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Traumatic Diaphragmatic Injury

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Case Presentation

19 yo male BIBEMS as a trauma code

- Backseat passenger (-seatbelt)
- MVA collision/rollover. + extrication
- GCS 15. BP 96/45 → 112/76.
- HR 93 RR 31 O2 91%

PE

- Decreased BS on the left
- Thin, scaphoid abdomen
- No obvious deformities

CXR

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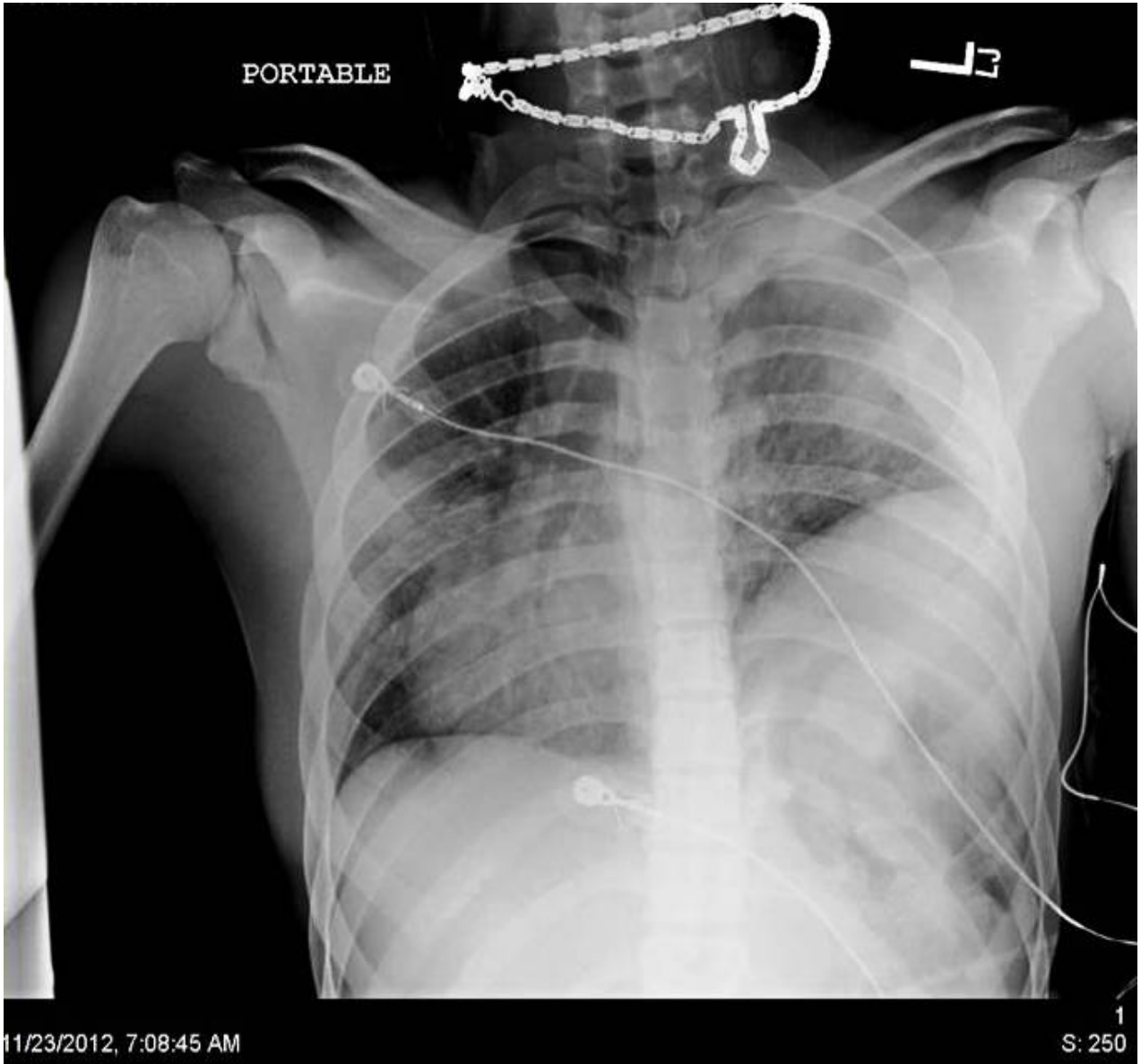
Case Presentation



