

**Denver Health Medical Center Indications for Surgical Stabilization of Severe Rib Fractures<sup>1</sup>**

Criterion	Indication	Description
1	Acute respiratory insufficiency despite optimal therapy*	Either need for mechanical ventilation or ≥ 2 of the following: tachypnea, hypercarbia, hypoxia, uncontrolled secretions, incentive spirometry <75% predicted
2	Uncontrolled pain despite optimal medical therapy*	≥ 2 of the following: numeric pain score ≥ 4/10, splinting, lung hypoexpansion on imaging.
3	Anticipated chronic pain/impaired pulmonary mechanics	≥ 1 of the following: flail chest, ≥ 3 severely displaced rib fractures**, hemithorax volume loss ≥ 30%***

\* Optimal medical therapy is based on an institutional algorithm involving escalating levels of both analgesia (local, regional, and intravenous) and pulmonary toilet.

\*\* Severe displacement is defined as the inner cortex of one fracture fragment either at or beyond the outer cortex of the other fracture fragment

\*\*\* As measured by chest computed tomography

Patients who meet one or more criteria are considered to have "severe" rib fractures. The criteria apply to both blunt and penetrating mechanisms.

<sup>1</sup>Pieracci FM, Rodil M, Stovall RT, Johnson JL, Biffi WL, Mauffrey C, Moore EE, Jurkovich GJ. Surgical stabilization of severe rib fractures. *J Trauma Acute Care Surg.* 2015; 78(3): 883-887

**Related Abstracts:**

**A prospective, controlled clinical evaluation of surgical stabilization of severe rib fractures.**

**Pieracci FM, LinY, Rodil M, Snyder M, Herbert B, Tran DK, Stoval RT, Johnson JL, Biffi WL, Barnett CC, Cothren-Burlew C, Fox C, Jurkovich, GJ, Moore EE.**

*J Trauma Acute Care Surg.* 2016 Feb; 80(2): 187-94.

**BACKGROUND:**

Previous studies of surgical stabilization of rib fractures (SSRF) have been limited by small sample sizes, retrospective methodology, and inclusion of only patients with flail chest. We

performed a prospective, controlled evaluation of SSRF as compared with optimal medical management for severe rib fracture patterns among critically ill trauma patients. We hypothesized that SSRF improves acute outcomes.

#### **METHODS:**

We conducted a 2-year clinical evaluation of patients with any of the following rib fracture patterns: flail chest, three or more fractures with bicortical displacement, 30% or greater hemithorax volume loss, and either severe pain or respiratory failure despite optimal medical management. In the year 2013, all patients were managed nonoperatively. In the year 2014, all patients were managed operatively. Outcomes included respiratory failure, tracheostomy, pneumonia, ventilator days, tracheostomy, length of stay, daily maximum incentive spirometer volume, narcotic requirements, and mortality. Univariate and multivariable analyses were performed.

#### **RESULTS:**

Seventy patients were included, 35 in each group. For the operative group, time from injury to surgery was 2.4 day, operative time was 1.5 hours, and the ratio of ribs fixed to ribs fractured was 0.6. The operative group had a significantly higher RibScore (4 vs. 3, respectively,  $p < 0.01$ ) and a significantly lower incidence of intracranial hemorrhage (5.7% vs. 28.6%, respectively,  $p = 0.01$ ). After controlling for these differences, the operative group had a significantly lower likelihood of both respiratory failure (odds ratio, 0.24; 95% confidence interval, 0.06-0.93;  $p = 0.03$ ) and tracheostomy (odds ratio, 0.18; 95% confidence interval, 0.04-0.78;  $p = 0.03$ ). Duration of ventilation was significantly lower in the operative group ( $p < 0.01$ ). The median daily spirometry value was 250 mL higher in the operative group ( $p = 0.04$ ). Narcotic requirements were comparable between groups. There were no mortalities.

#### **CONCLUSION:**

In this evaluation, SSRF as compared with the best medical management improved acute outcomes among a group of critically ill trauma patients with a variety of severe fracture patterns.

#### **LEVEL OF EVIDENCE:**

Therapeutic study, level II.

## **RibScore: A novel radiographic score based on fracture pattern that predicts pneumonia, respiratory failure, and tracheostomy.**

**Chapman BC, Herbert B, Rodil M, Salotto J, Stovall RT, Biffi W, Johnson J, Burlew CC, Barnett C, Fox C, Moore EE, Jurkovich GJ, Pieracci FM.**

J Trauma Acute Care Surg. 2016 Jan; 80(1):95-101.

#### **BACKGROUND:**

There is currently no scoring system for rib fractures that relates detailed anatomic variables to patient outcomes. Our objective was to develop and validate a radiographic rib fracture scoring system based on computed tomographic chest findings.

**METHODS:**

We reviewed our trauma registry from September 2012 to April 2014 for all blunt trauma patients with one or more rib fractures visualized on chest computed tomography. We identified the following six candidate radiographic variables and tested their individual associations with pneumonia, respiratory failure, and tracheostomy: (1) six or more rib fractures, (2) bilateral fractures, (3) flail chest, (4) three or more severely (bicortical) displaced fractures, (5) first rib fracture, and (6) at least one fracture in all three anatomic areas (anterior, lateral, and posterior). We developed the "RibScore" by assigning 1 point for each variable, which was validated among the sample using univariate analyses, test performance characteristics, and the receiver operating characteristic area under the curve c statistic.

**RESULTS:**

A total of 385 patients with one or more rib fractures were identified; 274 (71.2%) were males, median age was 48 years, and median Injury Severity Score (ISS) was 17. Of these patients, 156 had six or more rib fractures, 120 had bilateral fractures, 46 had flail chest, 32 had three or more severely displaced fractures, 91 had a first rib fracture, and 58 had fractures in all three anatomic areas. Each RibScore component variable was associated with the three pulmonary outcomes by univariate analysis ( $p < 0.05$ ). The median RibScore was 1 (range, 0-6). The distribution of the RibScore was as follows: score of 0, 41.9%; score of 1, 23.9%; score of 2, 15.4%; score of 3, 9.9%; score of 4, 7.6%; and score of five, 1.3%. RibScore was linearly associated with pneumonia ( $p < 0.01$ ), acute respiratory failure ( $p < 0.01$ ), and tracheostomy ( $p < 0.01$ ). The receiver operating characteristic areas under the curve for the outcomes were 0.71, 0.71, and 0.75, respectively.

**CONCLUSION:**

The RibScore predicts adverse pulmonary outcomes and represents a standardized assessment of fracture severity that may be used for communication and prognostication of the severely injured trauma patient.

**LEVEL OF EVIDENCE:**

Prognostic study, level III.