



**2022 CWISummit
Scientific Session – Friday 3B**

Moderator: John G. Edwards, MB ChB PhD FRCS(C-Th)
Recorder: Adam J. Kaye, MD, MHA, FACS

Title:

Determining complications from rib fractures and need for surgical fixation of rib fractures (SSRF).
Validation of predictive scores in an Australian trauma population

Presenting author:

Kabytto Chen, MBBS (Hons)
Surgical SRMO

Name one item still on your bucket list. Tiktoks showing items being packaged

Discussant:

Michael Bemelman, MD
ETZ, Trauma surgeon

If you were a baseball player, what would be your walk-up introduction song? I can't get no satisfaction

Authors:

- Kabytto Chen, MBBS (Hons)
- Bayan Minasian, MD
- Pranav Shivashankar, MBBS
- Evangeline Woodford, MBBS
- Kah Ann Ho, MBBS (Hons)
- Saimurooban Muralidaran, MD
- Jeremy Hsu, BPharm MBBS (Hons)
DCLinSurg FRACS FACS

Background: Identification of rib fracture patients who are at risk of complications and might benefit from SSRF is important to prevent morbidity and mortality in the trauma cohort. The RibScore and SCARF score are two scoring systems which have proven ability in predicting pulmonary complications in rib fracture patients. Currently there is minimal evidence on their ability to predict the need for SSRF.

This study aims to validate the scoring systems in their ability to predict complications and need for SSRF amongst an Australian trauma population with rib fractures. The RibScore is based on anatomical criteria while the SCARF score is a physiological criteria. Indications for SSRF are generally a combination of anatomical and physiological criteria. Thus it is hypothesised that the aggregate of both the Ribscore and SCARF score will more accurately predict complications and need for SSRF.

Methods: Retrospective cohort study of patients with rib fractures admitted to Level I trauma centre from Jan 2017 to Jan 2021. RibScore, SCARF score, as well as a RibScore-SCARF aggregate (RSA) was calculated. Demographics, complications and need for SSRF were abstracted. Receiver operator curve under the area curve (ROC AUC) was calculated.

Results: Data was available for 1074 patients. Patients who developed a complication or required SSRF had a statistically higher median RibScore (2 vs 0, 3 vs 0, $p < 0.001$) and SCARF score (3 vs 1, 4 vs 1, $p < 0.001$). On multivariate analysis, higher RibScore was associated with increased risk of respiratory failure (OR 2.32 $p < 0.001$ CI 1.99-2.783), pneumonia (OR 1.62 $p < 0.001$ CI 1.372-1.905),



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death (OR 2.0 p<0.001 CI 1.502-2.658) and SSRF (OR 2.3 p<0.001 CI 1.83-2.88). Odds ratio for SCARF score for respiratory failure, pneumonia, death and SSRF were 2.93 (CI 2.04-4.20, p<0.0001), 1.94 (CI 1.51-2.49, p<0.0001), 4.73 (CI 2.15-10.41, p<0.0001) and 5.41 (CI 2.92-10.05 p<0.0001) respectively. Similarly RSA was associated with increased risk of respiratory failure (OR 2.07 CI 1.69-2.54 p<0.0001), pneumonia (OR 1.43 CI 1.24-1.65 p<0.0001), death (OR 1.90 CI 1.42-2.54 p<0.0001) and SSRF (OR 2.58 CI 1.92-3.47 p<0.0001). The RibScore ROC AUC for respiratory failure, pneumonia, death and SSRF were 0.81, 0.73, 0.87 and 0.87 respectively. The SCARF ROC AUC for respiratory failure, pneumonia, death and SSRF were 0.85, 0.79, 0.92 and 0.91 respectively. The RSA ROC AUC for respiratory failure, pneumonia, death and SSRF were 0.91, 0.79, 0.90 and 0.94 respectively. RibScore of 3 demonstrated a 95% specificity in predicting lung complications (35% sensitivity) and SSRF (50% sensitivity). SCARF score of 3 demonstrated a 95% specificity in predicting lung complications (56% sensitivity) and SSRF (84% sensitivity). RSA of 5 demonstrated a 95% specificity in predicting lung complications (37% sensitivity) and SSRF (83% sensitivity).

