



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

Moderator: Mathieu M.E. Wijffels, MD, PhD
Recorder: Peter A. Cole, MD, FAOA

Title:

Classification and clinical validation of posterior rib fractures

Presenting author:

Felix Schäfer, MD

Department of Orthopaedic and Trauma Surgery University Erlangen, Germany, Classification and clinical validation of posterior rib fractures

If you were a baseball player, what would be your walk-up introduction song? Kanye West - Power

Discussant:

Marika Gassner, DO, FACS

St Charles HealthSystem, Trauma Surgeon

Name one item still on your bucket list. Dive with a whale shark

Authors:

- Felix Schäfer, MD
- Johannes Groh, MD
- Florian Kern, MD
- Stefan Schulz-Drost, MD, PhD, FEBS

Background: In general, rib fractures are common as well as prognostic injuries, especially in acute trauma. For a dedicated examination of this entity, a commonly recognized and clear classification is necessary. This then, through an exact description of the pathologies, enables scientific comparisons to be made with regard to cause, diagnosis, accompanying injury and, ultimately, treatment options. This thesis deals with the validation of the first major international classification of the bony thorax, especially in the area of the costovertebral junction.

Methods: As part of a retrospective study, 1734 consecutive patients from the University Hospital Erlangen with the diagnosis of serial rib fractures (ICD S22.4) in the period 2011 to 2016 and sternum fractures (ICD S22.2) in the period 2012 to 2016 were screened for posterior fractures. In the end, 170 patients were evaluated. Above all, the type and morphology of the fracture was analyzed, taking into account the new AO/OTA classification, as well as accompanying injuries and physiological parameters of the respective patient.

Results: A total of 315 posterior fractures were found in the evaluated patient collective, 113 of which were classified as type A, 173 as type B and 29 as type C fractures. Both halves of the thorax were affected almost equally and show a similar distribution of types. With regard to the number of fractures, an accumulation can be found in the area of the first rib. In addition, there were 298 closely spaced posterolateral fractures.

Conclusion: In general, posterior rib fractures can be divided into the new AO/OTA classification. However, further sub-categories of these classes for a more detailed and therefore clearer description. In this way, following the previous AO concept, subclasses for each type can be described for the first time, based on the current patients collective. Furthermore, based on the



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

Moderator: Mathieu M.E. Wijffels, MD, PhD
Recorder: Peter A. Cole, MD, FAOA

Title:

Clinical Outcomes of Intrathoracic vs Extrathoracic Plating in Rib Fracture Fixation

Presenting author:

Erika Tay, MD

University of California Irvine, Research Fellow

If you were a baseball player, what would be your walk-up introduction song? Eye of the Tiger

Discussant:

Lawrence Lottenberg, MD, FACS

Florida Atlantic University, Clinical Professor of Surgery Interim Chairman/Interim Program

Director Department of Surgery

If you were a baseball player, what would be your walk-up introduction song? Welcome to the Jungle

Authors:

- Leonardo Alaniz, BBA
- William Grant, BS
- Brynn Sargent, BS
- Madelyn Frank, BA
- Gabrielle Hovis, BS
- Colin Kincaid, BS
- Sebastian D. Schubl, MD, FACS

Background: Intrathoracic rib fixation allows for a less invasive approach to rib fracture repair. This approach offers less muscle disruption, which may improve patient recovery compared to traditional plating. We hypothesized that patients with intrathoracic plating have a shorter length of stay (LOS) and Intensive care unit (ICU) LOS compared with extrathoracic plating.

Methods: A prospective observational study was made from November 2017 until September 2021. Patients that underwent surgical fixation of rib fractures were included. Patients with an AIS ≥ 3 in any body part except for chest were excluded. Patients were divided into two groups: intrathoracic plating (ITP) and extrathoracic plating (ETP). Categorical variables were recorded as present or absent, and continuous variables were recorded as medians with interquartile ranges. Pearson chi-square tests were used to compare the rate of internal versus external plating. Mann-Whitney U tests were used to compare continuous clinical factors and outcomes that did not follow a normal distribution. Additionally, propensity score matching (PSM) was used to conduct 1:1 matching of ITP and ETP patients based on age, ISS, and the presence of AIS head.

