LUNG AND CHEST WALL INJURY

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I have no disclosures
Lung Injury

- **Mechanism:** blunt vs penetrating

- **Treatment** is nearly always nonoperative with focus on respiratory optimization
  - Incentive spirometry, deep breathing, cough, early ambulation
  - Chest physiotherapy: cough assist, percussion

- **Hemorrhage** may be indication for surgical intervention. Chest tube output should guide this decision.
  - Blunt: initial output >1500cc
  - Penetrating: initial output > 1000cc
  - >200cc/h over 2-4 hours
  - *Hemodynamics are most important factor*
  - Important to ensure coagulopathy corrected
Rib Fractures
Rib Score

- Used to relate anatomical CT radiographic findings with pulmonary outcome
- Retrospectively developed and validated scoring system
- Linearly associated with adverse pulmonary outcomes
  - Pneumonia
  - Acute hypoxic respiratory failure
  - Need for tracheostomy
- Goal to standardize communication surrounding rib fractures akin to solid organ injury

### RibScore

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Points</th>
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<tbody>
<tr>
<td>≥ 6 fractures</td>
<td>1</td>
</tr>
<tr>
<td>Flail chest</td>
<td>1</td>
</tr>
<tr>
<td>Bilateral fractures</td>
<td>1</td>
</tr>
<tr>
<td>≥ 3 severely displaced fractures</td>
<td>1</td>
</tr>
<tr>
<td>≥ 1 anterior, lateral, and posterior fracture</td>
<td>1</td>
</tr>
<tr>
<td>First rib fracture</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6</strong></td>
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Rib fracture scoring systems lack serial physiological variables to track progression

SCARF score developed to trend patients and predict adverse outcomes

Prospective cohort study (340 scores across 100 patients)

Each physiologic variable selected based on relationship with pulmonary reserve

Response to interventions assessed using score: failure designated as SCARF score >2

**The Sequential Clinical Assessment of Respiratory Function (SCARF) score:** A dynamic pulmonary physiologic score that predicts adverse outcomes in critically ill rib fracture patients

Kimberly S. Hardin, ACNP, Kiara N. Leasia, MD, James Haenel, RRT, Ernest E. Moore, MD, Clay Cothren Burlew, MD, and Fredric M. Pieracci, MD, MPH, Denver, Colorado

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Points</th>
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<tbody>
<tr>
<td>Number Pain Score ≥ 5</td>
<td>1</td>
</tr>
<tr>
<td>Incentive spirometry &lt; 50% predicted</td>
<td>1</td>
</tr>
<tr>
<td>Respiratory rate ≥ 20</td>
<td>1</td>
</tr>
<tr>
<td>Poor cough</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
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SCARF Score and Adverse Outcomes

Figure 2. (A), Likelihood of pneumonia for admission SCARF scores, $p = 0.39$. (B), Likelihood of pneumonia for maximum SCARF scores, $p < 0.01$. (C), ROC curve for outcome of pneumonia for admission SCARF scores. (D), ROC curve for outcomes of pneumonia for maximum SCARF scores.
SCARF Score and Prolonged ICU Stay

Figure 3. (A), Likelihood of prolonged ICU LOS for admission SCARF scores. $p < 0.01$. (B), Likelihood of prolonged ICU LOS for maximum SCARF scores. $p < 0.01$. (C), ROC curve for outcome of prolonged ICU LOS for admission SCARF scores. (D), ROC curve for outcome of prolonged ICU LOS for maximum SCARF score.
SCARF Score and Narcotic Use

![Bar chart showing the relationship between SCARF Score and median daily narcotic equivalents. The chart indicates that as SCARF Score increases, the median daily narcotic equivalents also increase.]
Outcome after surgical stabilization of rib fractures versus nonoperative treatment in patients with multiple rib fractures and moderate to severe traumatic brain injury (CWIS-TBI)

- Aimed to evaluate outcome of rib plating in patients with TBI
- Multicenter, retrospective study: 456 patients of which 111 underwent rib plating
  - GCS used to grade TBI: moderate (GCS 9-12), severe (GCS <9)
- No difference in liberation from the ventilator or ICU/hospital length of stay
- Decreased odd of pneumonia for moderate TBI only, no benefit for severe TBI
- Main impediment to ventilator liberation and likely pulmonary adverse outcomes = TBI > rib fractures
A multicenter, prospective, controlled clinical trial of surgical stabilization of rib fractures in patients with severe, nonflail fracture patterns (Chest Wall Injury Society NONFLAIL)

- Randomized controlled, multicenter study comparing rib plating within 72h to medical management for patients with 3 or more displaced rib fractures
  - 12 centers; 110 patients
  - 51 (46.4%) patients underwent rib plating
- Numeric pain score and pleural space complications were significantly lower in operative group
- Patient reported quality of life significantly improved in operative group at 2 week follow up
- Narcotic use trended towards lower in operative group
Surgical Approach to Rib Fixation

