Evidence for MatrixRIB® Fixation System
Management of Severe Rib Fractures

- Severe rib fractures can be devastating, life-altering events with high morbidity and mortality rates.\(^1\)
- As the number of fractured ribs increases, risk for undesired outcomes increases not only because of other serious injuries, but also because of the respiratory complications that are a direct consequence of the pain and impaired capacity to ventilate.\(^1-5\)
- Patients with flail chest (unilateral fractures of at least 3 consecutive ribs, each with 2 or more fractures\(^6,7\)) frequently require mechanical ventilation and are at risk for death.\(^8\)
- Flail chest occurs in 5% to 13% of patients with chest wall trauma\(^9\) and has a mortality rate of 10% to 20%.\(^5,7,8,10\)
- Studies have reported a prevalence of chronic pain of 22% and disability of 53% among patients with rib fractures.\(^11\)
- Up to one-third of patients require prolonged rehabilitation.\(^8\)

The Benefits of Operative Fixation for Severe Rib Fractures

- The strongest evidence for the effectiveness of rib fracture fixation is in patients with flail chest.\(^1\)
- Members of the Chest Wall Injury Society also recommend surgical fixation for most patients with non-flail, displaced rib fractures. However, this recommendation is contingent upon patient age, degree of traumatic brain injury, and pulmonary clinical status.\(^12\)
- Swart and colleagues (2017) conducted a systematic literature review and meta-analysis on outcomes after operative fixation of flail chest injuries and found a significant reduction related to operative treatment in terms of intensive care unit (ICU) stay, hospital length of stay (LOS), mortality, pneumonia, and need for tracheotomy compared to nonoperative rib fixation (\(P<0.05\)).\(^1\)

<table>
<thead>
<tr>
<th>Effect</th>
<th>Reduction</th>
<th>Risk Ratio [SD]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>56%</td>
<td>0.44 [±0.09]</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>41%</td>
<td>0.59 [±0.10]</td>
</tr>
<tr>
<td>Tracheotomy</td>
<td>48%</td>
<td>0.52 [±0.07]</td>
</tr>
<tr>
<td>ICU Days</td>
<td>3.25</td>
<td>±1.29</td>
</tr>
<tr>
<td>Hospital Days</td>
<td>4.84</td>
<td>±1.98</td>
</tr>
<tr>
<td>Ventilator Days</td>
<td>4.57</td>
<td>±0.59</td>
</tr>
</tbody>
</table>
Clinical Implications of Surgical Fixation

For every 100 flail chest patients treated with surgical fixation, there are expected to be:

- **7 deaths** prevented\(^1,5,10\)
- **19 cases of pneumonia** prevented\(^1\)
- **22 tracheotomies** prevented\(^1\)
- **32 to 68 ICU days** saved\(^1\)
- **30 to 48 hospital days** saved\(^1\)
- **46 to 60 mechanical ventilation days** saved\(^1\)
The MatrixRIB® Fixation System

- The MatrixRIB® Fixation System is designed to provide stable fixation of normal and osteoporotic ribs.
- To date, the MatrixRIB® System has been evaluated in **52 published studies** involving 1,028 patients.
  - These studies included 1 randomized controlled trial (29 patients), 4 comparative cohort studies (261 patients), 18 case series studies (694 patients), 3 conference proceedings (29 patients), and 25 case reports (35 patients).
  - Study findings from the MatrixRIB® System studies confirmed the meta-analysis findings regarding the benefits of surgical fixation vs nonoperative treatment in flail chest.

MatrixRIB® System Reduces Mechanical Ventilation Days

- A study of 21 patients with flail chest found that the surgical fixation group treated with the MatrixRIB® System demonstrated a significant reduction in total ventilator days as compared with the nonsurgical group (4.5 [0-30] vs 16.0 [4-40]; \( P = .040 \)).\(^\text{13}\)
- Patients treated with the MatrixRIB® System were permanently liberated from the ventilator within a median of 1.5 days (0-8 days).\(^\text{13}\)
- Another study of patients with flail chest or multiple rib fractures resulting in unstable thoracic cage showed that the mean time in ventilator was 9.0 days for nonoperative patients (n=153) compared to 2.7 for those patients treated with the MatrixRIB® System (n=60) (\( P<0.0001 \)).\(^\text{14}\)
MatrixRIB® System Improves Pulmonary Function

