# LUNG AND CHEST WALL INJURY

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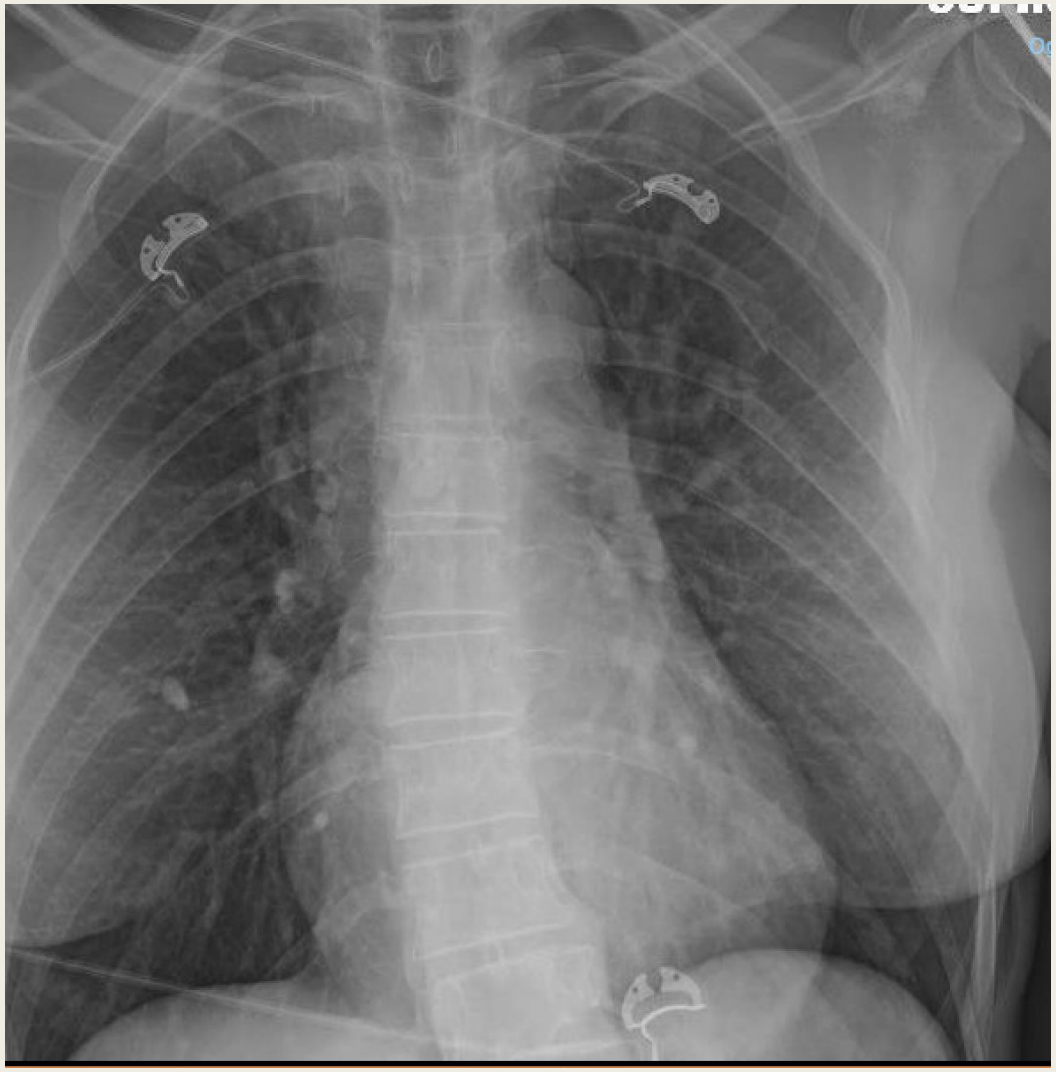
I have no disclosures

# 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

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## RibScore

| Parameter | Points |
|---|---|
| ≥ 6 fractures | 1 |
| Flail chest | 1 |
| Bilateral fractures | 1 |
| ≥ 3 severely displaced fractures | 1 |
| ≥ 1 anterior, lateral, and posterior fracture | 1 |
| First rib fracture | 1 |
| Total | 6 |

# 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*

- 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

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## SCARF Score

| Parameter | Points |
|---|---|
| Number Pain Score ≥ 5 | 1 |
| Incentive spirometry < 50% predicted | 1 |
| Respiratory rate ≥ 20 | 1 |
| Poor cough | 1 |
| Total | 4 |