Results: A total of 96 patients were analyzed, 59 (61%) were ETP and 27 (38%) were ITP.

The most common mechanism of injury was motor vehicle accidents (29.2%), followed by falls (22.9%) and motorcycles (20.8%). Median age was 55 years for ETP and 53 years for ITP. There were no differences between groups in comorbidities.

There was no significant difference with ISS when comparing ETP with ITP (18 vs. 19 p 0.89).



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

Moderator: Mathieu M.E. Wijffels, MD, PhD
Recorder: Peter A. Cole, MD, FAOA

Title:

Costal margin reconstruction for intercostal hernias: a case series

Presenting author:

Angelis Vazquez, MD

Angelis Vazquez Perez, Costal margin reconstruction for intercostal hernias: a case series

What is a current trend that you just don't understand? Gluten Free Everything

Discussant:

Adam Hansen, MD

West Virginia University Heart & Vascular Institute, Assistant Professor of Thoracic Surgery

Name one item still on your bucket list. Joining Seal Team 6

Authors:

- Karl A. LeBlanc, MD
- Patrick Greiffenstein, MD, FACS
- Leslie Son, PhD

Background: Acquired intercostal hernias (AIHs) are defects in the thoracic or abdominal wall that result in protrusion of the fascial layers between adjacent ribs. It is a rare condition believed to originate from a costal margin rupture. There is no established standard management, however, different tension-free methods using mesh have been described.

Methods: The aim of this study is to present a novel technique for repair of AIHs and the outcomes of this approach. We present a case series of five patients from a single institution for which a costal margin reconstruction technique was primarily used. These patients were diagnosed clinically, and CT imaging was performed preoperatively.

Results: Patients' characteristics included a mean age of 64 and an average BMI of 31. The most common causes for these hernias were traumatic and incisional. A successful repair was performed in all five patients with an open technique utilizing an absorbable plate, non-absorbable cerclage implants and occasional (n=2/5) sub-fascial mesh reinforcement. The most common complication was chest wall seroma (n=3). Results from post-operative follow-up showed a high rate of patient satisfaction and 80% of successful outcome.

Conclusion: Rib plating technique utilizing this technique for costal margin reconstruction is a good and safe option for the treatment of abdominal intercostal hernias.

Notes:



2022 CWISummit
Scientific Session – Friday 3A

Moderator: Mathieu M.E. Wijffels, MD, PhD
Recorder: Peter A. Cole, MD, FAOA



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

Moderator: Mathieu M.E. Wijffels, MD, PhD
Recorder: Peter A. Cole, MD, FAOA

Title:

Finite Element Analysis for Better Evaluation of Rib Fractures: A Pilot Study

Presenting author:

Zachary M. Bauman, DO, MHA, FACOS, FACS
University of Nebraska Medical Center, Surgeon
Name one item still on your bucket list. Seeing the Great Wall Of China

Discussant:

Tareq S. Kheirbek, MD, ScM, FACS
Brown University, Associate Professor of Surgery
Imagine you can instantly learn any language. Which would you choose? Italian

Authors:

- Zachary M. Bauman, DO, MHA, FACOS, FACS
- Sven Herrman, PhD
- Jana Binkley, MD
- Charity H. Evans, MD, FACS
- Andrew Kamien, MD
- Samuel Cemaj, MD, FACS
- Bennett Berning, MD
- Emily Cantrell, MD

Background: Modeling rib fracture stability is challenging given the lack of reliable models. Computer generated finite element analysis (FEA) is a possible option for assessment of chest wall stability (CWS). The objective of this study is to explore FEA as a means to assess CWS, hypothesizing it is a reliable approach to better understand rib fracture pathophysiology.

