Chest Wall Trauma

Jonathan Messing
MSN, ACNP-BC, CCRN, TCRN

Disclosures

• None

Objectives

• Describe chest wall trauma and concomitant injuries
• Compare and Contrast Standards of Care with Novel Pharmacologic Therapies
• Identify Indications, Advantages, and Disadvantages of Surgical Fixation of Fractured Ribs
What is the chest wall?

- Form & Function
- Ribs
- Clavicles
- Sternum
- Scapula

Epidemiology

Blunt

Penetrating

Energy

Rib Fractures
Lethal Injuries

- Airway
- Cardiac Tamponade
- Cardiac Failure

Protecting Important Structures

- Heart
- Aorta and its branches
- Pulmonary Artery
- Vena Cava
- Lungs
- Trachea
- Bronchi
- Esophagus
- Diaphragm

Concomitant Injuries

- Simple pneumothorax
- Tension Pneumothorax
- Blunt cardiac injury
- Pulmonary contusion
- Aortic transection
- Tracheobronchial injury
- Livers Laceration
- Kidney Laceration
- Hemothorax
- Open pneumothorax
- Traumatic Chylothorax
- Cardiac Tamponade
- Cardiac laceration
- Ruptured diaphragm
- Splenic Laceration
Pulmonary Contusions

• Why alarming?
• What’s the duration?

Case I – EMS call in

• 37 F
• Motorcycle crash
• Decreased breath sounds on right
• Right knee deformity

Where to start?

• Stick to the basics
Primary Survey

• A – Speaking, in cervical collar
• B – Right sided crepitus, chest wall instability
• C – palpable left radial pulse, HR 90, SBP 110, sat 96% on 2L, no gross hemorrhage
• D – GCS 15, PERRL, MAE
• E – Road rash

Secondary Survey

• Head
• Neck
• Chest
• Abdomen/Pelvis
• Extremities

Imaging
Imaging

Flail chest

• What is it?

What is concerning here?

• How can a rib fracture kill you?
Fractures and the Elderly

What about slightly younger?

Why does this matter?
Treatment

Medical

Surgical

Recovery

Nursing

Placement

- LV

- SV

Medical Management

MV

Fluids

Pain Control
Pain in trauma

Transduction  Transmission  Perception  Modulation


Failure to treat

• Exaggerated Stress Response
• Chronic pain syndrome
• PTSD


Where to start

• Depends on the patient

Multimodal Therapy
Pain
- Opioids
  - Morphine
  - Hydromorphone
  - Hydrocodone
  - Fentanyl
- Route
  - IV, PO, etc.
  - PCA
    - With/without basal
    - AA Call
- Non-opioids
  - Regional blocks
  - Ketamine
  - Acetaminophen
  - NSAIDs, COX-2 inhibitors
  - Gabapentin
  - Alpha-2 agonists
  - Muscle relaxants
  - Transdermal Lidocaine
  - Non-pharmacologic
  - Antidepressants

Non-opioids

<table>
<thead>
<tr>
<th>Non-opioids: NSAIDS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
</tr>
</tbody>
</table>

**Non-selective COX Inhibitors**

- *Ketorolac*
- *Ibuprofen*

**COX-2 Inhibitors**

- *Celecoxib*
Opioids

**Advantages**
- Rapid
- Effective
- Numerous routes
- Inexpensive

**Limitations**
- Respiratory
- CNS
- GI
- Heme
- Derm
- GU

Opioids

- Hydromorphone
- Morphine
- Fentanyl

**Personally Controlled Analgesia**

**PCA**
- Saves time
- Empowers patients
- Provides data

**AACA**
- Improves pain control
- Saves time
- Prevents higher doses
Ketamine

Category?
- General anesthetic

Mechanism? Pd? Pk?
- NMDA receptor antagonist
- Onset: 30 seconds when IV
- Duration: 5-10 mins IV
- Metabolized Hepatically

Ketamine

Adverse Reactions?
- Emergence Reaction

Contraindications?
- Schizophrenia
- Age < 3 months
- Elevated ICP?
- Cardiac Ischemia
- PTSD?

