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Surgical Fixation of Complex Rib Fractures to Sternum for Flail Chest: A Case Report

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ABSTRACT

Rib fractures are among the most common injuries found in patients presenting from blunt trauma. They are associated with significant morbidity and mortality, largely due to pulmonary complications. Open reduction and internal fixation (ORIF) has been the mainstay treatment for patients with multiple rib fractures. In this report, we present a case of a patient that sustained blunt thoracic trauma with multiple anterolateral rib fractures, including a flail segment. This fail segment involved the costal cartilage and required fixation of ribs to the sternum in order to restore chest wall stabilization and integrity. This was achieved using the Zimmer Biomet rib plate system. The approach utilized should be considered in patients with rib fractures associated with segments of displaced costal cartilage.

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KEYWORDS

Rib fractures, flail segment, rib plating

INTRODUCTION

Blunt thoracic trauma is a common mechanism of injury that occurs worldwide. The morbidity and mortality associated with rib fractures have been well documented.[1-3] The morbidity from such injuries increases with age, number of fractures, and presence of flail segments. Patients with rib fractures often present with underlining pulmonary contusions, are more susceptible to pneumonia, and have long-term pain and disability.[4] The mainstay of treatment has been conservative therapies, such as pain control and respiratory support. However, over the past 2 decades, there has been mounting evidence in the literature to suggest that open reduction and internal fixation (ORIF) of ribs shortens the length of ICU stays, decreases the need for tracheostomy, and lowers the rate of pneumonia.[5] Other advantages of ORIF include a decreased duration of intubation and a decreased likelihood of clinically significant long-term respiratory dysfunction and chest wall deformity.[6] Rib fixation is performed for a range of indications, including, but not limited to a flail chest segment, severely displaced fractures, multiple fractures, significant pain refractory to multimodal pain management, and nonunion or malunion.[7] It should be noted that the indications for rib plating are not perfectly defined, and continued studies are needed to develop the indications further. Here, we present a patient with a flail segment involving the costal cartilage requiring fixation of the rib to the sternum to achieve stabilization and restore chest wall integrity to a flail segment.

CASE REPORT

Our patient is a 39-year-old male that presented as a trauma consult from the emergency department. He was riding on a side-by-side all-terrain vehicle when he was struck on the right side of his chest by a large tree branch. He reported significant pain immediately with the impact and some associated shortness of breath. He arrived by ground via ambulance. He underwent a standard trauma workup in the emergency department, including a chest x-ray and CT scans of his head, C-spine, chest, abdomen, and pelvis. His notable findings were right fifth through seventh anterolateral rib fractures with displacement of the costal cartilage at the

same levels (Figures 1 and 2). He had underlying right middle and lower lobe contusions, a small right hemopneumothorax, and a grade 2 splenic laceration. He was hemodynamically stable in the emergency department on 2 liters nasal cannula with good oxygen saturation. A 36 French right-sided chest tube was placed with minimal output, but a significant air leak was noted.

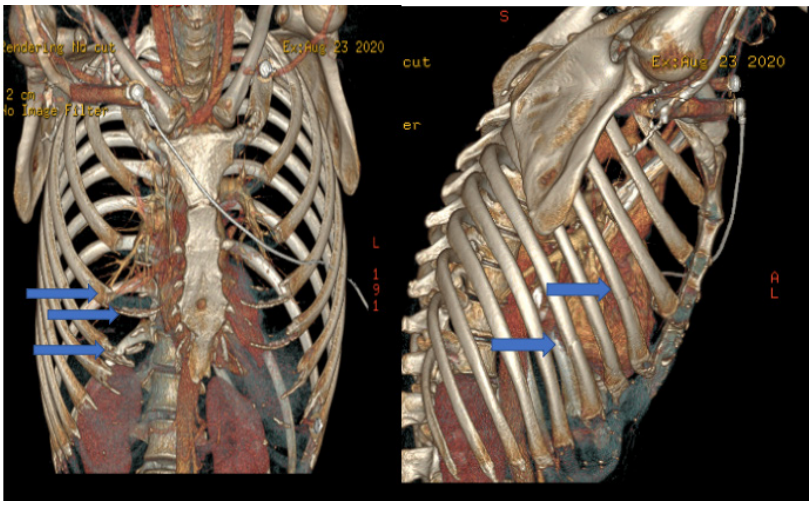

FIGURE 1. CT 3D reconstruction of rib fractures with displacement of costal cartilage at levels 5, 6, and 7.
FIGURE 2. CT 3D reconstruction of the chest demonstrating anterolateral fractures at levels 5 and 7.

The patient needed increased oxygen requirements overnight to maintain oxygen saturation. He was placed on a non-rebreather at 10L/min. On repeat chest x-ray, it was noted that his pneumothorax had worsened, and a second right-sided chest tube was placed. Due to acute hypoxic respiratory failure, the patient required endotracheal intubation on hospital day 1.