Methods: For preparation of the model, thoracic anatomy was generated from standardized skeletal models with internal/external organs, soft tissue and muscles using Digital Imaging and Communications in Medicine (DICOM) data. Material properties we assigned to bone, cartilage, skin and viscera based on current literature. Simulation was performed using ANSYS 2020 R2. Meshing of the model was completed identifying 1.3 million elements and 2.1 million nodes for analysis. An implicit solver was used for a linear, static finite element analysis while all bony contacts were identified and applied to the model. Lastly, all material behavior was modeled as isotropic and linear elastic.

6 load cases were evaluated in the FEA from a musculoskeletal AnyBody model; forward flexion, right/left lateral bending, right/left axial rotation and 5kg weight arm lifting. Standard application points and directions of muscle forces as well as joint positions were also derived from the AnyBody model and applied to the FEA.

For preparation of the model, thoracic anatomy was generated from standardized skeletal models with internal/external organs, soft tissue and muscles using Digital Imaging and Communications in Medicine (DICOM) data. Material properties we assigned to bone, cartilage, skin and viscera based on current literature. Simulation was performed using ANSYS 2020 R2. Meshing of the model was



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

Moderator: Mathieu M.E. Wijffels, MD, PhD
Recorder: Peter A. Cole, MD, FAOA

Title:

Late Chest Wall Margin Disruption and Intercostal Hernia Presenting as Rib Nonunions: A Case Series

Presenting author:

Ilexa Flagstad, MD

University of Minnesota, Resident Physician

Name one item still on your bucket list. Get my sailboat and sail the seas

Discussant:

Christopher W. Towe, MD

Associate Professor

If you were a baseball player, what would be your walk-up introduction song? Is baseball still a sport?

(Editor's note: Baseball is the epitome of sport)

Authors:

- Thomas Zach Paull, MD
- Peter A. Cole, MD, FAOA
- Michael C. LaRoque, BSME

Background: Costal margin injury is poorly understood, and at times major disruptions are associated with intercostal hernia and rib nonunions. The natural history of this injury pattern is not known, and there is no consensus on treatment. There is minimal literature on rib nonunions in the setting of costal margin disruption. The purpose of this study is to describe a series of patients with multiple rib nonunions in which costal margin disruption and intercostal herniation was encountered.

Methods: We performed a retrospective review of six patients with rib nonunions and costal margin disruption with associated intercostal herniation. Patient and injury characteristics were collected. Imaging, including radiographs, computerized tomography (CT) scans and 3D CT reconstructions were reviewed (Figure 1). The chronology of injury was established, from inciting event to sequential manifestation of pathology to treatment.

Results: All patients were male with a mean age of 60 years and a BMI of 34.5. Four of the patients had an underlying respiratory disease, and two of those are current smokers (Table 1). Three patients sustained the injury due to a ground-level fall, one from lifting a heavy object, one from coughing, and another from snowmobiling. All six had rib nonunions with a mean of 3.3 rib nonunions. On physical exam, there was a palpable bulge and pathologic separation of ribs at a specific intercostal space associated with tenderness and instability. Four of the patients underwent reconstruction, however two patients failed treatment and had a palpable bulge at final follow-up. Two patients have been managed expectantly and have demonstrated progressive worsening with an increase in the number of nonunions over time (Table 2).



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

Moderator: Mathieu M.E. Wijffels, MD, PhD
Recorder: Peter A. Cole, MD, FAOA

Title:

Non-trauma provider specialization is associated with higher rates of surgical intervention for rib fractures

Presenting author:

Avanti Badrinathan, MD

University Hospitals Cleveland Medical Center, General Surgery Resident

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

Discussant:

Steven Briggs, MD, FACS

Sanford Medical Center Fargo, Chair of Trauma and Acute Care Surgery

What is a current trend that you just don't understand? Anything teenage girl related

Authors:

- Anuja L Sarode, MPH
- Christine E Alvarado, MD
- Jillian Sinopoli, DO
- Jonathan D Rice, MD, PhD
- Philip A Linden, MD
- Matthew L Moorman, MD, MBA
- Christopher W. Towe, MD

Background: Surgical stabilization of rib fractures (SSRF) is performed on only a small subset of patients who meet guideline recommended indications for surgery. Although previous studies show that provider specialization was associated with SSRF procedural competency, little is known about the impact of provider specialization on frequency of SSRF performance. We hypothesize that provider specialization would impact performance of SSRF.