Intraoperatively

- Midline incision
- Moderate amt of hemoperitoneum
- transverse colon, small bowel, and stomach herniated into the left chest
- Reduction, chest tube placement

- **Diaphragmatic defect: 10 cm tear that extending from the left dome into the right crus of the diaphragm. No tissue loss (Grade 3)**

Intraoperatively

- Assessed reduced contents
- Zones 1 and 2 inspected to r/o retroperitoneal injury
- Assessed for additional visceral and thoracic injuries
- Primary repair of the diaphragm
- EGD

Procedure: Exploratory Laparotomy, reduction of abdominal contents, repair of diaphragmatic injury, left tube thoracostomy, EGD

Postoperatively

- CT scan
- Transferred to SICU
- NSGY and Ortho c/s

- Extubated POD #7
- Diet advanced POD#8
- Chest tube d/c'd POD# 11

  -PTX , anterior pigtail

- Pigtail d/c'd POD#16
- Currently awaiting subacute rehab placement

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Questions?

Objectives

- Definition
- History
- Anatomy and Physiology
- Epidemiology
- Pathophysiology of blunt injury
- Presentation
- Diagnosis
- Management

Definition

- A tear in the diaphragm that allows the abdominal organs to enter the chest cavity

- Transfer of energy across the diaphragm
  - penetrating ballistic fragment
  - stab wound
  - pressure gradient from compressive blunt trauma

- Diaphragmatic injury ≠ Diaphragmatic hernia

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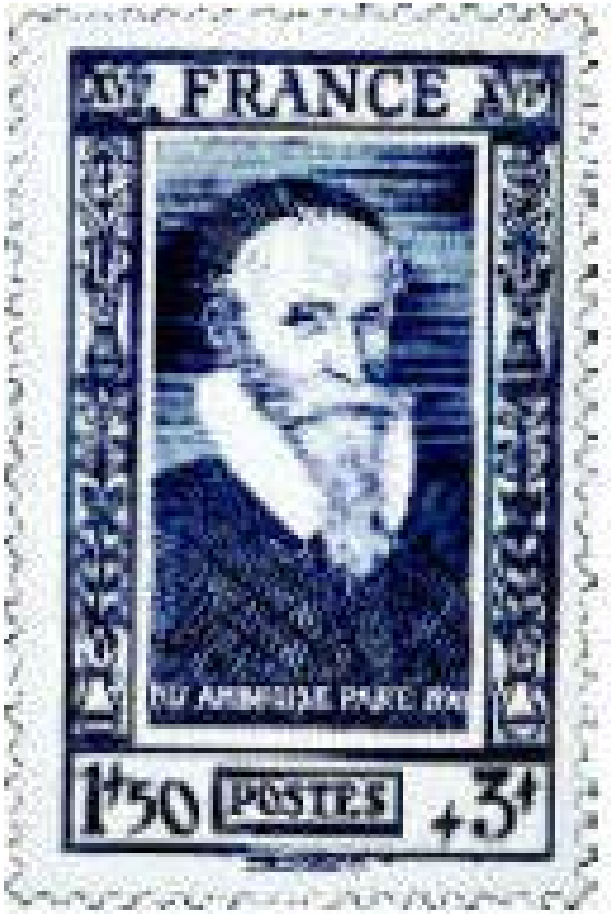
History

