of hemodynamic stability

[Diagnostic peritoneal lavage (DPL)]

Patients with a spinal cord injury

Those with multiple injuries and unexplained shock

Obtunded patients with a possible abdominal injury

Intoxicated patients in whom abdominal injury is suggested

Patients with potential intra-abdominal injury who will undergo prolonged anesthesia

FAST

4 acoustic windows (pericardiac, perihepatic, perisplenic, pelvic) with the patient supine.

positive if free fluid is found

negative if no fluid is seen

indeterminate if cannot be adequately assessed

Computed tomography

Standard for solid organ injuries

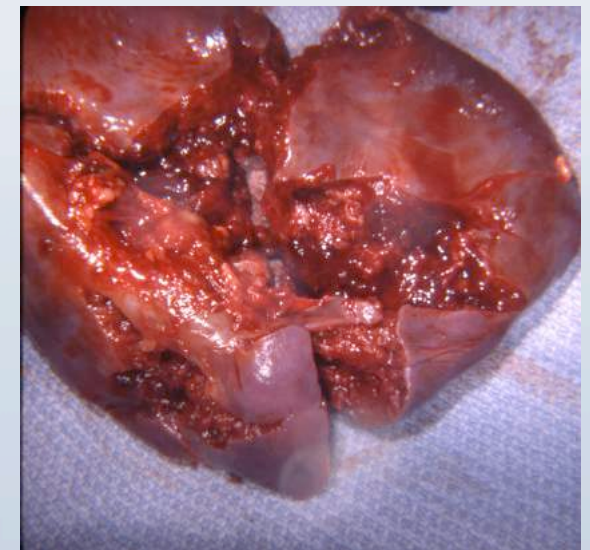
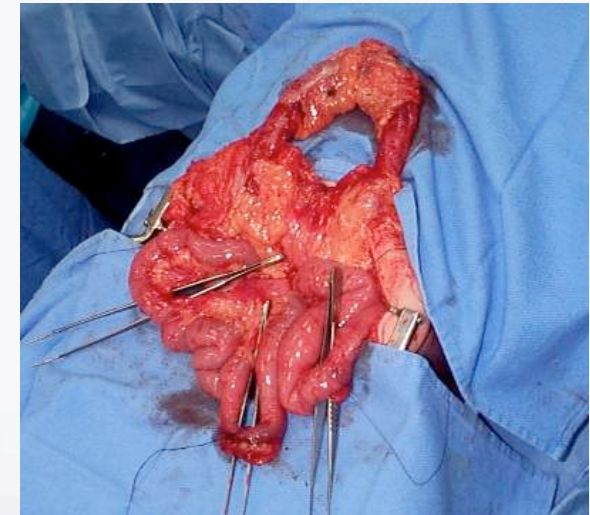
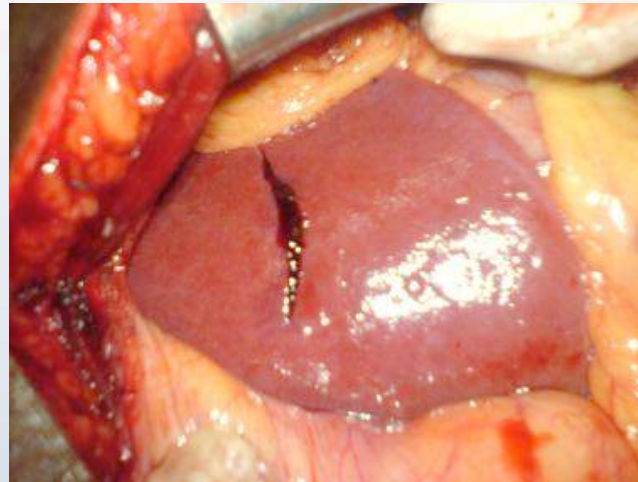
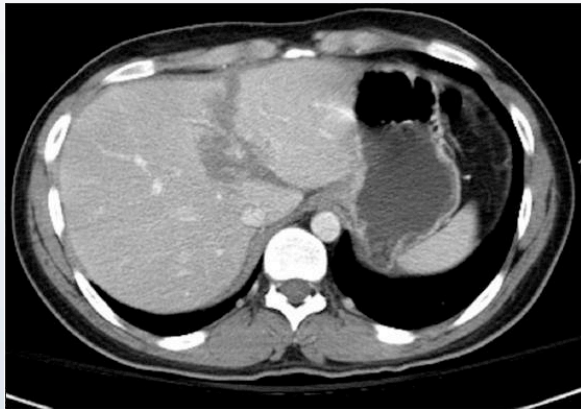
Unlike DPL or FAST, CT can determine the source of hemorrhage.