Conclusion: RibScore and SCARF score demonstrate predictive ability for pulmonary complications and SSRF in an Australian trauma rib fracture population. The aggregate of the two scores increases the predictive accuracy even further. The RSA is a useful tool to identify those patients at risk of complications from rib fractures as well as those who may require SSRF.

Notes:



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Scientific Session – Friday 3B**

Moderator: John G. Edwards, MB ChB PhD FRCS(C-Th)
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Title:

Identifying the Learning Curve for the Surgical Stabilization of Rib Fractures

Presenting author:

Christopher Janowak, MD, FACS
University of Cincinnati, Associate Professor
Name one item still on your bucket list. Learn woodworking

Discussant:

Richard J. Miskimins, MD, FACS
UNM Hospital
Imagine you can instantly learn any language. Which would you choose? SQL

Authors:

- Aaron M. Delman, MD, MS
- Kevin M. Turner, MD
- Allison M. Ammann, MD
- D. Millar, MD
- Michael Goodman, MD
- Christopher Janowak, MD, FACS

Background: The surgical stabilization of rib fractures (SSRF) has become an accepted treatment modality for patients with severe chest wall injuries. Despite the increasing utilization of SSRF, the learning curve to develop operative proficiency remains unknown. We hypothesized that intraoperative variables could define individual and institutional learning curves for SSRF.

Methods: SSRF procedures from July 2015 - March 2021 at a single institution, involving 3 acute care surgeons, were included in the study. Preoperative, intraoperative, and post-operative variables were analyzed on all patients. Operative time, as measured from incision until skin closure, was evaluated by Cumulative Sum methodology to determine the learning curve.

Results: 56 patients underwent SSRF with a median age of 51.5 years old, and a median of 15 rib fractures [IQR: 11.3-18]. 53 (94.6%) patients had > 5 rib fractures and 52 (92.9%) had > 2 displaced rib fractures. The average Rib Score was 4.3 ± 1.3 . Mean operative time over the entire study period was 194.5 minutes, and cumulative sum analysis identified a shift to decreasing operative times at case 22 (FIGURE 1). The Post-learning curve ($n \geq 22$) operative times were significantly shorter than Pre-learning curve ($n < 22$) (173.1 minutes vs 230.0 minutes, $p < 0.01$). There was no significant difference in estimated blood loss (150mL vs 200mL, $p = 0.50$), plates per procedure (4.1 vs 3.6, $p = 0.19$), or minutes per plate (59.4 vs 51.3, $p = 0.10$) between cohorts. After stratifying by surgeon, operative times decreased with increased volume for all surgeons (Surgeon A: $r = -0.45$, Surgeon B: $r = -0.34$, Surgeon C: $r = -0.70$).

Conclusion: The institutional learning curve for SSRF appears to be 22 procedures. The implementation of SSRF programs by trauma and acute care surgeons is feasible with an attainable learning curve in a reasonable amount of time.



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Title:

In- and out-of-hospital outcomes following surgical stabilization of rib fractures in 80 years and older: a single-institution experience

Presenting author:

Jaya Sai Varre, MD, MBA

Riverside Methodist Hospital, General Surgery Resident Physician

If you were a baseball player, what would be your walk-up introduction song? Blinding Lights by The Weeknd

Discussant:

Andrea Hufford, DO, FACS, FACOS

Overland Park Regional Medical Center, Physician/Surgeon

What is a current trend that you just don't understand? The return of the mullet

Authors:

- Peter Hopmann, MD
- Brent Goslin, MD
- Brian Dusseau, DO
- John Bach, MD
- Kwang Suh, MD

Background: Surgical stabilization of rib fractures (SSRF) has demonstrated benefit in flail chest and multiple displaced fractures. There is mounting evidence for SSRF following chest wall injury (CWI) for the geriatric trauma population. A recent multi-center retrospective study highlighted a mortality benefit even for those patients aged 80 years and older. The objective of this investigation was to review our institutional experience with both in- and out-of-hospital outcomes within this patient population following SSRF.

