Chest Wall Trauma: A Change in Perspective
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Nothing to disclose.
Objectives

1. Overview of Thoracic Trauma and Rib Fractures
2. Traumatic pneumothorax/hemothorax drainage
3. Early VATS for retained traumatic hemothorax
4. Rib and sternal fixation

Thoracic Trauma

• Thoracic trauma comprises 10-15% of all traumas
• Result in 25% of all trauma fatalities
• 70% of thoracic traumas are blunt, with the majority involving fractures of ribs 4 – 9
• Blunt: < 10% require operation
• Penetrating: 15-30% require operation
• Majority of thoracic trauma requires only simple procedures
Traumatic Pneumothorax and Hemothorax Drainage

“Old School” Thinking
- The bigger, the better
- 32–40 Fr chest tube to drain traumatic pneumothorax/hemothorax

“New School” Thinking
- Smaller is just as effective and results in less tissue damage and more comfort
- 14-Fr pigtail catheters work just as well to drain traumatic pneumothorax and hemothorax

Pleural Space Drainage

<table>
<thead>
<tr>
<th></th>
<th>CT (n = 307)</th>
<th>PC (n = 189)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr), mean ± SD</td>
<td>42 ± 19</td>
<td>52 ± 21</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Gender (male), %</td>
<td>77%</td>
<td>76%</td>
<td>0.69</td>
</tr>
<tr>
<td>Blunt, %</td>
<td>55%</td>
<td>86%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ISS, median (IQR)</td>
<td>17 (10, 29)</td>
<td>16 (10, 26)</td>
<td>0.09</td>
</tr>
<tr>
<td>Chest AIS, median (IQR)</td>
<td>3 (3, 4)</td>
<td>3 (3, 3)</td>
<td>0.07</td>
</tr>
<tr>
<td>Day tube inserted, median (IQR)</td>
<td>0 (0, 1)</td>
<td>1 (1, 3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Initial output (ml), median (IQR)</td>
<td>300 (150, 500)</td>
<td>425 (200, 800)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tube days, median (IQR)</td>
<td>5 (4, 7)</td>
<td>4 (2, 6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Insertion-related complications, n (%)</td>
<td>14 (5%)</td>
<td>17 (8.5%)</td>
<td>0.11</td>
</tr>
<tr>
<td>Failure rate, n (%)</td>
<td>73 (24%)</td>
<td>39 (21%)</td>
<td>0.39</td>
</tr>
<tr>
<td>VATS, n (%)</td>
<td>35 (13%)</td>
<td>7 (4%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ventilator days, median</td>
<td>0 (0, 3)</td>
<td>0 (0, 1)</td>
<td>0.01</td>
</tr>
<tr>
<td>ICU day, median</td>
<td>2 (0, 6)</td>
<td>1 (0, 5)</td>
<td>0.06</td>
</tr>
<tr>
<td>Hospital length of stay (days), median</td>
<td>8 (5, 14)</td>
<td>7 (4, 14)</td>
<td>0.47</td>
</tr>
<tr>
<td>Mortality, %</td>
<td>8%</td>
<td>3%</td>
<td>0.02</td>
</tr>
</tbody>
</table>
## New Prospective Trial

<table>
<thead>
<tr>
<th></th>
<th>Pigtail Catheters (N = 20)</th>
<th>Chest Tubes (N = 23)</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Output (median)(IQR)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 24 hrs</td>
<td>650mL (375, 1087)</td>
<td>400mL (240,700)</td>
<td>0.06</td>
</tr>
<tr>
<td>- 48 hrs</td>
<td>980mL (600, 1625)</td>
<td>660mL (430, 1000)</td>
<td>0.10</td>
</tr>
<tr>
<td>- 72 hrs</td>
<td>300mL (110, 424)</td>
<td>225mL (90, 400)</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>50mL (0, 200)</td>
<td>130mL (0, 260)</td>
<td>0.54</td>
</tr>
<tr>
<td><strong>Failure Rate</strong></td>
<td>10%</td>
<td>17%</td>
<td>0.49</td>
</tr>
<tr>
<td><strong>Tube Days (median)(IQR)</strong></td>
<td>3 (3,5.5)</td>
<td>4 (2,7)</td>
<td>0.79</td>
</tr>
<tr>
<td><strong>Insertion Complications</strong></td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>IPE (median)(IQR)</strong></td>
<td>1 (1,2)</td>
<td>3 (3,4)</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>ICU Days (median)(IQR)</strong></td>
<td>0 (0, 3.5)</td>
<td>0 (0, 3)</td>
<td>0.86</td>
</tr>
<tr>
<td><strong>Hospital Days (median)(IQR)</strong></td>
<td>6.5 (4.5, 10)</td>
<td>7 (3, 9)</td>
<td>0.54</td>
</tr>
</tbody>
</table>