Other options
- Transdermal Lidocaine
- Lidocaine Infusions
- Skeletal Muscle Relaxants
- TENS
Regional blocks

Thoracic Epidural Anesthesia

Pros
- Ease of placement
- Effective
- Can include personally controlled component

Cons
- Hemodynamics
- Coagulopathy limitations
- Sympathectomy
- Mobility impairment

Paravertebral Nerve Blockade

- What are they?
- Advantages?
- Complications?
**Intercostal Nerve Blocks**

- Single injection vs continuous
- Can be tedious
- Not limited by anticoagulation

![Image of intercostal nerve block diagram]

![Table 1: Pre/Post pain scores in patients at rest (p = 0.05) and after coughing (p = 0.03)]

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMI</td>
<td>0.4L</td>
<td>1.3L</td>
</tr>
</tbody>
</table>


**Interpleural**

- Blocks multiple dermatomes
- Can be lost via chest tubes

**Non-pharmacologic**

- Heat
- Ice
- Reiki Therapy
- Physical and Occupational Therapy
- Repositioning
- Distraction
Back to our patient...

- Right ribs 3-12 fractured
- Flail chest
- Pneumothorax

**Management?**

Case I - Management

- Paravertebrals
- fPCA
- Acetaminophen
- Celecoxib
- Ketamine
- And...
Failure of medical management

A chest trauma scoring system
to predict outcomes

Jenifer Cho, MD, Patricia Bower, MD, Robert McQuillan, MD, John E. Milenkovic, MD, and

Ribs Score: A novel radiographic score based on fracture pattern
that predicts pneumonia, respiratory failure, and tracheostomy

Brandon C. Chapman, MD, Brian Herbert, MD, Maria Bolli, Jennifer Sokol, MD,
Robert L. Norrel, MD, Valley HED, MD, Jeffrey Johnson, MD, and Colleen Hare, MD.
Caroline Barnett, MD, Charles Fox, MD, Francis O’Shea, MD, Gregory J. Jewell, MD,
and Frasier M. Peterson, MD, MFR, Denver, Colorado.

Scoring systems

Table 1. Chest wall trauma scoring system

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>Number of rib fractures</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 65 = 1 point</td>
<td>&lt; 65 = 1 point</td>
</tr>
<tr>
<td>&gt; 65 = 2 points</td>
<td>&gt; 65 = 3 points</td>
</tr>
</tbody>
</table>

Pneumonic contusion

Score = 1 point

Rib = 1 point

Sternal = 1 point

Total score = ___________

7 points or more = 14.3% Mortality (p = 0.0018)

Chest Trauma Scoring System

A chest trauma scoring system
to predict outcomes

Jenifer Cho, MD, Patricia Bower, MD, Robert McQuillan, MD, John E. Milenkovic, MD, and

Greater than 4 points:
Mortality 9%
PNA 10.1%
Predicting failure

- IS
- Deep breathing
- Coughing
- Speaking
- Mobility

Rib fractures in the elderly
Surgical Fixation

• Why?
• Benefits

Indications

Contraindications

Pulmonary Contusions? Severe Injuries? Instability?

Acute Resp. Failure? Infection?
What do we know so far?

- Review of studies for rib plating

Slobogean 2013

Surgical Fixation vs Nonoperative Management of Flail Chest: A Meta-Analysis

Gerald P. Slobogean, MD, MPH, FACIC, Calvin Alexander MacPherson, MD, MSc, Ten Il Sun, MD, Mario Rovelo-Pelazos, MD, Sam Manal Hammoud, MD, MPH, FACIC, FACS

Pieracci 2016

TABLE 1. Unadjusted Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Operative (n = 30)</th>
<th>Nonoperative (n = 35)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory failure</td>
<td>11 (37%)</td>
<td>9 (26%)</td>
<td>0.56</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>7 (23%)</td>
<td>13 (37%)</td>
<td>0.06</td>
</tr>
<tr>
<td>Base of Spontaneous Rupture</td>
<td>0.04 (0.4)</td>
<td>1.00 (10.0)</td>
<td>0.00</td>
</tr>
<tr>
<td>Mean hospital stay</td>
<td>10 (3.3)</td>
<td>15 (4.3)</td>
<td>0.31</td>
</tr>
<tr>
<td>Mortality</td>
<td>2 (6.7)</td>
<td>0 (0.0)</td>
<td>0.17</td>
</tr>
</tbody>
</table>

TABLE 2. From Multivariable Analysis

<table>
<thead>
<tr>
<th>Categorical Outcome</th>
<th>Adjusted Odds Ratio</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory failure</td>
<td>0.24</td>
<td>0.06-0.8</td>
<td>0.03</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>0.32</td>
<td>0.04-0.79</td>
<td>0.03</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>0.53</td>
<td>0.14-2.09</td>
<td>0.62</td>
</tr>
</tbody>
</table>
Lengths of stay

Chest wall stabilization in ventilator-dependent traumatic flail chest patients: who benefits?