# SCARF Score and Adverse Outcomes

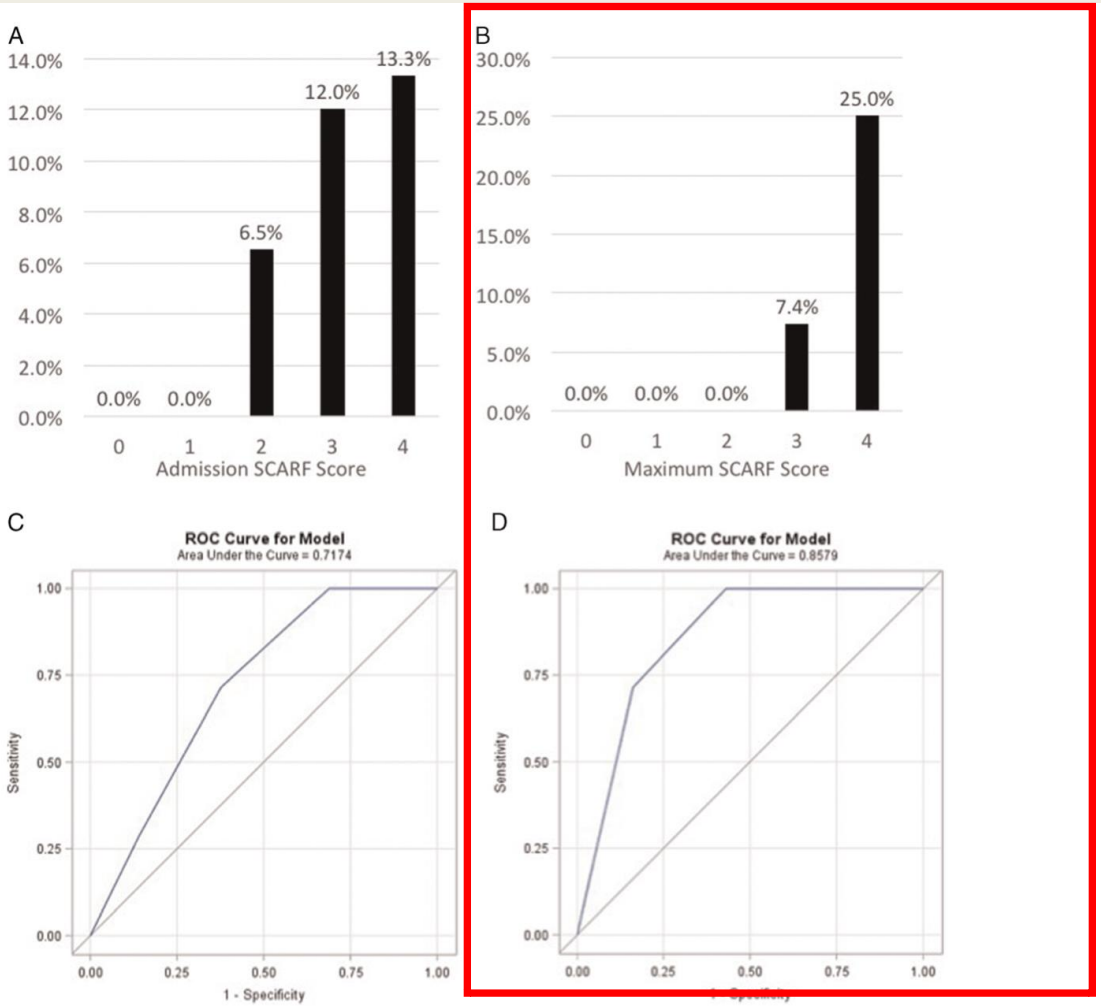
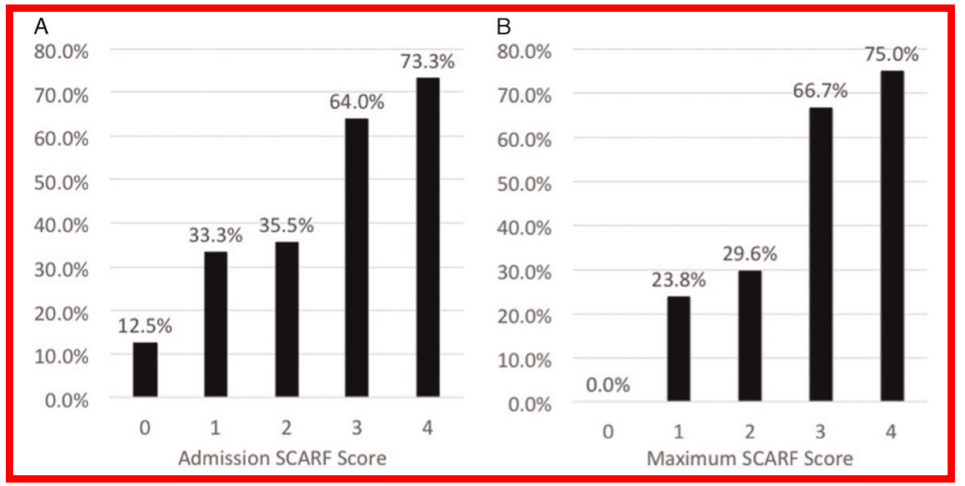



**Figure 2.** (*A*), Likelihood of pneumonia for admission SCARF scores. $p = 0.39$. (*B*), Likelihood of pneumonia for maximum SCARF scores. $p < 0.01$. (*C*), ROC curve for outcome of pneumonia for admission SCARF scores. (*D*), ROC curve for outcomes of pneumonia for maximum SCARF scores.