Methods: A retrospective review of patients 80 years and older was performed at a high-volume Level 2 trauma center, from 2017 to 2021. SSRF volume is routinely >30 cases per year. Pre-injury, intraoperative, inpatient, and outpatient data were collected as available. Primary outcomes were inpatient and 90-day mortality. Secondary outcomes included 1-year mortality, discharge on narcotics, freedom from narcotics at 30 days, disposition to pre-injury location, and 30-day readmission.

Results: 50 patients were included for review. Mean age was 86 years and mechanism of injury was most often fall. 28 of 50 (56%) patients had flail chest (radiographic). Total fractured rib levels was 6, number of ribs fixated was 5, and time to surgery averaged 2.5 days. Inpatient mortality was 3/50 (6%) and 90-day mortality was 9/50 (18%). In addition to inpatient mortality, three deaths within the 90-day interval were found to be attributable primarily to CWI (6/50, 12%). Of patients with follow-up of 1 year and beyond, 27/28 were alive (96.4%). With respect to narcotic consumption, 44.7% (21/47) were discharged on narcotics with 90.3% (28/31; N limited by missing data) being narcotic-free at 30 days. Disposition to pre-injury location was infrequent (29.7%) and 30-day readmission rate was 17%.



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Conclusion: In this high-risk patient population, inpatient mortality was comparably low and similar to prior reports, though 90-day mortality was notably increased both for CWI-related and unrelated deaths. Narcotic use was seen in the minority of patients upon discharge, and most progressed to being narcotic-free at 30 days post-hospitalization. Inpatient outcomes alone may not adequately define both the benefit and risk of SSRF performed in patients 80 years and older.

Notes:



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Title:

Liposomal bupivacaine versus catheter-based blocks in patients undergoing surgical stabilization of rib fractures

Presenting author:

Leeanna Clevenger, MD

Medical University of South Carolina, Surgical Critical Care Fellow

Name one item still on your bucket list. Scuba dive a shipwreck

Discussant:

Fredric M. Pieracci, MD, MPH, FACS

Director of Surgery, Denver Health

If you were a baseball player, what would be your walk-up introduction song? I will always love you (Whitney version)

Authors:

- Alicia Privette, MD
- Stuart Leon, MD
- Mujahed Laswi, MD
- Evert A. Eriksson, MD, FACS, FCCM, FCCP

Background: Optimal pain control for patients with rib fractures remains an area of considerable research. Surgical stabilization of rib fractures (SSRF) has been shown to improve outcomes in certain populations. Nerve blocks are underutilized in this population and the optimal type of block is not well established. We hypothesized that in patients undergoing SSRF, similar pain control would be obtained using a single-dose of liposomal bupivacaine (LB) as compared to a continuous infusion (CI) catheter.

Methods: A retrospective evaluation of patients undergoing SSRF was conducted. Inclusion criteria included patients undergoing a single field unilateral SSRF who were not ventilated and had some form of local anesthesia performed either LB or CI. The LB block was performed at the time of surgery as a thoracic field block injected under direct visualization at all ribs one above and one below the injured segments excluding ribs 1 and 2. The CI block was placed by the regional pain service and managed by that service. The primary outcome measure was daily narcotic equivalents over the first 5 postoperative days. Secondary outcomes were doses of multimodal pain medications, numeric pain scores, and incentive spirometer effort.