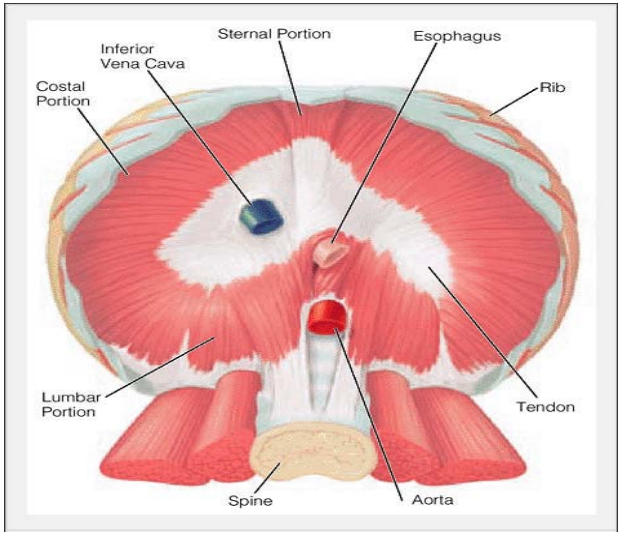
- Sennertus (1541)
- Paré (1579)
- Bowdich (1853) – antemortem
- Riolfi (1886) – First successful repair
- Hedbloe (1925) – case series

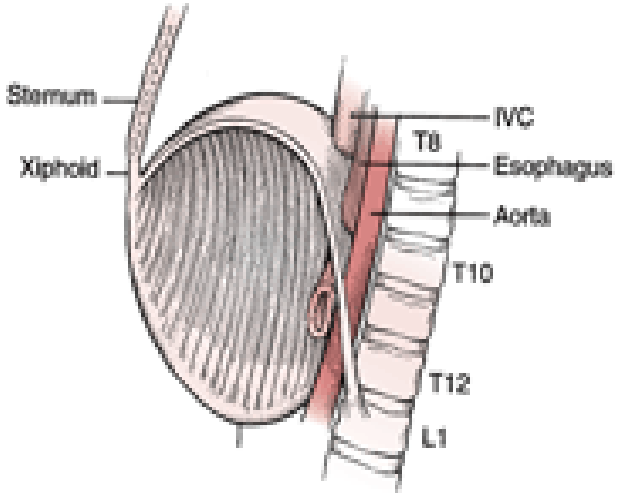


Anatomy & Physiology

- 3mm thick, dome shaped
- Musculotendinous
- 4-10th wks gestation
- ***Three parts***

  -sternal, costal & lumbar
- Site of insertion at the central tendon
- Right dome higher than left dome
- Pierced at the crura by IVC, Esophagus and Aorta





Anatomy

- **Blood supply**

  - **Internal Thoracic Artery** (Musculophrenic & Pericardiophrenic branches)

  - **Aorta** (Sup/inf phrenic)

