

# Severe Displacement of Initially Non-Displaced Rib Fractures Necessitating Surgical Fixation

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## Introduction

Blunt thoracic trauma poses a unique challenge to our understanding of and management of rib fractures. Rib fractures are the most common injury after blunt chest trauma. Conventional treatments have focused on locoregional pain control and pulmonary hygiene. In the last twenty years, surgical stabilization of severely displaced rib fractures has gained momentum by offering patients improved pain outcomes and a faster recovery. While many rib fracture patients present with severely displaced ribs, others show little or no signs of displacement on initial CT imaging.

No evidence currently exists supporting rib fixation for non-displaced fractures<sup>2</sup>. However, non-displaced rib fractures can progress to interval displacement over time, mostly due to patient motion, forces of chest wall musculature, and intrathoracic pressure variability<sup>25</sup>. In patients that present with multiple non-displaced rib fractures with a stagnant or worsening clinical course, repeat imaging 2-3 days after the initial insult can evaluate for interval rib displacement and help guide surgical management. **We present a patient with blunt thoracic trauma who sustained multiple minimally displaced rib fractures that progressed towards severe displacement necessitating rib fixation.**

## Case

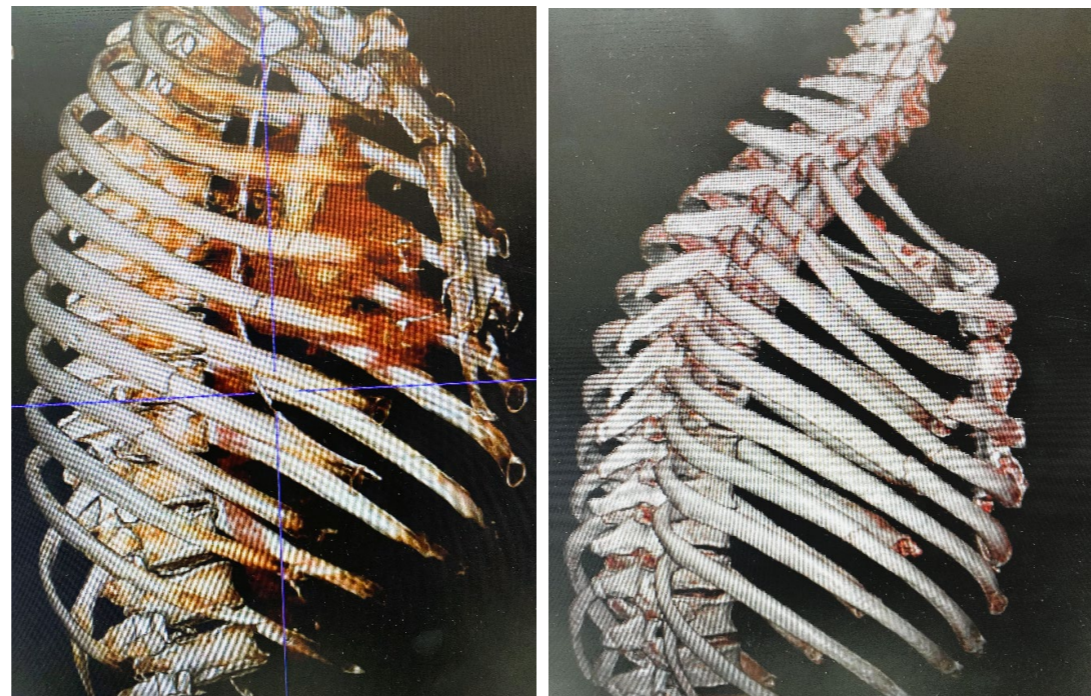
A 60-year old male presented to our trauma center after crashing his motorcycle, un-helmeted. He was intubated in the trauma bay for a GCS of 8. His injury burden included SAH/SDH, a right clavicular and scapular fracture, as well as minimally-displaced fractured ribs 2-10 on the right.

On hospital day # 3, the patient was successfully extubated. On hospital day # 4, a chest x-ray demonstrated an enlarging right sided effusion for which a repeat chest CT was obtained showing severely displaced and deformed rib fractures concerning for flail chest. Tube thoracostomy was performed with 500 cc of serosanguinous fluid evacuated. On hospital day #7, the patient had a worsening of his respiratory status necessitating re-intubation.

The following day, the patient was taken to the operating room for surgical fixation of his right sided rib fractures. Using the Zimmer Biomet RibFix Advantage Intrathoracic Fixation System, ribs 4-8 on the right lateral thorax were successfully plated. Simultaneous cryoablation of neurovascular bundles of ribs 3-8 was also performed.