- **Anterior fractures: supine**
  - Incision at inferior edge of pectoralis major
  - Subpectoral flap by dividing pectoralis anterior insertion site
  - Can fixate to costochondral cartilage or even sternum

- **Lateral fractures: lateral decubitus**
  - Muscle sparing: incision anterior to latissimus, skin flaps, mobilize latissimus posteriorly, spread serratus along its fibers

- **Posterior fractures: prone**
  - Incision just lateral to erector spinae muscles
  - Ability to plate limited by distance from spine transverse processes
Positioning/Incision(s)
Anterior Fractures
Working underneath the pectoralis flap

Incisions post op day #2
Positioning/Incision(s)
Lateral Fractures
Positioning/Incision(s)
Lateral Fractures

Retract latissiumus dorsi laterally

Split serratus anterior muscle along its fibers to expose ribs/fractures
Positioning/Incision(s)
Posterior Fractures

Prone positioning with incision lateral to erector spinae muscles
Sternum Fractures

- Indications:
  - Instability on exam: clicking/popping on palpation
  - Associated anterior rib fractures (flail segment)

- Same operative technique as rib plating
  - Center plate over fracture
Operative Sternal Plating
Advanced Options in Chest Wall Injury

- Absorbable plates
  - Titanium plates preferred due to decreased risk of displacement (prospective study)
Advanced Options in Chest Wall Injury

- Advantages: allow clearance of pleural space during procedure, smaller incisions, better cosmesis
- Disadvantages: steeper learning curve with pulley system

RibFix System (Zimmer Biomet)
Thoracoscopic (Internal) Rib Plating System

1) After identifying and reducing fractures via VATS, guide holes are drilled to allow passage of pulley system to internally fixate plate.

2) Pulley system allow for internal placement of plate. Drill sockets are then placed to secure plate with locking screw.

3) Successful placement of internal rib plate

RibFix System (Zimmer Biomet)
Rib Plating at Denver Health

■ Indications:
  - Flail segment or chest (radiographic vs clinical)
  - Three or more bicortically displaced (50% or more)
  - >30% loss of hemithorax volume
  - Persistently, severe physiologic derangement or pain despite optimal medical management as demonstrated by SCARF >2

■ Standardized rib fixation technique:
  - Therapeutic bronchoscopy
  - Muscle sparing incisions to plate all accessible rib fractures (ribs 3-10)
  - Pleural space irrigation and clearance (VATS)
  - VATS guided locoregional pain control (liposomal bupivacaine)
Rib Fracture Physical Therapy Guidelines

Inpatient physical therapy should include but not limited to

• Full mobility evaluation
  – Ability to get into and OOB
  – Strength or ability to generate power
  – Seated and standing dynamic stability
  – Gait analysis
  – Ability to navigate stairs (applicable)

• Additional recommendations for pain control
  – Soft tissue mobilization to surrounding tissue
  – Relaxation techniques
  – Self splinting during cough, sneeze or rolling in bed
  – Ice or heat

• Education
  – Breathing techniques (diaphragmatic, avoiding holding breath with movement, segmental activation, tripod if tolerated)
  – Posture education
  – Importance of avoiding prolonged REST or BEDREST
  – Modification of home setup
  – Modification of work activity

• Additional Interventions
  – Interval pulmonary training
  – Strength training (functional activity and targeted resistance training)
WATER SEAL VS SUCTION

- Controversial decision
- 10 RCTs included in the meta-analysis = 1601 patients after pulmonary surgery
- Findings with suction:
  - Decreased postop PTX
  - Increased duration of chest tube
  - No change in occurrence of prolonged air leak
- Recommendation = selective application of suction for residual/increasing PTX

External suction versus simple water-seal on chest drainage following pulmonary surgery: an updated meta-analysis
Published: 19 July 2018

DOES SIZE MATTER?

A Prospective Study of 7-Year Experience Using Percutaneous 14-French Pigtail Catheters for Traumatic Hemothorax/Hemopneumothorax at a Level-1 Trauma Center: Size Still Does Not Matter

Zachary M. Bauman, Narong Kulvatunyou, Bellal Joseph, Armanaa Jain, Randall S. Friese, Lynn Gries, Terence O’Keeffe, Andy L. Tang, Gary Vercruysse & Peter Rhee


- Aimed to compare pigtail (14Fr) to thoracostomy (32-40)
- n=496 trauma patients
  - Pigtail = 189 patients
  - Thoracostomy = 307 patients
- Pigtail had similar outcomes:
  - Failure rates = similar need for VATS in both groups
  - Tube insertion complications = learning curve with pigtails
  - Initial drainage = higher for pigtails
- RCT enrolling: ClinicalTrials.gov NCT01537289