Rib Fracture Stabilization

Thomas Varghese Jr, MD, MS, FACS
Director of Thoracic Surgery – Harborview Medical Center
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Aims

- Identify critical issues in the continuum of care for adult trauma patients with rib fractures
- Discuss new modalities and cutting-edge advances in traumatic chest trauma care

Disclosures

Grants

- Strong for Surgery
- AHRQ, Life Science Discovery Fund, Nestle
- UW Patient Safety Innovation Program
- UW Dept. of Surgery
- Chest Procedures Simulation Project
- Department of Defense

None relevant to current presentation
Background

- Rib Fractures
  - 350,000 people/yr US
- Blunt Thoracic Trauma
  - 10% of all trauma patients
  - 30% of patients with significant chest trauma
- 1/3 → Hospitalization
- 1/3 → Complications

Rib Fractures: Syndromes

- Flail Chest
  - Multiple ribs, more than one location
  - Paradoxical movement w/respiration
  - 10-20% of trauma admissions, 20% mortality
- Chest Wall Implosion
  - Multiple displaced rib fx (posterolateral)
  - Clavicle Fracture
  - +/- Scapula Fracture

Rib Fractures: Complications

Short-Term
- Chest Wall Defect
- Pulmonary Herniation
- Pneumonia
- ARDS
- Respiratory Failure

Long-Term
- Nonunion
- Disability
Rib Fractures: Disability

- Uncomplicated rib fracture
  - Lost an average 70 days of work

- Crush injury w/severe chest wall deformities
  - Significant long-term disabilities
    - Chest wall pain
    - Chest wall deformity
    - Exertional dyspnea

J Trauma 2003; 54(6):1058

Rib Fractures in the Elderly

J Trauma 2000;48(6): 1040-47

<table>
<thead>
<tr>
<th>Table 4. Outcome measures</th>
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<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>Mean ventilator days</td>
</tr>
<tr>
<td>Mean ICU days</td>
</tr>
<tr>
<td>Mean hospital days</td>
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<td>Mortality (%)</td>
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ICU, intensive care unit.
Epidural analgesia improves outcome after multiple rib fractures

John D. Boger, MD, Thomas Curreri, PhD, MS, Patricia Brier, RN, and
James J. Kedchic, MD, Seattle, WA

Table 1. Demographics and injury severity

<table>
<thead>
<tr>
<th></th>
<th>Epidural</th>
<th>Opioids</th>
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<tbody>
<tr>
<td>(n = 22)</td>
<td>(n = 24)</td>
<td>P value</td>
</tr>
<tr>
<td>% male</td>
<td>77%</td>
<td>67%</td>
</tr>
<tr>
<td>Age (y)**</td>
<td>69 ± 18</td>
<td>66 ± 16</td>
</tr>
<tr>
<td>ISS*</td>
<td>26 ± 8</td>
<td>25 ± 8</td>
</tr>
<tr>
<td>APACHE II*</td>
<td>13 ± 3</td>
<td>11 ± 3</td>
</tr>
<tr>
<td>Chest X-ray*</td>
<td>5.7 ± 0.7</td>
<td>5.7 ± 0.8</td>
</tr>
<tr>
<td>Head AIS*</td>
<td>2 ± 1</td>
<td>1 ± 1</td>
</tr>
<tr>
<td>No. of rib Fr*</td>
<td>7.2 ± 3.2</td>
<td>6.8 ± 3.3</td>
</tr>
<tr>
<td>Fluid aspirated</td>
<td>8 (38%)</td>
<td>5 (21%)</td>
</tr>
<tr>
<td>Chest tube</td>
<td>21 (95%)</td>
<td>17 (71%)</td>
</tr>
</tbody>
</table>

*All abbreviations: AIS, Injury Severity Score; APACHE, Acute Physiology and Chronic Health Evaluation; ISS, Injury Severity Score; Fr, fractures.
Goals of Management

- Control Pain
- Support Respiratory Function
- Stabilize Chest Wall
  - Mechanical Ventilation
  - Surgical Fixation

Team Approach

Technical Issues

- Ribs are elastic
- Ribs have a thin cortex (1-2mm)
- Neurovascular bundle
Pathology of Rib Fracture

- Clot, tissue, fibroblasts
- Parietal pleura tear

Pathology of Rib Fracture after 7 days

- Inflammatory peel on surface of rib fx’s
- Displaced rib fx’s

Guidelines

- East Trauma practice guidelines 2006
  - Surgical fixation Level III recommendation for management of flail chest

http://www.east.org/tpg/pulmcontflailchest.pdf
Survey

- Operative fixation not widely practiced
- Survey of trauma/thoracic surgeons in US
  - Majority felt fixation was appropriate for select patients
  - Only 26% had been involved in such a case

J Trauma 2009; 66(3):875

Flail Chest

- Reduction of Pain and Instability
  - Despite Epidural and Narcotics
- Chest Wall Deformity / Defect
- Symptomatic Rib Fracture Non-union
  - Non-union: >3 months
- Thoracic Procedure for other indications


Operative Management

- Rib resection
- ORIF
  - Plate
  - Anterior plates
  - U-plates
  - Intramedullary fixation
  - Wiring
U-plate

Anterior Plates/Intramedullary Pin

Anterior Plates/Intramedullary Pin
Traditional Lateral & Posterolateral Thoracotomy Incisions.