# SCARF Score and Prolonged ICU Stay



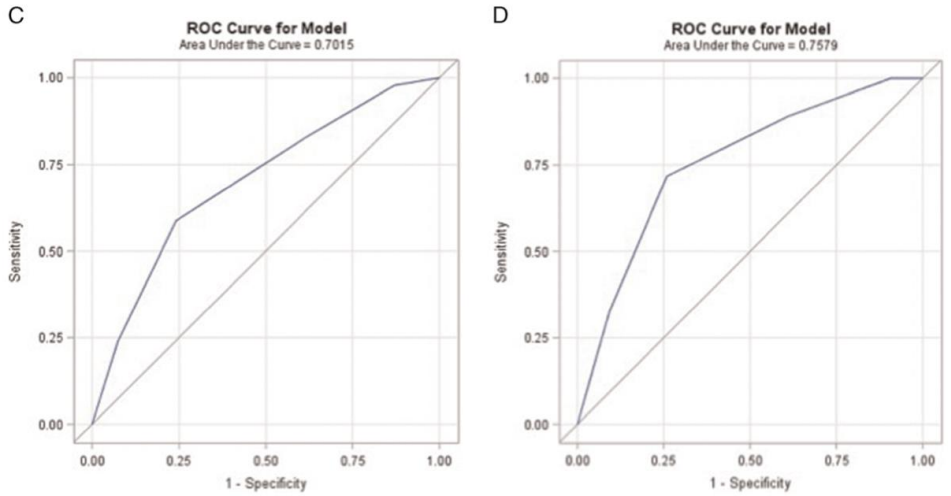
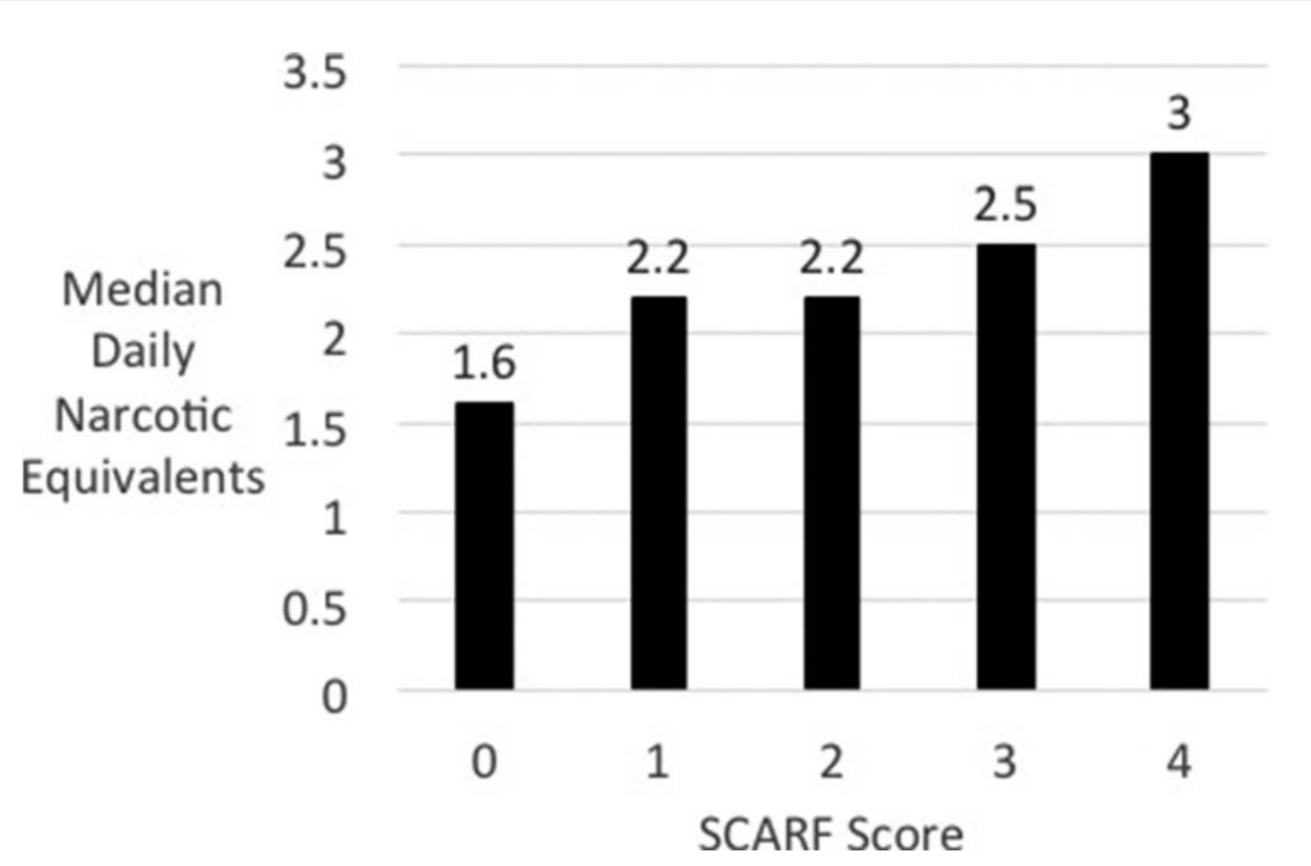