Management

Indications for laparotomy

- Uncontrolled shock or hemorrhage
- Clinical deterioration during observation
- Hemoperitoneum findings on FAST or DPL (±)
- Signs of peritonitis



Hollow viscus: suture, resection

Solid organ: suture, resection, partial resection

Damage control – staged surgery

Nonoperative management

Strategies based on

- CT scan diagnosis
- hemodynamic stability of the patient

Candidates

Pediatric patients

- Hemodynamically stable adults with solid organ injuries (liver, spleen)
 - [(Splenic artery embolotherapy)]
 - closely monitoring vital signs
 - frequently repeating the physical examination

Penetrating Abdominal Trauma

gunshot wounds

Small bowel (50%)

Colon (40%)

Liver (30%)

Abdominal vascular structures (25%)

stab wounds

Liver (40%)

Small bowel (30%)

Diaphragm (20%)

Colon (15%)

Approach

Mechanism and location of injury

Hemodynamic and neurologic status of the patient

Associated injuries

Institutional resources



Workup

as int blunt trauma +



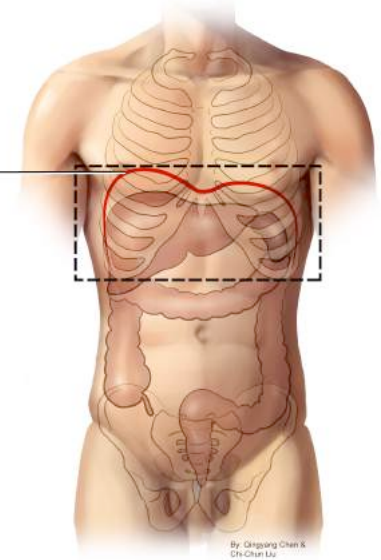
local wound exploration (anterior and lateral wounds [? penetration])
triple-contrast helical CT (posterior wounds [? organ injury])

Penetrating Thoracoabdominal Wounds (Thoracoabdominal injuries)

“thoracoabdominal zone”; “intrathoracic abdomen”

damages to both cavities to be addressed

Diaphragm as high
as nipples during
full expiration



Damage control surgery:

abbreviated laparotomy followed by resuscitation in the intensive care unit and staged abdominal reconstruction



Blunt splenic injuries

Change in the approach:

splenectomy → splenic preservation during surgery → non-operative management

Workup: US, CT



I



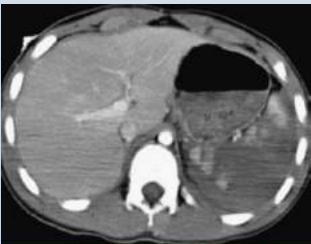
II



IV



III



V



THE AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA

Spleen injury scale (1994 revision)

Grade*	Injury type	Description of injury
I	Hematoma	Subcapsular, <10% surface area
	Laceration	Capsular tear, <1cm parenchymal depth
II	Hematoma	Subcapsular, 10%-50% surface area intraparenchymal, <5 cm in diameter
	Laceration	Capsular tear, 1-3cm parenchymal depth that does not involve a trabecular vessel
III	Hematoma	Subcapsular, >50% surface area or expanding; ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma ≥ 5 cm or expanding
	Laceration	>3 cm parenchymal depth or involving trabecular vessels
IV	Laceration	Laceration involving segmental or hilar vessels producing major devascularization (>25% of spleen)
V	Laceration	Completely shattered spleen
	Vascular	Hilar vascular injury with devascularizes spleen

*Advance one grade for multiple injuries up to grade III.