Posterolateral Thoracotomy

Posterolateral Thoracotomy

 Courtesy: Mario Gasparri MD
Posterolateral Thoracotomy

Anterior Longitudinal Incision
Divides the serratus at insertion sites

Operations on flail chest: Sternum.
Operative Planning
- CT w/3D reconstruction
- VATS
  - Aid fracture fixation
  - Evaluate retained HTX
  - Repair associated injuries (diaphragm rupture)

Incision
- Muscle sparing techniques
- Anterior port placed first
- Inferior Camera port
- Small (8cm), localized incisions (up to 3 ribs)
Known Risks

- 650 rib fracture repairs 1975-2008
  - Stiffness/rigidity/pain requiring removal (1.4%)
  - Superficial wound infections (1.2%)
  - Wound drainage without infection (0.6%)
  - Empyema (0.3%)
  - Wound hematoma (0.2%)
  - Persistent pleural effusion (0.2%)
  - Osteomyelitis (0.2%)
Potential Benefits

- Short term
  - ↓ pneumonia
  - ↓ ventilator days
  - ↓ hospital stay
  - ↓ hospital costs

- Long-term
  - ↓ time loss from work/usual activity
  - ↓ pain and disability
  - Maintaining pre-injury lung function

Challenges

- Lack of standardized definitions
  - Early fixation: within 7 days

- Outcomes
  - Patient-centered outcomes needed

Nomenclature for Types of Rib Fractures

| Simple, transverse, no fragmentation | STN |
| Simple oblique, no fragmentation     | SON |
| Green Stick fractures                | GS  |
| Comminuted, localized                | CL  |
| Segmental, intercostal muscle intact | Si  |
| Segmental, intercostal muscle torn   | Sit |
| Segmental, muscle devascularized     | Sid |
| Posterior ribs, floating, denervated | PRD |
| Rib cage, > 2 ribs and muscles destroyed | RCD |

Courtesy: Bill Long MD
Case Presentations

Case 1

- 43yom, restrained passenger HSMVC
- Injuries
  - Bilateral pneumothoraces
  - R 3-7 rib fractures
  - R clavicle fracture
  - R Pulmonary contusion
  - Facial fractures
  - R pararenal hematoma
  - L3-L4 transverse process fracture

Hospital Course

- Initial therapy
  - Non-operative management
  - Supportive care (mechanical ventilation)
- Complicated by
  - Extrapleural chest tube placement
  - Retained extra/intra-pleural hemothorax
  - Respiratory failure
    - HD#1 failed 2 SBT
    - HD#2 reintubated 2 hours after extubation
Step 1: Patient Positioning

Position and Incisions

Additional Incisions
Step 2: Exposure

Step 3: Rib measurement for Plate selection

Step 4: Targeting Guide
Step 5: Contour Plate

Step 6: Drill Bone for Screw Insertion

Step 7: Secure Plate
Step 8: Final adjustments

Fracture Identification

End Intraoperative Result
Post-Operative CXR

Case

- 33 yr old male professional bull rider
  - Trampled by a bull during a rodeo
  - You-tube video
    - 2:25 – 2:45
Case

- 33 yr old male professional bull rider
  - Trampled by a bull during a rodeo
- You-tube video
  - 2:25 – 2:45
- Injuries: Right hemopneumothorax, bronchopleural fistulae. Left pneumothorax, Right 2nd to 9th rib fractures with flail. Left 1st, 2nd and 12th rib fractures, Left clavicle fracture, left scapula fracture

Hospital Course

- 10/2/11
  - Bronchoscopy
  - Bilateral Chest tubes
  - ARDS
- 10/5/11
  - Desaturation episodes: 5 chest tubes (3 on right, 2 on left)
  - VA Pneumonia
- 10/28/11
  - Bronchoscopy, Right Thoracotomy, Decortication, Right upper lobe wedge resection, Open repair of BP fistulae, ORIF 4th and 6th rib fractures
- 11/2/11
  - Trach + PEG
  - Weaned from vent
  - DC home 12/9/11
Operative management of rib fractures is possible

Team approach is key

Need for multicenter prospective database

Standardized definitions
Tuesday October 8th 8am – 9:30am Eastern
Panel Session PS201
Managing Thoracic Trauma
Webcast

Moderator: Thomas Varghese Jr MD, MS, FACS
Speakers: Thomas Varghese Jr MD, MS
Bill Long MD
Mario Gasparri MD
John Mayberry MD