Flail chest

- Definition and incidence
- Complications
- Treatment
- Pitfalls
- Future
Flail chest

Defined as 4 consecutive rib # in 2 or more locations (bilateral and sternum)
Large enough for paradoxical motion visible with respiration
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Large enough for paradoxical motion visible with respiration
Aim of chest?

- Ventilation
  - Diaphragm
  - Rigid chest wall
Facts and numbers

1% trauma patients with ISS > 9
  - 75% MVC
  - 16% falls
50% lung contusion
45% chest tube
60% intubation
20% pneumonia
12 ICU LOS days
16% death

Dehghan. J Trauma 2013
Pulmonary contusion

- 50% of patients
- Contribute perfusion mismatching and poor oxygenation
- Delayed radiologic evidence
Causes of death:

- Pneumonia (sepsis, MOF)
- Tension Pneumothorax (barotrauma)
- Hypoxia
Treatment:

- Pain management with physiotherapy
  - Pulmonary toilette
- Positive pressure ventilation (pneumatic stabilization)
- Operative rib fixation
Role of physiotherapy and pain control
PAIN

- Pain (and not mechanical failure) is the most common cause of poor inspiratory effort and pulmonary toilet
- Results in atelectasis as alveoli collapse
- Leads to pneumonia
Multimodal pain treatment

Patient-controlled analgesia (magic button):
- Fentanyl / Morphine

Paracetamol + Non Steroidal anti inflammatory

Stool softener

Blocks

Ketamine / neuroleptics
Thoracic epidural anaesthesia

Good pain control
- reduces pneumonia, LOS

Complications (relative common):
- Bilateral spreading
- Hypotension
- Motor deficit
- Bleeding (contraindicated if any coagulopathy)

Logistically demanding (not timely placed)
Paravertebral blocks

Unilateral block of spinal nerve (dorsal and ventral rami) and sympathetic chain ganglion

- Similar effect to epidural (RCT in thoracotomy)
- Less complicated
- Preferred
- Coagulopathy: OK
Continuous Intercostal Nerve Blockade

2 catheters on top of each broken ribs and elastomer:
- Placed by surgeon at the bedside under L/A
- Provide adequate pain control
- Improve pulmonary toilet
- Continued as outpatients (reduced LOS)
### Positive pressure ventilation pneumatic stabilization

<table>
<thead>
<tr>
<th></th>
<th>NIV</th>
<th>ETI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygenation</td>
<td></td>
<td>similar</td>
</tr>
<tr>
<td>Barotrauma (pnx)</td>
<td></td>
<td>similar</td>
</tr>
<tr>
<td>ICU LOS</td>
<td></td>
<td>similar</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>10%</td>
<td>50%</td>
</tr>
<tr>
<td>Pt compliance</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Costs</td>
<td>low</td>
<td>more</td>
</tr>
</tbody>
</table>
Surgical fixation

- 3 RCT
  - Reduced ICU stay, ventilation days
  - Similar long term outcome
  - Limits:
    - series over long period
    - vague inclusion criteria
    - different techniques

- Comparison with our experience:
  - Similar results to best (operative) arm

Tanaka. J Trauma 2002
Granetzny. Car Thor Surg 2005
Surgical fixation

Severe TBI excluded

<table>
<thead>
<tr>
<th>Table 3. Outcomes</th>
<th>Operative group (n = 23)</th>
<th>Nonoperative group (n = 23)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of ICU stay prerandomization, h, mean ± SD</td>
<td>61.6 ± 36.1</td>
<td>81.3 ± 84.2</td>
<td>0.31</td>
</tr>
<tr>
<td>Duration of ICU stay between randomization and surgery, h, mean ± SD</td>
<td>49.4 ± 35.9</td>
<td>N/A</td>
<td></td>
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<tr>
<td>Duration of IMV postrandomization, h, mean ± SD</td>
<td>151.8 ± 83.1</td>
<td>181.0 ± 130.2</td>
<td>0.37</td>
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<tr>
<td>Duration of ICU stay postrandomization, h, median (IQR)</td>
<td>285 (191–319)</td>
<td>359 (270–581)</td>
<td>0.03</td>
</tr>
<tr>
<td>Total ICU stay, h, median (IQR)</td>
<td>324 (238–380)</td>
<td>448 (323–647)</td>
<td>0.03</td>
</tr>
<tr>
<td>Failed extubation, n (%)</td>
<td>3 (13)</td>
<td>1 (4)</td>
<td>0.61</td>
</tr>
<tr>
<td>Received NIV postextubation, n (%)</td>
<td>13 (57)</td>
<td>19 (83)</td>
<td>0.05</td>
</tr>
<tr>
<td>Duration of NIV postextubation, h, median (IQR)</td>
<td>3 (0–25)</td>
<td>50 (17–102)</td>
<td>0.01</td>
</tr>
<tr>
<td>Tracheostomy, n (%)</td>
<td>9 (39)</td>
<td>16/23 (70)</td>
<td>0.04</td>
</tr>
<tr>
<td>Patients requiring blood product transfusion, n</td>
<td>18</td>
<td>19</td>
<td>0.78</td>
</tr>
<tr>
<td>Packed cell transfusion during inpatient stay, mL, median (IQR)</td>
<td>620 (0–3,100)</td>
<td>1,240 (620–3,100)</td>
<td>0.39</td>
</tr>
<tr>
<td>Total blood products transfused, mL, median (IQR)</td>
<td>930 (620–1,860)</td>
<td>900 (500–1,395)</td>
<td>0.57</td>
</tr>
<tr>
<td>Readmission to ICU, n (%)</td>
<td>2/23 (9)</td>
<td>2/23 (9)</td>
<td>0.99</td>
</tr>
<tr>
<td>ICCs required, n, median (IQR)</td>
<td>2 (1–4)</td>
<td>2 (1–4)</td>
<td>0.99</td>
</tr>
<tr>
<td>Pneumonia, n (%)</td>
<td>11/23 (48)</td>
<td>17/23 (74)</td>
<td>0.07</td>
</tr>
<tr>
<td>Duration of hospital stay, d, median (IQR)</td>
<td>20 (18–28)</td>
<td>25 (18–38)</td>
<td>0.24</td>
</tr>
<tr>
<td>In hospital mortality, n</td>
<td>0</td>
<td>1</td>
<td>0.87</td>
</tr>
</tbody>
</table>

ICC, intercostal catheter; IMV, invasive mechanical ventilation; IQR, interquartile range; NIV, noninvasive ventilation.
Surgical fixation

- Proper RCT required (power calculation: 300 pt)
- Patient selection:
  - Non union
  - Flails
  - Pain
  - Deformity
- Timing to repair
- Method of repair
Recurrent haemothorax

Thoracoscopy
Rib reduction/fixation
Future....

Better blocks
Better pneumatic stabilization
Better patient selection

...in the mean while

Provide what available in a timely fashion
Move from treatment of complications to complication prevention
Remember to cough every 15 minutes to keep chest clear.
Questions?