Methods: The Premier Hospital Database was used to identify adult patients with rib fractures from 2015 and 2019 using ICD-10 codes for single rib fracture, multi-rib fractures, and flail chest. The outcome of interest was performance of SSRF and was defined using ICD-10 PCS coding. Patients were categorized as receiving their procedures from a thoracic surgeon, general surgeon, trauma surgeon, or orthopedic surgeon. Patients with missing or other provider types were excluded. Elixhauser score was calculated from ICD coding. Multivariate modeling was performed to evaluate the effect of surgical specialization on outcomes of SSRF. Given a priori assumptions that trauma centers may have different practice patterns, a subgroup analysis was performed excluding patients with "trauma center" admission type.

Results: Among 39,733 patients admitted with rib fractures, 2,865 (7.2%) received SSRF. Trauma centers admission represented a minority (1,034, 36%) of SSRF procedures relative to other admission types (1831, 64%, $p=0.15$). SSRF procedures were most commonly performed by general surgeons (1,666/2,865, 58.1%), followed by trauma surgeons (706/2,865, 24.7%), thoracic surgeons (280/2,865, 9.8%) and orthopedic surgeons. (213/2,865, 7.4%).



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

Moderator: Mathieu M.E. Wijffels, MD, PhD
Recorder: Peter A. Cole, MD, FAOA

Title:

Rib Injury Burden (RIB) Survey: An International Survey of the Chest Wall Injury Society Member Practices in the Analgesia of Rib Fractures.

Presenting author:

Gary Jain, MD

Hartford Hospital, Acute Care Surgery Fellow

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

Discussant:

Nicole Werner, MD, MS, FACS

Denver Health Medical Center, Trauma Surgeon

Name one item still on your bucket list. Diving at Galapagos

Authors:

- Gary Jain, MD
- Jane Keating, MD
- SarahAnn Whitbeck, MBA
- Daniel Daman, MD
- Adam J. Kaye, MD, MHA, FACS
- Daniel Ricaurte, MD

Background: Traumatic rib fractures are common injuries that carry a high morbidity. Historically, the mainstay of treatment has been a pain regimen that relied heavily on opioid therapy. Due to the opioid epidemic, a major push towards multimodal pain regimens has occurred in recent years. To date, there is no consensus as to what medications or adjuncts should be utilized in these regimens.

Methods: A 28-question survey was distributed electronically amongst all members of the Chest Wall Injury Society (CWIS) to gain a better understanding of current practice patterns for pain management in patients admitted with rib fractures.

Results: 72 CWIS members completed the survey representing eleven countries. Respondents were mainly trauma surgeons (71%). 69% of respondents practice at a Level 1 trauma center, with 42% reporting > 200 rib fracture admissions per year at their institution. 92% of respondents actively perform surgical stabilization of rib fractures (SSRF), with 22% reporting they perform more than 30 SSRF cases per year.

The most common inpatient multimodal pain regimen included a combination of an oral opioid (97%), acetaminophen (93%), ibuprofen (70%), gabapentinoid (78%) and a muscle relaxant (69%). Methadone or suboxone do not appear to be frequently used (4%). The presence of specialized pain teams appears to be common amongst institutions surveyed (76%), with failure to achieve adequate pain control with oral analgesia being the predominant trigger to get them involved (50%). In those with access to regional blocks (79%), elevated pain scores despite oral analgesia (49%) and PIC scores (19%) were the most common reason for their use. Epidural catheters (32%) and erector spinae blocks (32%) are the most commonly used regional anesthesia for unilateral rib fractures, while an