- **Innervation**

  Phrenic nerve

  -C3, C4, C5

  -sensory and motor

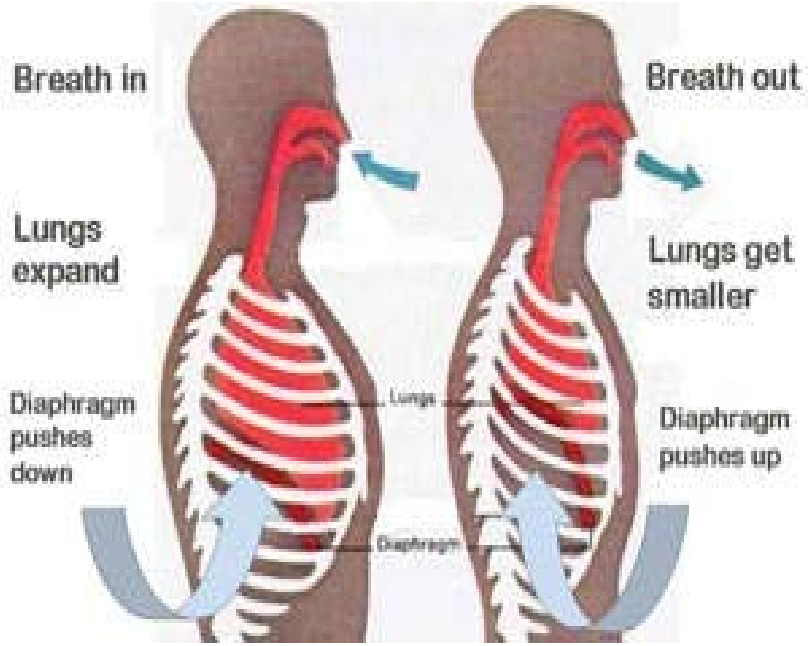
- **Lymphatic drainage**

  To parasternal, lateral aortic, and posterior mediastinal lymph nodes

Physiology

Actions: Work of breathing

1. **Contraction**
2. **Relaxation**



At rest, right dome is at ICS 4 and left dome is ~ 1 to 2 cm lower
Maximal inhalation at ICS 6 on right and ICS 7 on left

Epidemiology

- Incidence unclear
  - studies range ~0.8-8%, overall 0.63%
- 35% related to blunt injury
- ~ 15% discovered > 48hrs s/p injury
- Up to 65% are diagnosed at surgery
- Right vs. left sided considerations

- ¾ Lt. sided, 23% Rt. Sided, 2% bilateral
- Liver
- Pressure requirements less on the left (anatomic)

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Pathophysiology of Blunt Injury