Results: Thirty-seven patients were evaluated with 18 in the LB arm and 19 in the CI arm. Most of the CI blocks were epidural blocks (n=17). Only one paraspinal and one serratus block were placed. No difference was noted between the groups with respect to age, sex, comorbidities, location of fractures, number of rib fractures and number of ribs undergoing SSRF, time to SSRF, and Hospital length of stay. The injury severity score was similar between the groups (17+/-7 vs. 15+/- 6, p=0.364). Additionally, the patient's injuries were focused on the number of fractured ribs (6+/-3 vs. 7+/-2, p=0.555) with a thoracic abbreviated injury score of 3 (3(3-4) vs. 3 (2-4), p=0.799) and a



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Title:

Retrospective Case Controlled Study of Cryoablation of the Intercostal Nerves during Surgical Stabilization of Rib Fractures

Presenting author:

Alex Clem, MD
Evans Army Community Hospital, General Surgeon
Name one item still on your bucket list. Tour du Mont Blanc

Discussant:

Mark A. Kryskow, DO
Berkshire Medical Center, Director of Surgical Critical Care
Name one item still on your bucket list. Skiing in Japan

Authors:

- Alex Clem, MD
- Philip Kemp-Bohan, MD
- Richard N. Lesperance, MD, FACS

Background: Cryoablation of intercostal nerves during Surgical Stabilization of Rib Fractures (SSRF) has been described as a pain-control adjunct. We reviewed our experience before and after adoption to determine any pain control benefits.

Methods: Single institution retrospective review of patients undergoing SSRF with (n=10) or without (n=10) cryoablation of the intercostal nerves. Demographics analyzed included age, sex, injury severity score, mechanism, number and characteristics of rib fractures, and other post-operative analgesia including thoracic epidural use. Outcomes include surgical time, ventilator days, ICU and hospital Length of Stay (LOS), narcotic usage, numerical pain score (NPS), and Incentive Spirometry levels.

Results: Patient demographics including injury characteristics were not significantly different between the two groups. The mean number of rib fractures was 7.9 (95% CI 6.2-9.6) and 8.4 (95% CI 5.9-10.9) for the non-cryo and cryo groups. Mean length of surgery was 225 minutes for the non-cryo group and 315 min. for those receiving cryo (p=0.02). Thoracic epidurals were placed pre-operatively for 7 of the 10 cryo patients and 5 of the 10 non-cryo patients (p=0.3). There were no significant differences between the groups for NPS, Incentive Spirometry goals or narcotic usage during the first 5 postoperative days. The cryo group had a lower NPS at post-op follow up (3.1 vs 6.3), but this did not reach statistical significance (p=0.09).

Conclusion: Intraoperative cryoablation of intercostal nerves during SSRF did not result in statistical benefit in inpatient opioid usage, ICU or hospital LOS, numeric pain scores, or incentive spirometry values. High utilization of thoracic epidurals pre-operatively may have obscured short term benefits of cryoablation.



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Title:

Rib fixation in patients with severe rib fractures and pulmonary contusions: is it safe?

Presenting author:

Suzanne F.M. van Wijck, MD
Erasmus MC

Imagine you can instantly learn any language. Which would you choose? Arabic

Discussant:

Christopher Kinnard, MD, FACS

University of South Alabama, Assistant Professor

If you were a baseball player, what would be your walk-up introduction song? Readymade by Red Hot Chili Peppers

Authors:

- Suzanne F.M. Van Wijck, MD
- Ernest E. Moore, MD, FACS
- Fredric M. Pieracci, MD, MPH, FACS
- Clay C. Burlew, MD, FACS
- Elizabeth F. Smith, MSPH
- Mathieu M.E. Wijffels, MD, PhD
- Kelley Madden, MBA
- Nicole L. Werner, MD, MS, FACS

Background: Pulmonary contusions have traditionally been considered a contra-indication to surgical stabilization of rib fractures (SSRF). The aim of this study was to evaluate the relationship between pulmonary contusions and outcomes after SSRF, hypothesizing that outcomes would be worse in patients with pulmonary contusions who undergo SSRF compared to patients whose rib fractures are managed non-operatively.