**Figure 3.** (*A*), Likelihood of prolonged ICU LOS for admission SCARF scores. $p < 0.01$. (*B*), Likelihood of prolonged ICU LOS for maximum SCARF scores. $p < 0.01$. (*C*), ROC curve for outcome of prolonged ICU LOS for admission SCARF scores. (*D*), ROC curve for outcome of prolonged ICU LOS for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

# SCARF Score and Narcotic Use



# 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

Chest Wall Injury Society

# 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

CWIS
NON-FLAIL STUDY

# 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)

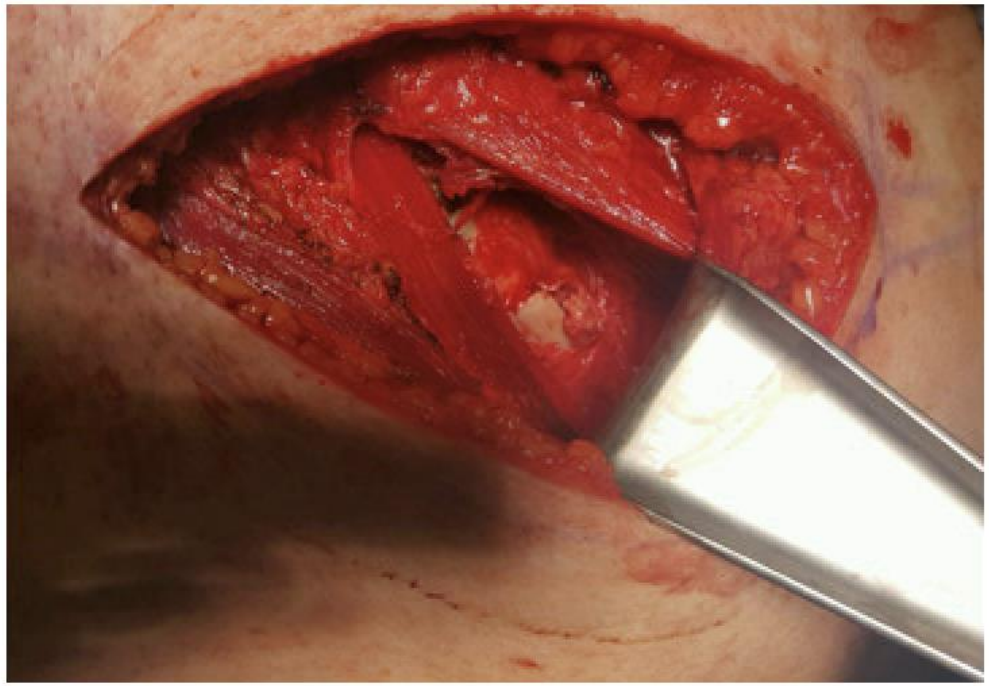
## Lateral Fractures

# Positioning/Incision(s)

## Lateral Fractures

Retract latissiumus dorsi laterally

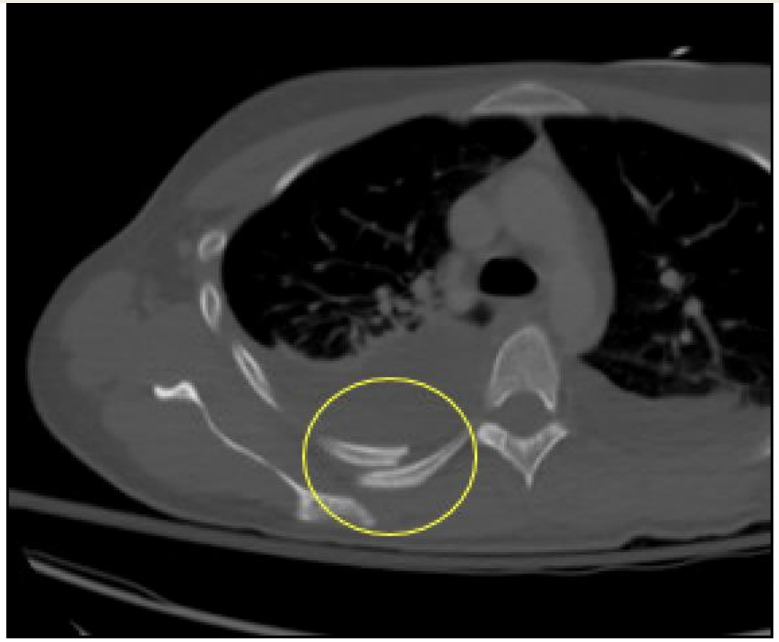
Split serratus anterior muscle along its fibers to expose ribs/fractures