- Compression

  -Anterior

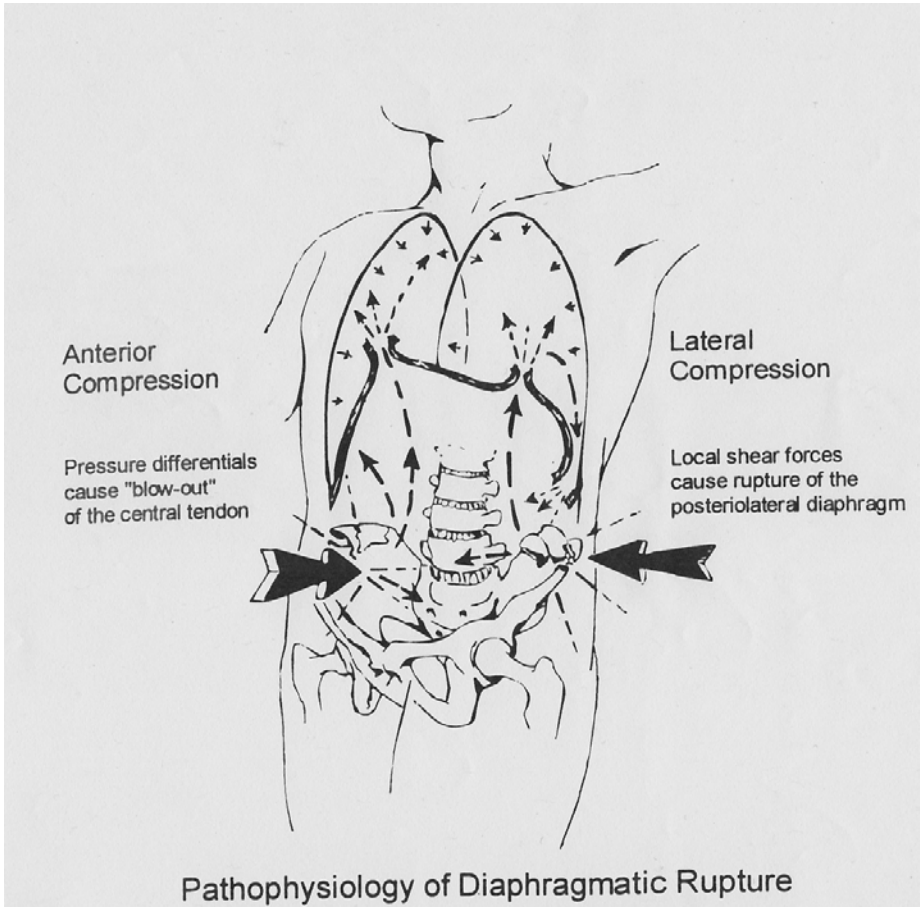
  - Pressure differences→ blow out

  - Lateral

  - Shearing force → posterlateral rupture

  Lateral >>>Anterior

- Commonly assoc w/ multiple injuries (>80%)



Pathophysiology of Diaphragmatic Rupture

Presentation

- Chest and abdominal pain
- Orthopnea/Dyspnea
- Reduced breath sounds in the lower lung fields
- Respiratory failure
- Bowel sounds heard in the chest
- Scaphoid abdomen
- Peritonitis
- Palpation of abdominal viscera during insertion of chest tube
- Hemodynamic instability and/or respiratory decompensation

Diagnosis

- History

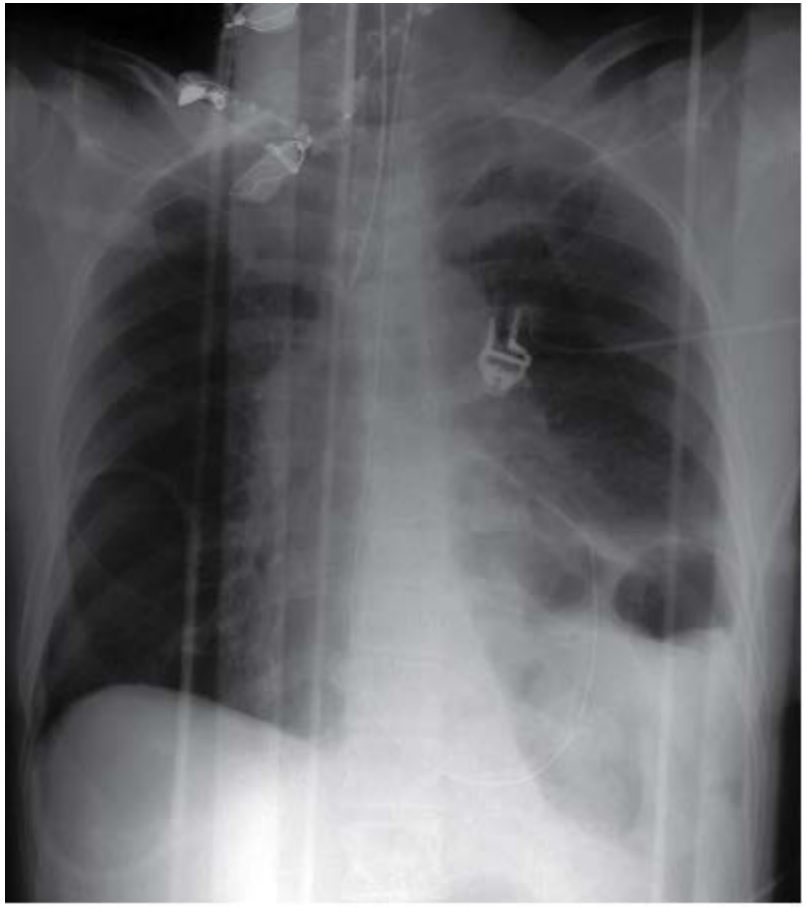
  -mechanism of injury
- Physical exam

  - Usually limited, but may have thoracic or abdominal findings
- Radiology

Diagnosis

CXR

- Nml/nonspecific in 20%-50%
- Variable accuracy (Left>>Right sided injury)
- Elevated diaphragm
- Gastric or colonic bubble in the left chest
- Coiled NGT