- A study of 16 patients treated with the MatrixRIB® System found that, within 3 months, patients regained 84% forced vital capacity (FVC) and 77% forced expiratory volume (FEV1).7

- Another study evaluating lung function over time in 54 patients treated with the MatrixRIB® System found that peak expiratory flow (PEF) significantly increased by 28.5% (SD 20.4; P<.001) from 3 months to 1 year. After 1 year, the mean FVC was 106%, PEF was 110%, and FEV1 was 80% compared to predicted values.15

MatrixRIB® System Reduces Pain

- Pain was gone at 5.4±1.1 weeks post-discharge and 84% of patients had no pain at 16±1 months (n=50).16

- Another study showed that, at 27.6 (12–68) months follow-up (n=18), 77% of patients had no pain and 13% of patients had minimal pain.17

Patient pain and analgesia use was found to decrease over time during the year after surgery.15

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>6 weeks (n=34)</th>
<th>3 months (n=34)</th>
<th>6 months (n=37)</th>
<th>1 year (n=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain at Rest</td>
<td>12 (35.3%)</td>
<td>4** (11.8%)</td>
<td>6 (16.2%)</td>
<td>6** (13.3%)</td>
</tr>
<tr>
<td>Pain on Breathing</td>
<td>8 (23.5%)</td>
<td>5 (14.7%)</td>
<td>3 (8.1%)</td>
<td>4** (8.9%)</td>
</tr>
<tr>
<td>Local Discomfort</td>
<td>14 (41.2%)</td>
<td>17 (50.0%)</td>
<td>19 (51.4%)</td>
<td>21 (46.7%)</td>
</tr>
<tr>
<td>Breathlessness</td>
<td>14 (41.2%)</td>
<td>12 (35.3%)</td>
<td>10 (27.0%)</td>
<td>7** (15.6%)</td>
</tr>
<tr>
<td>Analgesia Use</td>
<td>18 (52.9%)</td>
<td>13 (38.2%)</td>
<td>5†b (13.5%)</td>
<td>4‡c (8.9%)</td>
</tr>
</tbody>
</table>

P<.05; †P<.01; ‡P<.001.

*Difference from 6 weeks to 3 months (n=27); †Difference from 6 weeks to 6 months (n=27); ‡Difference from 6 weeks to 1 year (n=33).
MatrixRIB® System Accelerates Return to Work

Return to work was evaluated in two studies with the MatrixRIB® System. One study showed that at three months, 31% of patients returned to work, and that at six months, 7 of 15 (47%) patients that completed follow-up had returned to work. In a 16-month survey, 90% of employed patients (n=36) returned to the same work at 8.5±1.2 weeks.

MatrixRIB® System Ensures Patient Satisfaction

On a scale of 1 to 10, with 1 being not satisfied at all, and 10 being very satisfied, patients (n=50) rated their experience with the MatrixRIB® System and the results of the procedure as 9.2±0.2.

Ninety-four percent of patients who received surgical fixation with the MatrixRIB® System stated that they would recommend the surgery to injured friends/family.

MatrixRIB® System Continuously Improves Quality of Life

Change in QoL over time was evaluated using the EQ-5D-3L, showing the percentage of patients with some or extreme difficulties and median QoL. Patients show a gradual improvement of symptoms, therefore the final outcome of surgery cannot be assessed before 1 year postoperatively.
Economic Impact of the MatrixRIB® System

- The increased cost of surgery is offset by decreased length of stay in both the ICU and non-ICU, by decreased duration of mechanical ventilation, and by decreased cost due to pneumonia.\(^1,7,17-20^*\)

- **The total potential savings with use of the MatrixRIB® System are estimated to be $3.4M for 100 patients with flail chest.\(^1,7,17-20^*\)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Potential Savings (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU</td>
<td>$2,247,280</td>
</tr>
<tr>
<td>Mechanical Ventilation</td>
<td>$1,813,817</td>
</tr>
<tr>
<td>Non-ICU</td>
<td>$446,647</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>$186,651</td>
</tr>
<tr>
<td>OR Costs</td>
<td>-$487,353</td>
</tr>
<tr>
<td>Implant Costs</td>
<td>-$829,600</td>
</tr>
<tr>
<td>Total Potential Savings</td>
<td>$3,377,441</td>
</tr>
</tbody>
</table>

*Values based on US costs from US Hospital Inpatient National Statistics.
References