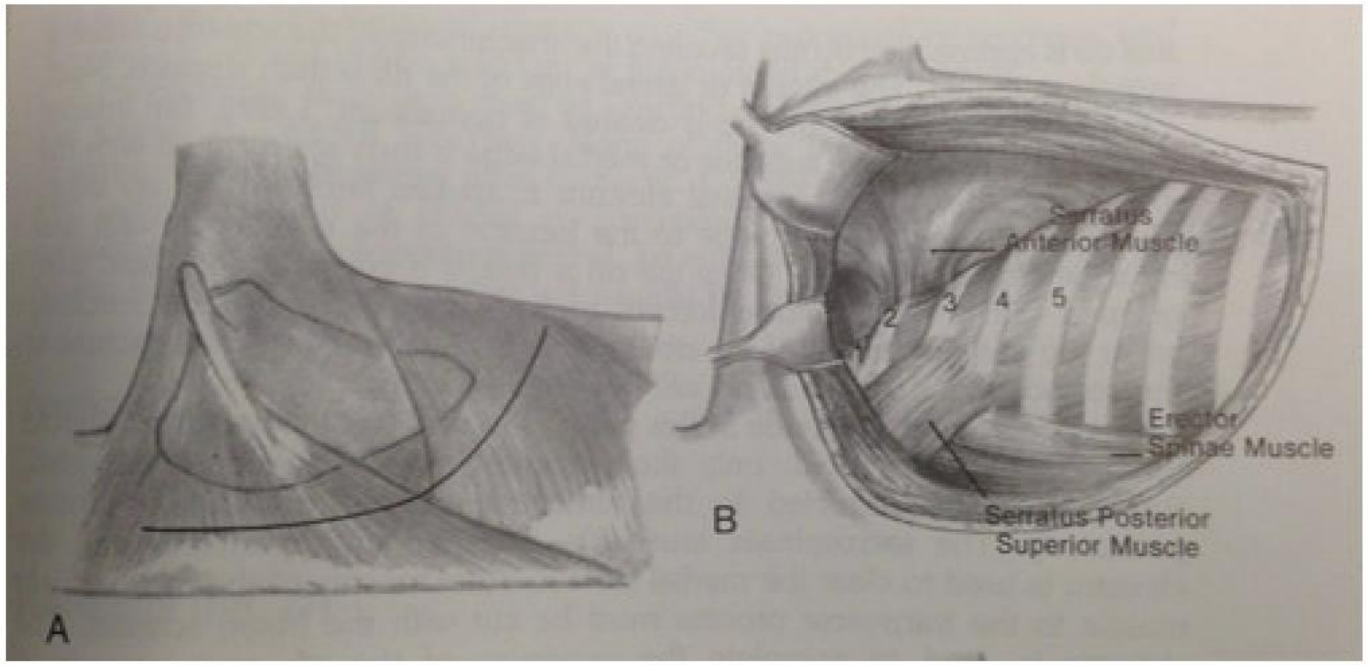


# Positioning/Incision(s)

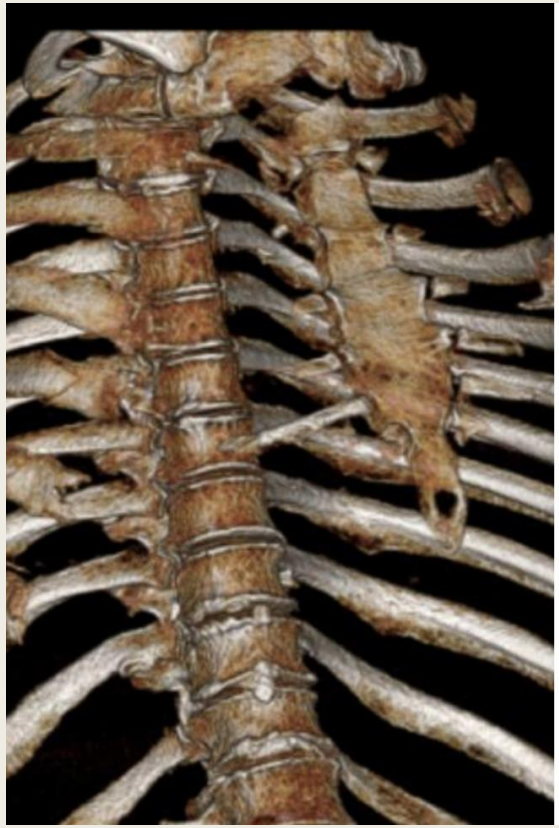
## Posterior Fractures

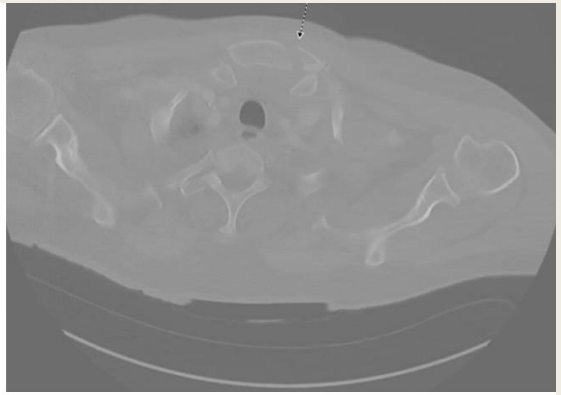
Prone positioning with incision lateral to erector spinae muscles