Source: Feliciano DV, Mattox KL, Moore EE: *Trauma*, 6th Edition: http://www.accesssurgery.com

Diagnosis

- **UGI series/Barium enema**
- **CT (Conventional)**

  - 61% sensitivity, Specificity 76-99%
- **Helical CT**

  - diagnoses 78% of left-sided injuries & 50% of right-sided injuries w/ PPV & NPV ~ 80-100%
- **MRI**

  -can be useful; provides direct coronal and saggital images & delineates the diaphragm

Diagnosis

- **DPL**

  -25-35% false neg. rate

- **Laparoscopy and thoracoscopy**

Laparoscopy/Thoracoscopy

- Allows diaphragmatic assessment and repair
- Used when open surgery is not mandated

  -Asx, hemodynamically stable
- Thoracoscopy

  - highly specific and sensitive

  - more useful in Rt. Sided injury
- Diagnostic Laparoscopy for Lt. sided injury

****The evaluation of the diaphragm by laparotomy in the acute setting remains the gold standard for diagnosis**.

Grading/Staging

GRADE	INJURY DESCRIPTION
I	Contusion
II	Laceration 2 cm
III	Laceration 2–10 cm
IV	Laceration >10 cm with tissue loss 25 cm^2
V	Laceration with tissue loss >25 cm^2

Adapted from American Association for the Surgery of Trauma-Organ Injury Scale for Diaphragmatic Injuries

Management

- Immediate: ABC's
- Focused assessment
  - Identify/treat associated injuries
  - CXR, other studies
- OR

Surgical Goals

- Control of hemorrhage and shock
- Control of GI spillage
- Identify associated visceral injuries
- Reduce herniated abdominal contents
- Assess extent of diaphragmatic injury
- Inspect the thorax
- +/- Debridement
- Repair

Rationale for early repair

- Lack of a hernia sac allows the herniated viscera to become adherent to the thoracic contents.

  - surgical repair in cases in which the diagnosis is delayed or the repair is deferred requires a thoracic approach
- Associated abdominal injuries identified and addressed
- Early repair reduces the likelihood of respiratory compromise and long-term complications associated with incarceration and strangulation of the intraabdominal viscera.

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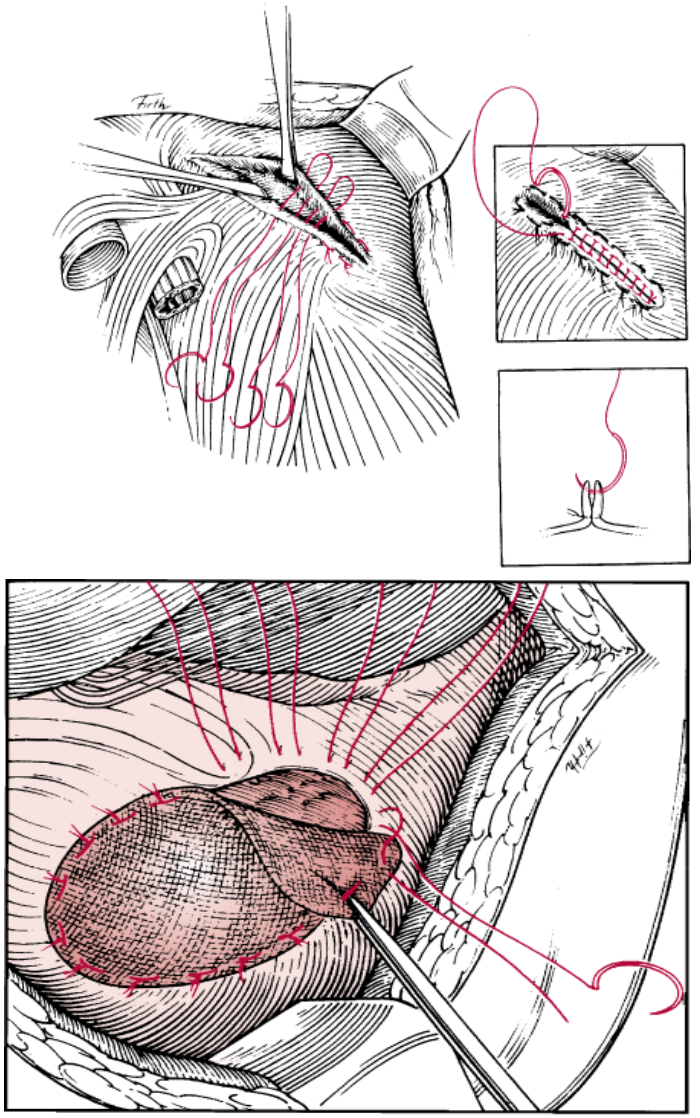
Surgical techniques