## Insertion Perception Experience

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>It was okay, I can tolerate it, I can do it again</td>
</tr>
<tr>
<td>2</td>
<td>It was okay, but I don’t want to go through this again</td>
</tr>
<tr>
<td>3</td>
<td>It was a bad experience for me</td>
</tr>
<tr>
<td>4</td>
<td>It was a worse experience for me</td>
</tr>
<tr>
<td>5</td>
<td>It was the worst experience of my life! I never want to have this done again</td>
</tr>
</tbody>
</table>
VATS for Retained Hemothorax

Early VATS for Retained Hemothorax

- Radiographically apparent hemothorax after tube thoracostomy
  → 33% rate of empyema (Karmy-Jones R et al. Can Respir J.)

- If retained hemothorax within 72 hours of initial chest tube placement
  → Patients benefited from early VATS (3-7 days) as opposed to second chest tube
  - Shorter duration of chest tube drainage
  - Shorter duration in hospital stay
  - Significantly less hospital costs
  - Almost half the patients that had a second chest tube still required surgery (Meyer DM et al. Ann Thoracic Surg.)
Retained Hemothorax

What about thrombolytics??

• Currently in trauma, it is considered a second-line intervention behind VATS

(Rguzukaya F et al. Injury.)

Rib and Sternal Fractures
• What happens if you break your arm/hand?
• What happens if you break your arm/hand?
  • Your leg/foot?
• What happens if you break your arm/hand?
  • Your leg/foot?
    • Your pelvis?
      • Your back/neck?
        • Your clavicle/scapula?
          • Your face?

What about your ribs??
Traditional Treatment for Rib Fractures

- Pain medications (Narcotics)
- Muscle relaxants
- Lidocaine patches
- Anti-inflammatory agents
- Aggressive pulmonary hygiene
- Epidural/Rib block
- Ketamine/Lidocaine drip
Chest Wall Trauma

• 39% of patients with blunt thoracic trauma will have multiple rib fractures.

• National Trauma Database Study 1994-2003
  1 Rib Fracture = 5.8% Mortality
  5 Rib Fractures = 10% Mortality
  7 Rib Fractures = 15% Mortality
  8 or More Rib Fractures = **34.4% Mortality**

  Flail Chest Alone = 17% Mortality
  Flail chest + Pulmonary Contusions = **42% Mortality**

  Presence of 1st Rib Fracture = 36% Mortality

• 70% of patients with rib fractures are still not back to full work capacity at 6 months

• 60% of patients with rib fractures are still having pain at 1 year from injury

Witt et al. TSACO. 2017

Chest Wall Trauma

• Over the age of 65…

  • The risk of pneumonia **increases by 27%** with each rib fracture!!

  • Mortality **increases by 19%** for each rib fractured!!

  • Mortality for patient’s with blunt chest trauma is nearly double for those over 65 years of age compared with those under 65 even when the Injury Severity Score is the same or less!!

  • Morbidity, Hospital LOS and ICU Length of Stay is higher for those >65 y/o after sustaining 3 rib fractures

Kane ED et al. JACS. 2018
Surgical Stabilization of Rib Fractures

- Still a very new procedure
- Still a lot of controversy sounding it
- Time to fixation?
  - Most studies would argue within the first 24-72 hours of injury
- Who do we offer surgical stabilization?
- Traumatic brain injured patients?
Surgical Stabilization of Rib Fractures

What do we know?

- Patients with 3 or more rib fractures benefit from surgical fixation compared to those who are managed non-operatively.