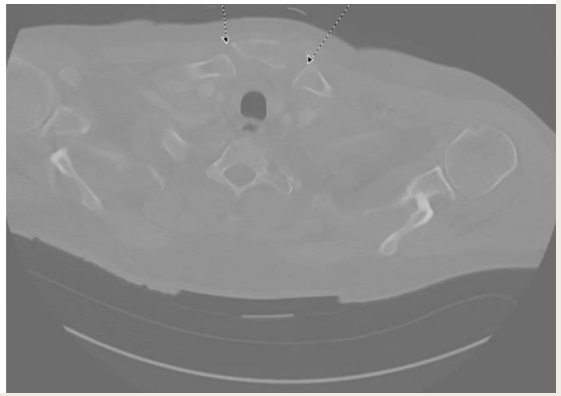




# Sternum Fractures

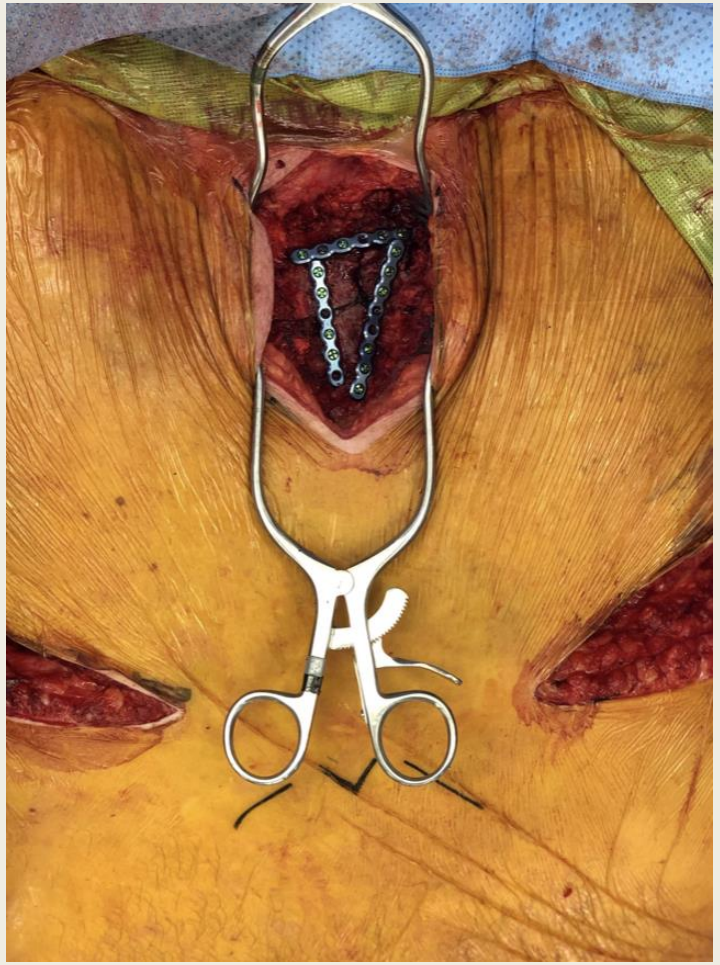


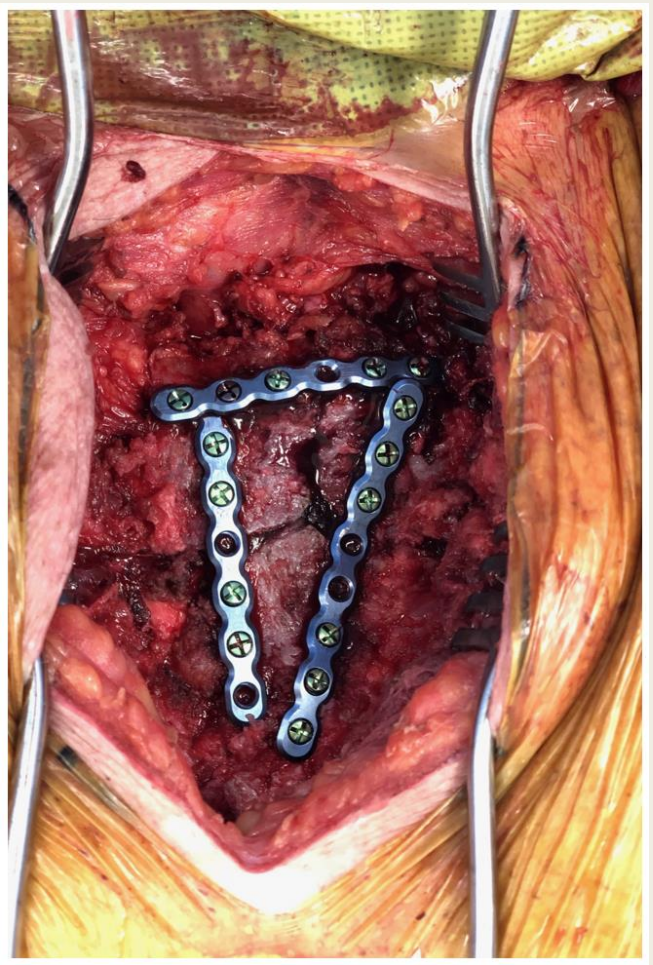




- Indications:
  - Instability on exam: clicking/popping on palpation
  - Associated anterior rib fractures (flail segment)
- Same operative technique as rib plating
  - Center plate over fracture

