Ode to the Diaphragm

Management of Penetrating Thoracoabdominal Injuries

Julie Miller
Royal Melbourne Hospital
University of Melbourne
Penetrating Injury of the Diaphragm

Suspicion of Injury

Occult Diaphragmatic Injury from Stab Wounds to the Lower Chest and Abdomen

Madden, et al. J Trauma, 1989
Physiology

- Unsung workhorse of the body
- Creates (-) intrathoracic pressure
- Pleuroperitoneal gradient
  - supine position: +7 to +20 cm H$_2$O
  - peak inspiration: > 100 cm H$_2$O
Penetrating Injury of the Diaphragm

Natural History if Untreated

- Atrophy and retraction of diaphragm
- Progressive herniation of abdominal viscera
  - Cardiorespiratory compromise
  - Obstruction, strangulation

Marchand, et al. Thorax, 1957
Bernatz, et al. JAMA, 1958
Bark, et al. Resp Dis, 1988
Penetrating Injury of the Diaphragm Incidence in Thoracoabdominal Wounds

All patients

- **50%**: (n=100)  

- **42%**: (n=119)  
  - 31% non-tender abdomen
  - 40% normal CXR; 49% hemo-ptx
Penetrating Injury of the Diaphragm
Incidence in Thoracoabdominal Wounds

Stable patients without peritonitis

  - incidence similar for anterior, lateral, and posterior injuries

- **28%** \((n=80)\) McQuay & Britt, \textit{Ann Surg}, 2003
  - 27% were R-sided
Penetrating Injury of the Diaphragm

Diagnosis

- **CXR**: diagnostic in only 30%
- **CT scan**: typically unhelpful
- **DPL**: 34% false (-), including 3 reported cases with RBC count = 0
- *The only way to see the diaphragm is to see the diaphragm*

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References:

Madden, et al. J Trauma, 1989
Miller, et al. J Trauma, 1984
Alyono, et al. Surgery, 1992
Penetrating Injury of the Diaphragm

Surgical Repair

- Acute phase: abdominal approach
  - 60-80% associated injury

- Chronic phase: thoracic approach or combined thoracotomy / laparotomy

- Interrupted horizontal mattress sutures
  - non-absorbable
Penetrating Injury of the Diaphragm

Sequelae of Missed Injury

Tension fecopneumothorax due to colonic perforation in a diaphragmatic hernia

_Chest. 115: 288-91, Jan, 1999_

- 2 years after stab wound to left chest
- patient survived

- 11 total cases reported
Penetrating injury of the diaphragm

Sequelae of Missed Injury
Penetrating injury of the diaphragm

Sequelae of Missed Injury
“Lesson of the week” BMJ 2008

15yo boy

- Stabbed L posterior chest, 9th interspace
- HD stable
- L haemopneumothorax drained
- CT scan – no visceral injury
- Discharged home day 7
Penetrating injury of the diaphragm

Sequelae of Missed Injury

Obstruction-strangulation of post-traumatic diaphragmatic hernia - delayed diagnosis and fatal outcome


- Series of 9 cases
- History of penetrating trauma (6 mos-18 yrs)
- 4 / 9 (44%) died
Penetrating injury of the diaphragm
Sequelae of Missed Injury

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Diaphragmatic herniation after penetrating trauma
[Original Articles]


Department of Surgery, Baragwanath Hospital, University of the Witwatersrand Medical School, Johannesburg, South Africa

Correspondence to: Mr E. Degiannis, Department of Surgery, University of the Witwatersrand Medical School, 7 York Road
Burg, South Africa
Penetrating injury of the diaphragm

Sequelae of Missed Injury

- case series of 45 penetrating injuries

<table>
<thead>
<tr>
<th>dx</th>
<th>n</th>
<th>died</th>
<th>LOS</th>
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</thead>
<tbody>
<tr>
<td>early</td>
<td>0-72hr</td>
<td>29</td>
<td>3%</td>
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<tr>
<td>late</td>
<td>5m-9y</td>
<td>16</td>
<td>25%</td>
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Diaphragmatic herniation after penetrating trauma

*British Journal of Surgery. 83:88-91, Jan, 1996*
Penetrating Injury of the Diaphragm

Summary

- The incidence of diaphragmatic injuries after penetrating thoracoabdominal trauma is high.
- Failure to diagnose diaphragmatic injury leads to increased morbidity and mortality.
- Clinical, radiologic, and lavage findings are unreliable.
Penetrating Thoracoabdominal Injury

Management Guidelines

ABC’s

Insert ICC if needed

CXR, FAST

Indication for surgery?
- HD instability
- peritonitis
- massive hemothorax
- impalement

Laparotomy or thoracotomy. Inspect diaphragm

No indication for surgery?

Laparoscopy

* have chest tube ready

Hole in diaphragm?

Laparotomy
Penetrating Injury of the Diaphragm

Conclusion

Patients with this:

Who don’t need this

Need this:
3m followup

- Clinically well
- CXR normal
- discharged
One year later

- Sudden severe epigastric pain
- Dysphagia, blood-stained vomit
- Constitutionally unwell, LUS shows:
- Decreased air entry L chest
Laparotomy

- Entire stomach strangulated through 4cm defect in diaphragm
- Irreversible ischaemia
- Total gastrectomy, roux-en-y
Ambrose Paré, 1579

- **Case report**: French artillery captain

- Died of colonic obstruction & sepsis 8 months after GSW left chest

- **Autopsy**: colon strangulated and gangrenous within diaphragmatic rent

- “a hole only large enough to admit the tip of the little finger....”
Anatomy

- Dome - shaped
- The diaphragm rises to
  - T4 on the right
  - T5 on the left
- \[
\text{any missile at or below nipple (T4) has a potential intra-abdominal course}
\]
Definition:
“Thoracoabdominal”

- Anteriorly: nipple to costal margin
- Posteriorly: scapular tips to costal margin