For the anteriorly fractured ribs 2, 3, 4, a vertical incision along the medial border of the right pectoralis major muscle was made and the pectoralis major muscle was dissected from the chest wall. The KLS Martin external rib fixation system was utilized to stabilize ribs 2, 3, 4. Fibertak DX Suture Anchors were then used to anchor the titanium plates at the costochondral junction with the sternum. Three suture anchors were used to ensure adequate fixation of ribs 2, 3, 4 to healthy sternal bone

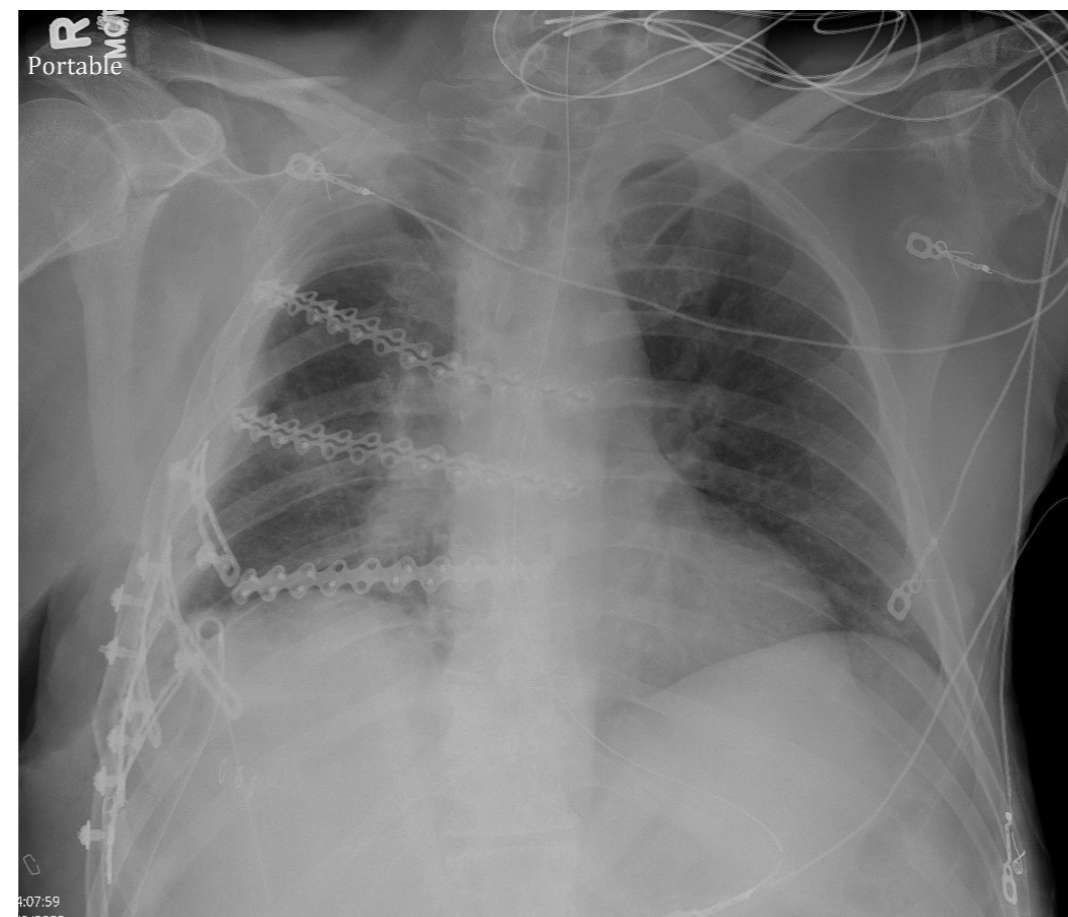
## Case (continued)



**Initial 3-D reconstruction of the patient's thorax showing minimally displaced right sided rib fractures (L). Interval worsening of right sided rib fractures with flail segment during hospital admission (R).**



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**Post-op chest xray demonstrating the use of the internal and external rib fixation systems to help stabilize the right hemi-thorax. Anterior ribs 2, 3, 4 were plated using the external rib fixation system. Posterior-lateral ribs 4-8 were plated using the internal rib fixation system.**

## Results

The patient was able to safely extubate on post-op day # 2. He was subsequently downgraded to the surgical floor with continued physical therapy. He was discharged home on post-op day # 22.

## Conclusion

Our case report highlights an important and understudied topic in thoracic trauma; the degree of rib fracture displacement during ones' hospital course. This interval displacement is due to patient motion, forces of chest wall musculature, and intrathoracic pressure variability<sup>2</sup>. With every inhalation, the average adult chest expands 3 to 5 cm, further exacerbating rib malunion<sup>2</sup>. Clinically, interval displacement can present as increased work of breathing, failure to wean from mechanical ventilation, new effusions/consolidations on imaging, and worsening thoracic pain<sup>1</sup>.

Often, lack of or minimal rib displacement on computed tomography imaging is one of the reasons for non-operative management of rib fractures<sup>2</sup>. However, a recent study from the University of Nebraska showed increased rib displacement over time in all ribs except fractured ribs eleven and twelve<sup>2</sup>. This displacement over time is inherent in normal chest wall physiology and very difficult to predict or prevent<sup>2</sup>. As such, clinical vigilance is imperative to identify the patients that present with multiple non-displaced rib fractures with a stagnant or worsening clinical course. In this select group, repeat imaging 2-3 days after the initial insult can evaluate for interval rib displacement and help guide surgical management.

Indications for surgical fixation of rib fractures exist, and help guide surgical management, however such guidelines do not recommend surgery for non-displaced rib fractures. As such, the agreed-upon criteria for surgical fixation fail to address the significant degree of rib fracture displacement that patients experience over time. A significant portion of our trauma patients are thus denied the potential benefits of surgical stabilization, such as improved pain control, decreased rates of pneumonia, and a reduced hospital stay.

## References

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