- Edges grasped w/ Allis clamps
- Single layer interrupted or horizontal mattress suture
- Complex lacerations (>5cm)
  - running suture
  - mesh repair (rare)
- Use 0 or 1 monofilament sutures
- Central tendon repair considerations
- Tube thoracostomy



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Morbidity

- Pneumonia, Empyema, Subphrenic or Intrabdominal abscess

- Dehiscence, hemidiaphragm paralysis, Respiratory insufficiency, Pulmonary Embolism

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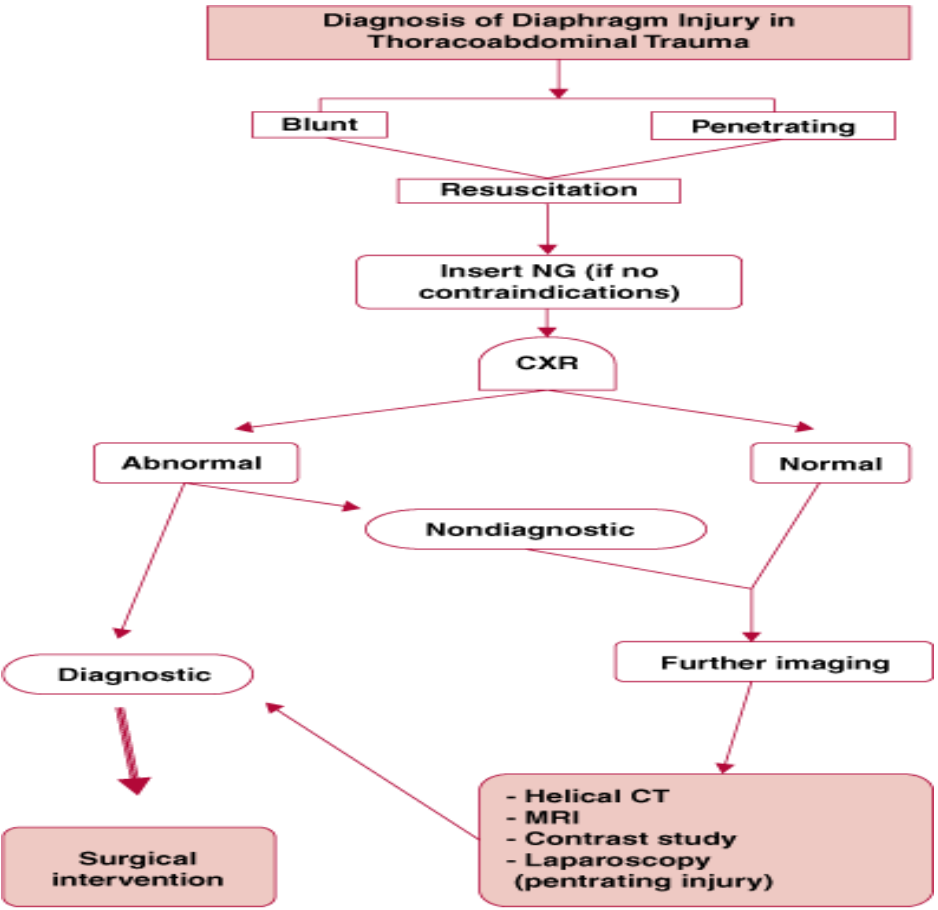
Treatment Algorithm