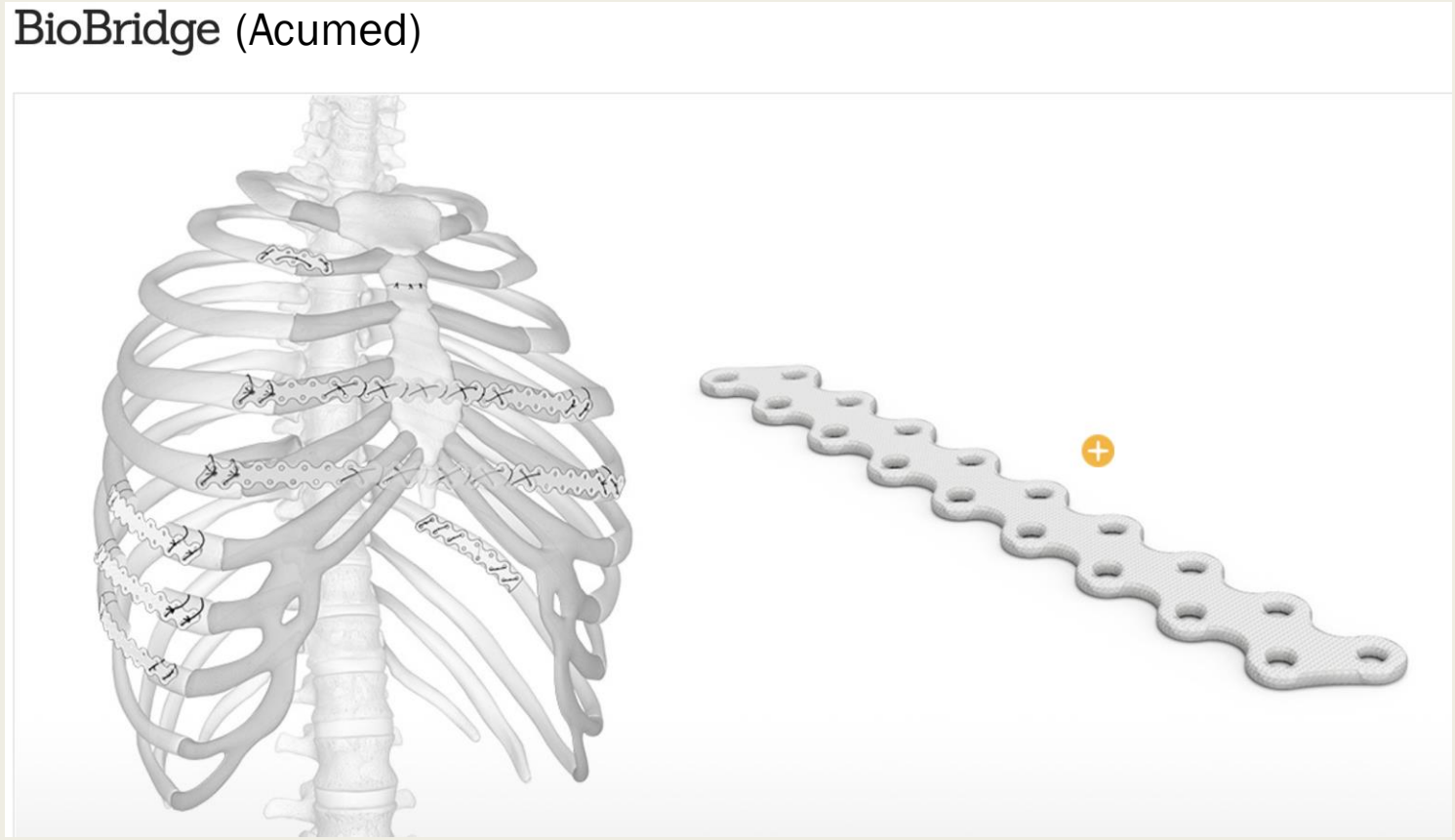
# Operative Sternal Plating





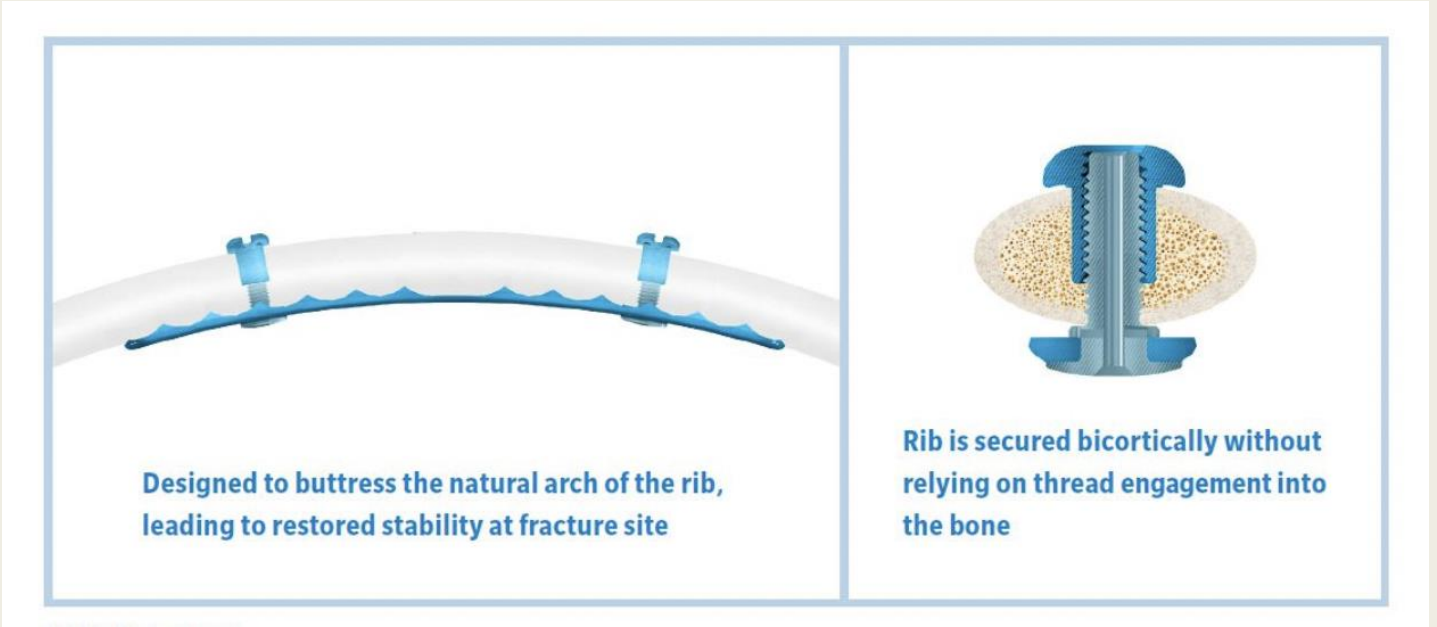
# Advanced Options in Chest Wall Injury

- 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)

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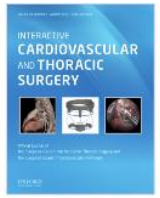
# Rib Fracture Physical Therapy Guidelines

<u>Inpatient physical therapy should include but not limited to</u>

- 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




Volume 28, Issue 1
January 2019

**External suction versus simple water-seal on chest drainage following pulmonary surgery: an updated meta-analysis** FREE

Jian Zhou, Nan Chen, Yang Hai, Mengyuan Lyu, Zihuai Wang, Yuanjing Gao, Long Pang, Hu Liao, Lunxu Liu ✉ Author Notes

*Interactive CardioVascular and Thoracic Surgery*, Volume 28, Issue 1, January 2019, Pages 29–36, https://doi.org/10.1093/icvts/ivy216