Hemodynamically unstable:

laparotomy

If feasible:

spleen preservation:

parenchymal suture

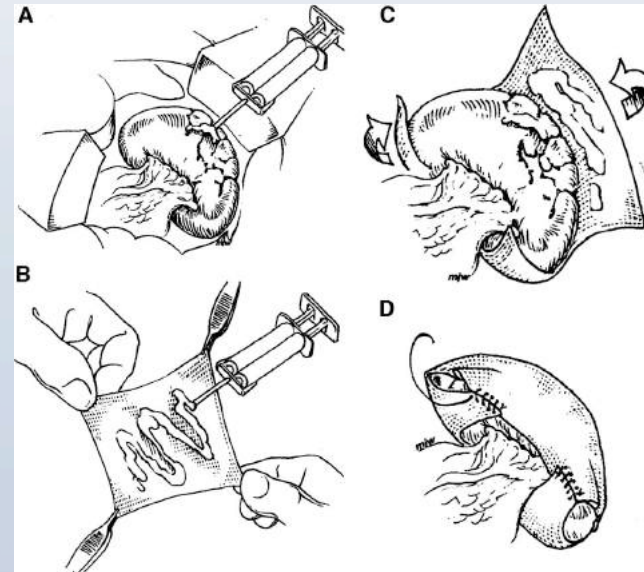
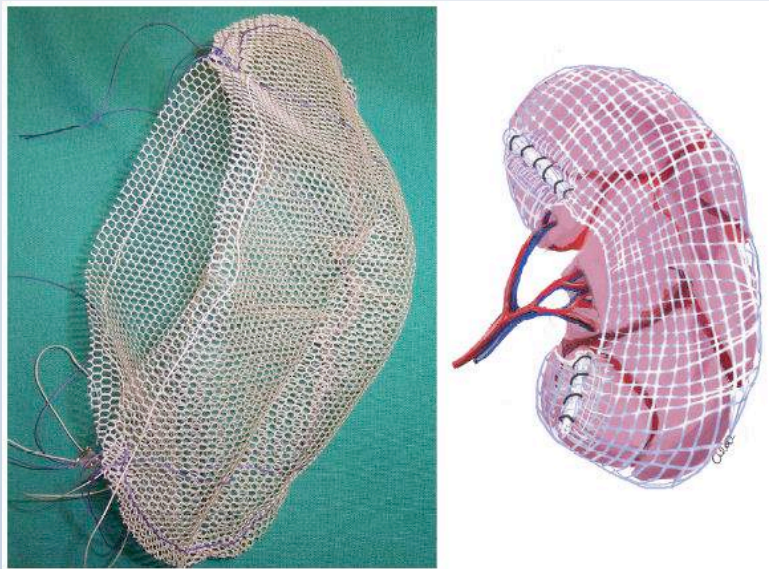
fibrin glue

laser

omental patch

mesh bag

partial splenectomy

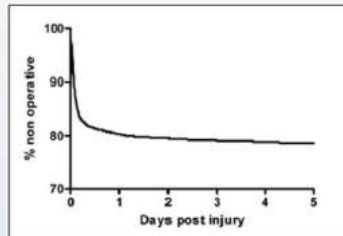


Hemodynamically stable:

non-operative management with close monitoring

vital signs
Hgb levels
repeat US
[repeat CT]

3-5 days



Success depends on:

Grade of injury
Amount of peritoneal blood
Age of patient
Contrast extravasation on CT

Angioembolisation: evolving method

Mobilization: no guideline

Delayed splenic rupture: no evidence of relationship
w/ mobilization

Infection prevention:

Vaccination:

Pneumococcus

Haemophilus influenzae type b

Meningococcus

2 weeks post splenectomy

Thank you