Methods: This retrospective cohort study included adults admitted with ≥ 3 displaced acute rib fractures or flail segment on chest computed tomographic scan (CT) between 2010 and 2021 at a single institution. Patients were divided into those who underwent SSRF vs. those managed non-operatively. Severity of pulmonary contusions was assessed on the admission chest CT, using the blunt pulmonary contusion (BPC18) score. Pulmonary contusion severity was defined as mild with BPC18 of 1-3, moderate with 4-6 and severe with 7-18. Outcomes (pneumonia, tracheostomy, mechanical ventilation days, ICU length of stay, hospital length of stay, mortality) were retrieved from patients' medical records. Nonparametric statistics were used for non-normally distributed data. Comparisons were made using the Fisher's exact and Kruskal-Wallis tests, and correction for potential confounding was done with regression analyses

Results: Included were 231 patients (70.1% male) with a mean age of 52.2 (SD 16.4) years. Patients had a median of 12 (P25-P75 7-15) rib fractures and 135 (58%) had a flail segment. In total, 226 patients (98%) had some degree of pulmonary contusion on admission CT: 84 (37%) patients mild, 96 (42%) moderate, and 46 (20%) severe. SSRF was performed in 153 (66%) patients. The median BPC18 on admission CT of SSRF patients was 4 (P25-P75 3-6) and the median BPC18 of non-operative



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Title:

Surgical stabilization of rib fractures versus nonoperative treatment in patients with multiple rib fractures following cardiopulmonary resuscitation: an international, retrospective Chest Wall Injury Society matched case-control study (CWIS-CPR)

Presenting author:

Jonne T.H. Prins, MD
Erasmus MC, University Medical Center Rotterdam, The Netherlands, PhD Candidate
Name one item still on your bucket list. Roadtrip from East to West coast USA

Discussant:

Megan E. Bowen, MD

Authors:

- Jonne T.H. Prins, MD
- Esther M.M. Van Lieshout, PhD, MSc
- Evert A. Eriksson, MD, FACS, FCCP
- CWIS-CPR study group
- Michael H.J. Verhofstad, MD, PhD
- Mathieu M.E. Wijffels, MD, PhD

Background: Rib fractures are the most common chest wall injuries due to cardiopulmonary resuscitation (CPR). The presence of six or more rib fractures or a displaced rib fracture in this population has been associated with longer hospital stay and intensive care unit (ICU) stay, respectively. Evidence on the effect of surgical stabilization of rib fractures (SSRF) for severe rib fractures following CPR is limited to case reports or series. This study aimed to evaluate the effect of SSRF versus nonoperative management on in-hospital outcomes in patients with multiple rib fractures after CPR.

Methods: A multinational, retrospective study was performed in patients who underwent SSRF or nonoperative management for multiple rib fractures following CPR between January 1, 2012 and July 31, 2020. Patients who underwent SSRF were matched to one or two nonoperative controls by cardiac arrest location, cause of arrest, rib fracture pattern (i.e., unilateral or bilateral, flail chest, or flail sternum), and age. The primary outcome was ventilator-free days, defined as the number of days without (non)-invasive mechanical breathing. Secondary outcomes were ICU and hospital stay, pneumonia, thoracic complications, and mortality.

Results: Thirty nine patients underwent SSRF and were matched to 69 nonoperative controls. The treatment groups had comparable matching criteria. Other patient and CPR-related characteristics were similar. Patients who underwent SSRF more often had at least one displaced fractured rib (28, 72% vs. 31, 47%; $p=0.015$) and a higher median number of displaced ribs (2, P25-P75 0-3 vs. 0, P25-P75 0-3; $p=0.014$). SSRF was performed at a median of 5 days (P25-P75 3-8) after CPR. In the nonoperative group, a rib fixation specialist was consulted in 14 patients (21%). There was no difference in the number of ventilator-free days between the treatment groups. The ICU LOS was