- Patients 65 years or older, benefit more from surgical fixation than those younger than 65.

Kane et al. JACS. 2018
Surgical Stabilization of Rib Fractures

What do we know?  (Pieracci et al. *J Trauma*. 2018)

- Early surgical fixation results in decrease in operative time by 68 minutes
- Each additional hospital day before surgical fixation was independently associated with:
  - 31% increased likelihood of pneumonia
  - 27% increased likelihood of prolonged ventilation
  - 26% increased likelihood of tracheostomy
Surgical Stabilization of Rib Fractures

Flail chest patients should be given strong consideration for rib fixation:

- Improved mortality (OR 0.3)
- Decreased ventilator days (6.07 days)
- Decreased ICU LOS (4.21 days)
- Decreased hospital LOS (7.63 days)
- Decreased incidence of pneumonia (OR 0.24)
- Decreased need for tracheostomy (OR 0.24)
- Increase in inspiratory volume and peak flows by 71%

Kasotakis G et al. J Trauma. 2017
Pieracci FM et al. J Trauma. 2015
Slobogean GP et al. Arch Trauma Res. 2015
Surgical Stabilization of Rib Fractures

- Non-flail rib fractures and fixation is the area still in question among the trauma community
- Lack of prospective studies

Surgical Stabilization of Rib Fractures: A Single Institution Experience (Kane ED et al. JACS. 2017)
- 116 patients with at least 3 rib fractures undergone SSRF
- Retrospective and Propensity matching
- No difference in ventilator use
- 12% decrease in mortality
- 13% decrease in pneumonia incidence
- 9% decrease in mortality for those patients 65 and older
Surgical Stabilization of Rib Fractures

Indications:
- Active and reliable person
- Pulmonary compromise
- Severe pain
- <50% predicted on Incentive Spirometry
- If they feel the fractures moving
- Going for another procedure (VATS, etc)

My Technique:
- Muscle sparing technique
- No standard incision
- 3D recon of the chest
- 2cm from the transverse processes
- Most will get a 14Fr pigtail catheter
- Don’t always plate all the ribs
- +/- Cryoablation
Cryoablation

• Freezing the nerves to -70 degrees Celsius

• Axonotmesis
  • Disruption of the myelin and nerve axon creating a nerve lesion without destruction of perineural structures

• Wallerian degeneration – distal degeneration of the nerve axon

• Nerve regeneration occurs at 1-2mm/day
What is rib fixation potentially preventing?
Surgical Stabilization of Traumatic Sternal Fractures

• Literature is extremely scare in this area

• Anecdotally, it works great!
# Surgical Stabilization of Traumatic Sternal Fractures

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Pre-Fixation (n=13)</th>
<th>Post-Fixation (n=13)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain Score (±SD)</td>
<td>7.08 (2.32)</td>
<td>3.54 (2.5)</td>
<td>0.0013</td>
</tr>
<tr>
<td>Total Number of Medications Taken (±SD)</td>
<td>4.23 (1.01)</td>
<td>3.23 (1.36)</td>
<td>0.0018</td>
</tr>
<tr>
<td>IV Hydromorphone Amount (mg)(±SD)</td>
<td>1.31 (2.35)</td>
<td>0.18 (0.31)</td>
<td>0.0416</td>
</tr>
<tr>
<td>PO Oxycodone Amount (mg)(±SD)</td>
<td>44.36 (30.9)</td>
<td>42.31 (37.8)</td>
<td>0.3931</td>
</tr>
<tr>
<td>Total Narcotic Conversion to Oxycodone (mg)(±SD)</td>
<td>61.9 (44.5)</td>
<td>44.8 (39.04)</td>
<td>0.0405</td>
</tr>
<tr>
<td>Full Range of Motion Upper Extremity (n)</td>
<td>0</td>
<td>12</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Bauman ZB et al. ACS. 2018
Summary

- 14Fr pigtail catheters are just as good as large bore chest tubes
- Early VATS for retained HTX → 3 to 7 days
- Rib fixation for flail chest should be strongly considered. For non-flail rib fractures and sternum fractures → conditional fixation.
- Sternal fixation should be strongly considered for patient with traumatic sternal fractures to reduce pain and narcotic use.
Thank You