Kocher GJ, Sharafi S, Azenha LF, et al.

Chest wall stabilization in ventilator-dependent traumatic flail chest patients: who benefits.


In-hospital outcomes and costs of surgical stabilization versus nonoperative management of severe rib fractures


In-hospital outcomes and costs of surgical stabilization versus nonoperative management of severe rib fractures.


Reduced infection

Surgical stabilization of severe rib fractures decreases incidence of retained hemothorax and empyema


Surgical stabilization of severe rib fractures decreases incidence of retained hemothorax and empyema.


Plating the elderly

<table>
<thead>
<tr>
<th>TABLE 2. Study Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>NO</strong></td>
</tr>
<tr>
<td><strong>RP</strong></td>
</tr>
<tr>
<td>Patients</td>
</tr>
<tr>
<td>Age (yrs)</td>
</tr>
<tr>
<td>ISS</td>
</tr>
<tr>
<td>Time to discharge (days)</td>
</tr>
<tr>
<td>ICU stay</td>
</tr>
<tr>
<td>Rehabilitation stay</td>
</tr>
<tr>
<td>Readmissions</td>
</tr>
<tr>
<td>Pneumonia</td>
</tr>
<tr>
<td>Pneumothorax</td>
</tr>
<tr>
<td>Recurrent hemothorax</td>
</tr>
<tr>
<td>Death</td>
</tr>
</tbody>
</table>
So who should we plate?

- Non-TBI patients with flail chest that can be plated early

Case I - Rib Plating

- Hospital Day 2
- Ribs 5-9 plated through an 8 cm transverse thoracic incision
- Procedure time 1 hour 45 minutes
- Extubated same day
Case I - Post-op Imaging

Post-op care
• Chest tube?
• Pain control!
• Ambulation

Case II
• 71M Ped Struck
• Polytrauma
• Ketamine infusion
• AACA hydromorphone
• Gabapentin
• Transdermal lidoderm
• Lidocaine infusion
• Paravertebral blockade
Case II

0200 Seizure Activity
Head CT: Normal

Local Anesthetic Systemic Toxicity

CNS
Prodromal Symptoms
Seizures
LOC
Agitation

CV
HR changes
Ectopy
ST segment changes
Hypo/Hypertension

Local Anesthetic Systemic Toxicity

<table>
<thead>
<tr>
<th>Agent</th>
<th>Pain solution (mg)</th>
<th>Maximum dose (mg</th>
<th>Maximum dose (mg/kg)</th>
<th>Maximum dose (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine</td>
<td>7 mg/kg</td>
<td>300 mg</td>
<td>7 mg/kg</td>
<td>100 mg</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>7 mg/kg</td>
<td>300 mg</td>
<td>7 mg/kg</td>
<td>100 mg</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>7 mg/kg</td>
<td>300 mg</td>
<td>7 mg/kg</td>
<td>100 mg</td>
</tr>
<tr>
<td>Levobupivacaine</td>
<td>7 mg/kg</td>
<td>300 mg</td>
<td>7 mg/kg</td>
<td>100 mg</td>
</tr>
<tr>
<td>Ropivacaine</td>
<td>7 mg/kg</td>
<td>300 mg</td>
<td>7 mg/kg</td>
<td>100 mg</td>
</tr>
</tbody>
</table>
LAST Treatment

- Airway
  - ACLS

- Seizures
  - Benzodiazepines

- Lipids
  - 20% Emulsion

Case III

- 85 yo female presents after choking on food
- CPR with ROSC and normal MS
- Extubated
- Injuries: flail sternum, bilateral rib fractures of 2-8

Rib plating after CPR
Case IV – Bicyclist Struck

Chest wall failure

Post ORIF
Take home messages

- Value the clinical exam
- Optimize medical management
- Provide multimodal pain therapy + regional blocks
- We need more data needed on SSRF, but early results promising
- Remember limitations of local anesthetics

References


References


Questions?

jmessing@mfa.gwu.edu