Use of Surgical Fixation for Chest Wall Stabilization in Severe Traumatic Rib Fractures

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Surgical fixation of chest wall injuries is a historically underutilized procedure. Surveys of Trauma/Ortho/Cardiothoracic surgeons from 2009 showed only 22% of these physicians were aware of any literature on the topic. The majority of previous studies are small, include only flail segments and therefore do not include severe/debilitating rib fracture patterns. Flail chest is defined as 3 adjacent ribs that are fractured in at least 2 places resulting in paradoxical motion of the free segment of the chest wall. “Severe rib fractures” usually refers to >3 fractured ribs, ribs angulated into the chest, severely displaced fractures, and those associated with a large hemothorax, persistent pneumothorax, prolonged ventilation, and severe pain from non union or malunion. There is a significant morbidity associated with both flail chest and severe rib fractures. Severe rib fractures may in fact warrant rib fixation but the use of operative rib fixation is understudied in the trauma population. Unfortunately there are no absolute indications for surgical treatment of rib fractures.

Primary aim

Determine the absolute indications for surgical stabilization of rib fractures and to determine if surgical stabilization of rib fractures improves patient outcomes compared to medical management alone.

Secondary aims

1. Surgical treatment of thoracic injury in the setting of multiple rib fractures

2. Flail chest

3. Greater than or equal to 3 rib fractures with displacement

Inclusion Criteria

4. Greater than or equal to 30% hemithorax volume loss AND severe pain OR respiratory failure

5. Persistent air leak AND severe pain OR respiratory failure

6. Nonunion or Malunion AND severe pain OR respiratory failure

Exclusion Criteria

1. Age less than 15

2. Severe Head Injury mandating Intracranial Monitoring Devices

3. Hemodynamic instability due to concomitant injuries

4. Patients that expire within 24 hours of injury
Therapeutic Interventions

Standard care for patients with rib fractures including analgesia (i.e. PO/IV pain medication or PCA), pulmonary toilet (i.e. suctioning, incentive spirometry), chest physiotherapy, operative technique protocols.

1. Respiratory failure (need for mechanical ventilation)
2. Pneumonia
3. Tracheostomy

Primary Outcome

4. Duration of chest tube
5. Total ventilator days
6. Intensive care unit and hospital length of stay
7. Mortality
   1. Narcotic Requirements

Secondary Outcomes

2. Oxygen Requirements
3. Daily Maximum Incentive Spirometer Volume
List specific variables to be collected & analyzed

- Demographics
- BMI
- Pre-existing pulmonary disease
- Mechanism of Injury
- Injury Pattern
- Injury Severity Score
- Time to surgery
- Pre and Post op Analgesia
- Pulmonary toilet
- Operative Times
- Number of ribs fixed
- Outcomes
- Respiratory failure (mechanical ventilation)
- Pneumonia
- Tracheostomy
- Chest Tube Days
- Ventilator Days
- Length of Stay
- Mortality
- Narcotic Requirements
- Oxygen Requirements
- Daily Maximum Incentive Spirometer Volume

Outline the data collection plan and statistical analysis plan succinctly

This will be a prospective study. Standardized data will be collected for each patient (see variable list above). Data will then be analyzed using comparative statistics (uni variate and multi variable analyses) to identify differences between the operative and non-operative groups. Data will be reported as adjusted odds ratios with 95% confidence intervals. Statistical significance will be set at a p<0.05.
The patient will be consented for inclusion in the study when they agree and consent to undergo operative fixation of their rib fractures. This study involves minimal risk to the patients as there is no additional intervention outside of the standard of care for the management of flail chest or severe rib fractures. The rights and welfare of the patients will not be adversely affected. Furthermore, the data is already collected and documented as a part of the patients’ medical records.

The risks to the patient are minimal and are the risks associated with standard open fixation of the ribs, including, but not limited to bleeding, infection, injury to surrounding organs and death. However, when compared to medical management alone, this operation can improve patient outcomes in regards to respiratory failure (mechanical ventilation), pneumonia rates, tracheostomy rates, chest tube days, ventilator days, length of stay, and mortality. This study may identify the optimal timing and type of intervention to optimize outcomes in patients with these types of injuries. This may result in significant benefit to patients in the future.


Include a brief listing of key references


