Rib Fractures

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Injury Demographics

- Rib fractures are the most common thoracic injury and primarily occur after blunt chest trauma.
- Lower rib fractures (8^{th} and below) are associated with intraabdominal organ injuries. Multiple rib fractures (≥ 3 has been associated with an increased risk for intra-abdominal, specifically splenic and hepatic, injury.
- Multiple rib fractures (≥ 3) are predictive of pulmonary complications and mortality, particularly in the elderly (age ≥ 65 years).
- Rib fractures and sternal fractures frequently occur after cardiopulmonary resuscitation.

Clinical Presentation/Evaluation

- Most patients with rib fractures will have pain with breathing and movement. In fact, pain is central to the pathophysiology of the complications that arise from fractured ribs.
- Patients with multisystem injuries, particularly with traumatic brain injuries or altered mental status, may not communicate pain.
- Tenderness on exam is the most common finding.
- Patients with flail chest may have a visible chest wall deformity or paradoxical chest wall movement.
- Physical examination is central to the diagnosis of rib fractures; chest radiography may not identify, single or even multiple, rib fractures.
- Patients with multiple rib fractures or a flail chest may develop rapid respiratory deterioration due to the underlying pulmonary contusion. These more severe injuries should be identified early in the patient's evaluation.

Diagnostic Imaging

- Antero-posterior chest radiography is a standard part of the initial evaluation of a trauma patient.
- For ambulatory patients suspected of having rib fractures, a posterior-anterior and lateral chest radiograph is indicated.
- In the multiple-injured patient, rib fractures will generally be identified and easily characterized on the abdominal and thoracic computed tomography scans, done to identify torso injuries. A high proportion of rib fractures identified on computed tomography may not be seen on plain radiography.

Role of Conservative Management and Associated Considerations

- The vast majority of rib fractures are best managed with appropriate analgesia without restriction of activity when not limited by other injuries. Isolated rib fractures, whether single or multiple will respond to multimodal analgesia and treatments aimed to encourage deep breathing and mobility.
- Multimodal analgesia that includes regional approaches, such as paravertebral and epidural analgesia and non-steroidal anti-inflammatory agents may help minimize the use of narcotics.
- An organized, multidisciplinary approach (institutional protocol) to rib fracture management is ideal.
- The institutional protocol should include indications for admission to an intensive care unit. Some of these will be institution specific, but should reflect factors that increase the risk for complications such as pneumonia or the need for mechanical ventilation:
    - Increasing number of rib fractures (generally dichotomized as 1 – 2 or ≥ 3 fractures)
    - chronic lung disease
    - hypoalbuminemia
    - Age ≥ 65 years
- The institutional protocol should also include indications for acute pain service consultation for consideration of neuraxial regional analgesia.

Indications for Operative Intervention

- The indications for surgical stabilization of rib fractures are evolving.
- Most studies are retrospective and have primarily focused on patients with flail chest but some have expanded indications to patients with multiple fractures (≥ 3) without flail chest, patients with fewer fractures but with significant pain. Other reported indications include: fractures with bicortical displacement, > 30% loss of hemithorax volume or computed tomographic evidence of lung herniation.
- Most approaches and studies have focused on early stabilization, which has been variously defined (0 – 3 days post injury; in other cases 1 – 5 days.
- Few data are available regarding delayed stabilization for patients requiring prolonged mechanical ventilation or patients with chronic pain and non-union. However, patients may benefit under these circumstances as well.
- The hypothesized benefits of surgical stabilization are:
    - Reduced mortality
    - Reduced pneumonia
    - Shorter duration of mechanical ventilation
    - Decreased need for tracheostomy
    - Improved pain control (reduced narcotic use)
    - Decreased incidence of chest wall deformities
    - Improved patient reported outcomes such as chronic pain
    - Decreased overall costs

- Three small randomized studies were included in a 2015 meta-analysis of surgical stabilization of flail chest. This review concluded that there was some evidence that surgical stabilization reduced pneumonia, chest wall deformity, tracheostomy use and duration of mechanical ventilation. However, the authors concluded that larger, well-designed studies are needed.

Pre-operative Preparation

- Patients must be stable to tolerate anesthesia and the lateral decubitus or prone position. Surgical rib fracture stabilization should be delayed until any active infection has stabilized.
- Although there are presently no indications for urgent surgical stabilization of rib fractures, stabilization within 24 to 48 hours of injury may be indicated to prevent deterioration in patients with severe pain or mechanical instability that could lead to respiratory failure.
- The presence and number of rib fractures is typically determined by reviewing the 2 dimensional computed tomography scan. However, 3 dimensional reconstruction can be helpful in preoperative planning for stabilization; particularly in understanding the relationship between the fractures, and the scapula.
- The surgical field should include the shoulder; inclusion of the upper arm in the sterile field allows full mobility and may facilitate retraction of the scapula but is not mandatory in many cases.

Operative Techniques and Intraoperative Considerations

- The surgical techniques are evolving, but generally involve open reduction and internal fixation with plates placed across the fractures. In most circumstances, rib fractures can be managed by remaining extra-pleural.
- In patients with residual hemothorax or other thoracic injuries requiring treatment, rib fracture stabilization can be supplemented with video-assisted thoracoscopy. Often the pleural is open at the fracture site, permitting direct suctioning of the pleural space to evacuate the hemothorax.
- Ultrasound as well as intraoperative fluoroscopy and VATS has been described for fracture localization; this may facilitate the use of smaller incisions.
- Whether it is necessary to fix all fractures on all ribs (flail chest) is uncertain. However, it appears that stabilizing both ends of a flail segment is necessary to optimize healing and prevent chest wall deformity. Therefore, both anterior and posterior fractures of a flail chest should be stabilized.
- There are three common fracture lines, anterior, lateral, and posterior. Anterior can be fixed with the patient in the supine position, lateral fractures in lateral decubitus position, and posterior fractures in the prone position. Posterior fractures can be fixed at the same time as posterior spine fixation in the prone position.
- Regional pain catheters should be placed at the time of surgery.

Postoperative Management

- Preoperative regional anesthesia should be continued or either epidural or paravertebral blocks placed at the time of surgery when possible.
- Patients should be mobilized as their other injuries allow and there are no restrictions specific to the rib stabilization.

Complications

- Incidence of pneumonia and death increase with number of rib fractures in the elderly.
- Injury to adjacent structures.
- The major complications of rib fixation include:
    - Failure of stabilization as demonstrated by continued pain or by radiographic evidence of non-union or hardware failure.
    - Hardware infection with non-union and osteomyelitis.
    - Pain from hardware.

Considerations for Special Populations

- Rib fractures in the elderly (age > 65 years) are associated with a high risk of complications and deterioration, even when the patient initially seems stable. This warrants careful monitoring and an organized approach to pain management.
    - Elderly patients should be considered for monitoring in an intensive care unit as indicated above
    - Elderly patients should receive multimodal analgesia given their higher intolerance to opioid medications.
- Rib fractures in young children are generally uncommon due to the greater elasticity of their chest wall. They should also prompt consideration of physical abuse in the appropriate circumstances.

Suggested Readings

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