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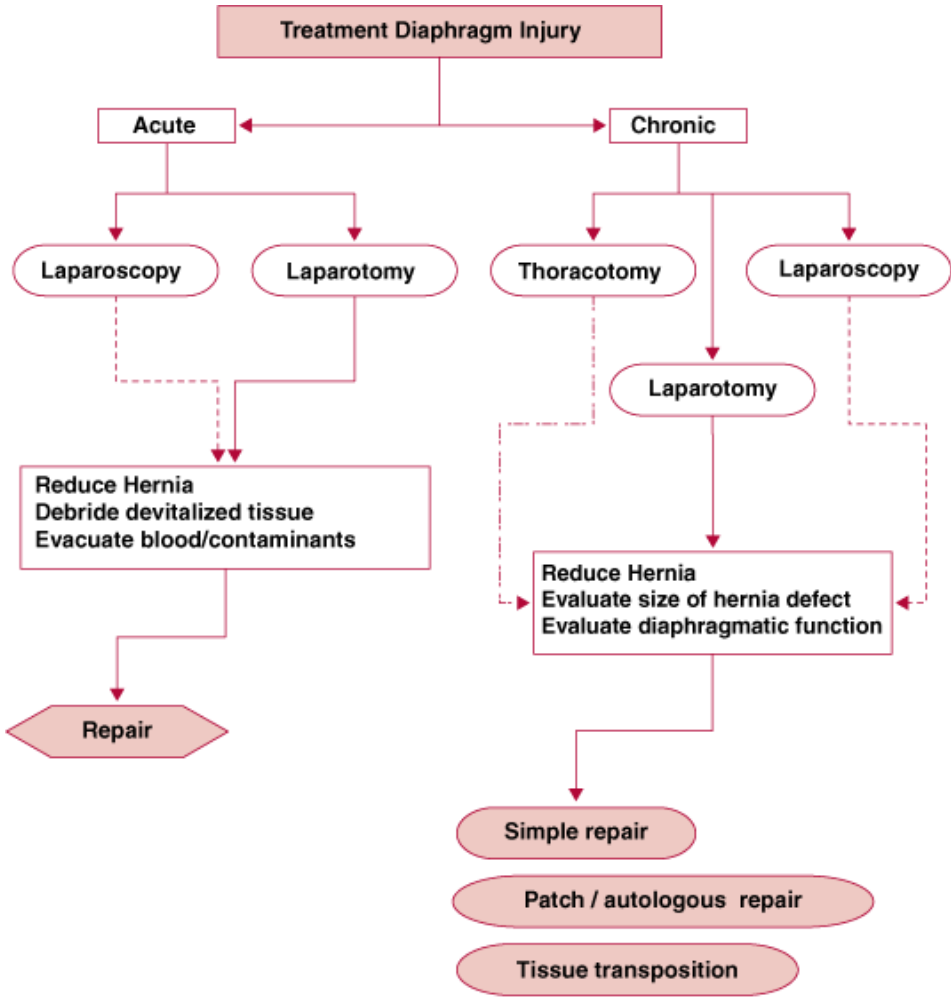

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Conclusions

- **Traumatic injuries of the diaphragm are often clinically silent However, the results of a missed injury can be catastrophic. Clinical suspicion must be high.**

- **Chest X-ray is the initial screening option followed by helical CT**

- **Optimal treatment of consists of early repair via laparotomy w/ careful evaluation of other associated visceral injury**

- **With an increase in experience and expertise, laparoscopy and thoracoscopy, are finding their places in both diagnosis and definitive management of thoracoabdominal trauma with occult diaphragmatic injuries in stable patients**

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