Surgical Stabilization of Rib Fractures (aka “Rib Plating”)

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Background

- Rib fractures are the most common chest injury, but the vast majority can be treated with pain/symptom management only.
- Morbidity/mortality increase 19% with each broken rib, with more pronounced effect in those age 65 years or older.[1,2]
    - Probability of death can be as high as 35% in patients over age 65% with numerous rib fractures or flail chest.
    - Most common cause of death due to rib fractures is pneumonia due to inability to carry out pulmonary hygiene (e.g. cough, deep breathing, walking).
    - Patients with flail chest are at risk of acute respiratory failure due to impaired tidal volume from both impaired chest wall function and pain.

Medical Management

- Medical management of rib fractures is based on pain control to allow for adequate pulmonary hygiene.
    - Would like to minimize narcotic use.
    - Regional analgesia, such as epidural or paravertebral catheters, for persons age 65 years or more and those who have 4 or more rib fractures.[3]
    - Rib blocks with Marcaine are useful in patients with 4 or fewer rib fractures.
    - A multimodality pain regimen starting with around-the-clock acetaminophen and NSAIDs may allow for decrease narcotic need.
    - An intravenous ketamine infusion may be used as an additional adjunct.

Surgical Stabilization of Rib Fractures (SSRF)

- Goal of SSRF is to relieve pain and restore chest wall function.
    - Prevent the need for mechanical ventilation or facilitate extubation.
    - Two RCT and numerous single center studies show decreased need for mechanical ventilation/tracheostomy, decreased ICU and hospital length of stay, and decreased risk of pneumonia. Some studies also cite decrease mortality.[4]
- Identifying patients for SSRF
    - There are no validated scoring systems to identify candidates. The scoring systems that exist are retrospective and predict respiratory failure. They have not been validated to predict those who will benefit from SSRF.[5-7]
    - Chest CT is useful to define the injury
    - Factor often considered include:
        - Total number of fractures
        - Bicortical displacement of fractures
        - Amount of fracture displacement
        - Flail segment
        - Loss of thoracic cavity/volume > 20%

- Patients who have or at risk for developing acute respiratory failure are ideal candidates.
    - Cause of respiratory failure has to be chest wall related (pain or loss of bellows function). SSRF has limited, if any, role in acute respiratory failure due to parenchymal injury/contusion.[8]
    - Clinical signs: inability to speak in full sentences, inability to get out of bed due to pain.
  - Patients who present with chronic pain 2-3 months following injury AND are noted to have malunion or nonunion of fractures on CT scan may benefit from SSRF, but this has not been studied well.[9]
- No evidence regarding timing to operation but should be done early to avoid mechanical ventilation or facilitate estuation before pneumonia occurs.

Preparation for Operation

- All patients need a CT scan of the chest wall.
  - 2D CT scan is better for identifying fractures. 3D CT scan may be more useful for planning operative approach.[10]
  - Measure distance to the fracture from the sternum and from the spinous process to determine incision location.
  - Determine location of fracture relative to body of scapula. SSRF of retroscapular fractures can be difficult depending on rib number.
  - Can identify a residual hemothorax.
- Most benefit is derived from SSRF of ribs 4-8.
  - Displaced first rib fracture can be resected if symptomatic.
  - Only need to carry out SSRF until chest wall is stabilized. Not every fractured rib needs to be plated, but all fracture lines on a single rib (e.g. flail segment) should be fixed. [11,12]
- Choosing the plating system:
  - There are no studies comparing the various plating systems available.
  - Unicortical fixation: anterior plates which are fixed in place with screws that are placed at angles to obtain better fixation given the thin cortex of ribs.
  - Bicortical fixation: anterior plates which are fixed in place with screws that are locked into both the anterior/posterior cortices of the rib.
  - Bicortical/Biplate fixation: U-plates which are fixed in place with screws that are locked into both the anterior/posterior cortices of the rib as well as to the back wall of the plate (U-plate construct).

Intraoperative Considerations[13]

- Administer first generation cephalosporin antibiotic or its equivalent
- Most commonly, patients are positioned in a lateral decubitus position
  - Most common area of rib fractures is the flank
  - Also allows access to posterior fractures

- Thoracoscopy is rarely needed but can be useful in evacuating hemothorax and/or localizing fractures
- No need for single lung ventilation for routine SSRF cases
- Steps of the operation
    - Localize and expose the fracture:
        - Horizontal incision allows for exposure of multiple fracture lines along the same rib(s) and may be associated with less chest wall numbness.
        - Vertical incision allows for better exposure of multiple rib fractures without the need for raising of subcutaneous flaps. This may, in turn, avoid the need for drain placement post-operatively.
        - Muscle sparing technique minimizes post-operative pain.
    - Reduce the fracture.
        - There is no need to compress the fracture because ribs are not weight bearing bone.
    - Choose a plate to span the fracture and screw it in place.
        - Need at least 2cm on each side of the fracture using a U-plate system.
        - Need at least 3cm on each side of the fracture using anterior plates.
    - Place thoracostomy tube if there is pleural violation.
        - This is common, particularly in cases with severely displaced rib fractures, due to the need to manipulate the ribs and reduce the fracture(s).
        - More common when using U-plates than anterior plates.
        - Place tube well away from implanted plates to minimize risk of infection.
    - Evacuate associated hemothorax if present.
    - Place paravertebral pain catheters to instill local anesthetics.

Post-operative Care

- If placed, thoracostomy tube can be removed in 24-48 hours.
- Continue pain management with same strategy as previously noted.
- 24 hours of first-generation cephalosporin antibiotic or equivalent.

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