**Published:** 19 July 2018 **Article history** ▾

**Key question**

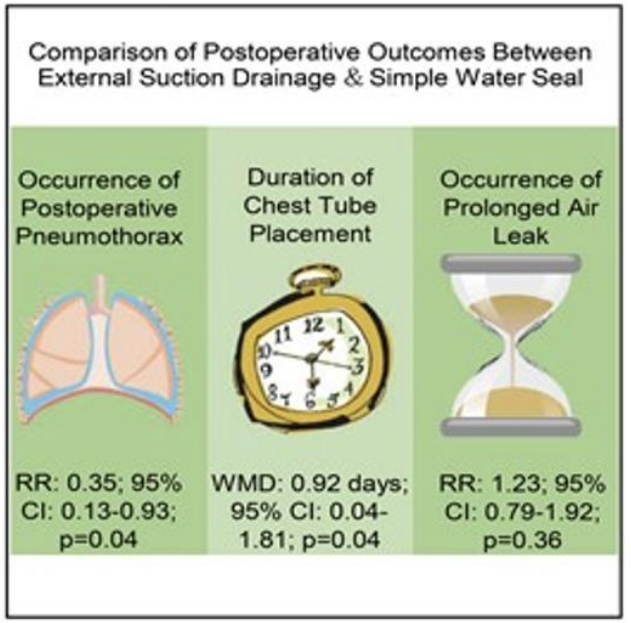
Which is better: The addition of suction drainage or a simple water seal after pulmonary surgery?

**Key findings**

Suction resulted in lower occurrence of postoperative pneumothorax, longer chest tube duration and same length of hospital stay.

**Take-home message**

Suction on chest drainage may be as effective as simple water seal for postoperative chest drainage following pulmonary surgery.



# DOES SIZE MATTER?

Springer Link

Original Scientific Report | Published: 09 August 2017

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, Arpana Jain, Randall S. Friese, Lynn Gries, Terence O'Keeffe, Andy L. Tang, Gary Vercruysse & Peter Rhee

*World Journal of Surgery* **42**, 107–113 (2018) | Cite this article

**3128** Accesses | **24** Citations | **22** Altmetric | Metrics

- 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