Over the next 2 days, the patient required a Positive End Expiratory Pressure (PEEP) of 14 and FIO2 ranging from 55 to 70%. The decision was made for rib fixation to optimize physiologic respiratory dynamics. He was taken to the operating room on hospital day 3. Rib levels 5 and 7 on the right were fixated on the anterolateral fractured segments, and then separately on the medial aspect, levels 5, 6, and 7 were fixated onto the sternum (Figure 3). A postoperative chest x-ray was obtained, as demonstrated (Figure 4).

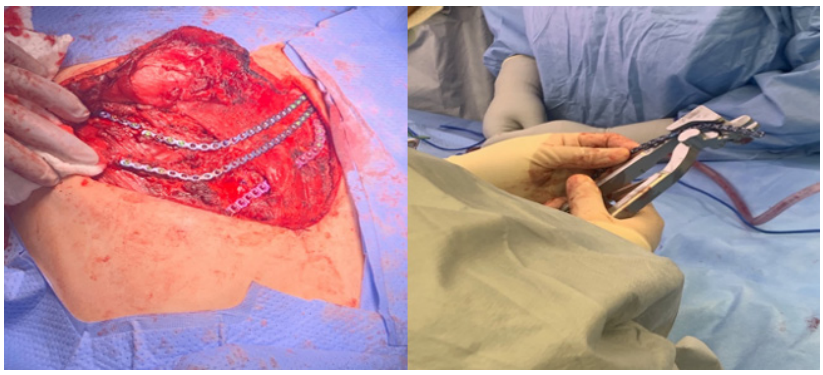

FIGURE 3. Intra-operative picture of medial aspect of rib fixated to the sternum. The Zimmer Biomet system was used.

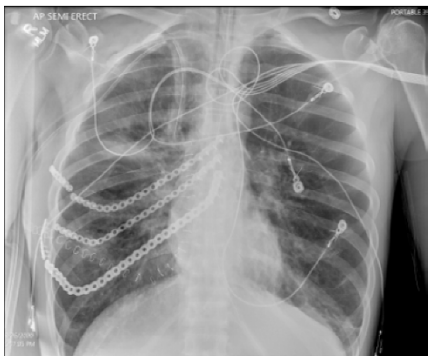

FIGURE 4. Immediate postoperative AP chest X-ray of rib fixation.

Postoperative, the patient's oxygen requirements were significantly lowered. By postoperative day 2, his PEEP was weaned to 8, and FIO2 was 40%. The patient remained severely agitated postoperatively. On postoperative day 8, he was extubated after weaning parameters were met. Due to worsening agitation and desaturations, he was re-intubated later that evening. He was found to have klebsiella pneumonia on deep sputum culture and was treated with a course of antibiotics. He was extubated again 5 days later.

He was transferred to the floor and discharged to an acute rehab placement. He was seen for follow-up in the clinic 2 weeks after discharge (Figure 5). During his clinic visit, he reported minimal pain at the operative site. He was back to his daily activities at the same level pre-injury.

FIGURE 5. Postoperative clinic follow-up visit with examination of surgical site.

ISCUSSION

The indications for rib plating are not fully established, and work is ongoing to define all indications for rib fixation more clearly. Current guidelines suggest that patients who should be considered are those with 3 or more acutely displaced fractures, those with flail segments, those that fail optimal non-operative management, and patients with rib fractures that require thoracic surgery for other indications.[8] Timing of intervention is another important consideration. Most research shows that early intervention within 48 to 72 hours of injury is optimal to mitigate factors such as inflammation, hematoma, empyema, deformities of the chest wall, and early callous formation.[4,5]

Operative rib fixation is beneficial for pain relief, length of stay in the ICU, length of mechanical ventilation, and decreasing incidence of pneumonia.[6] However, the evidence looking at the long-term benefits of rib plating is scarce. One study examined postoperative quality of life (QOL) indices as part of their trials. They found that patients with rib plating were more likely to return to a high-activity job sooner.[9] Another study sent out retrospective questionnaires post-surgery and was unable to demonstrate any long-term benefits of rib plating past 24 months.[10]

The anterolateral approach to external rib fixation is most commonly utilized because it allows access to the majority of rib fractures (anterolateral, lateral, and posterolateral) located from the mid-clavicular line to the vertebral border of the scapula. The posterior approach is recommended for posterior and subscapular rib fractures and those occurring at the spine. Another common approach is the line of best fit, in which the incision is made directly over the top of the fracture sites. These approaches can all be utilized in a muscle-sparing technique, depending on where the fractures lay.[11]

While there are documented cases of separately fixating sternal fractures and rib fractures, no studies report rib fixation directly onto the sternum that we could find in our literature search. More cases such as this are needed to determine further the short- and long-term outcomes of fixating a rib directly to the sternum so that management guidelines can be developed.

CONCLUSION

Our approach of external fixation across the costal cartilage from the rib directly onto the sternum is a sound technique that, by necessity, is warranted for flail chest and costal cartilage destruction. Our patient was able to be extubated shortly after the fixation with a good short-term outcome. This approach should be considered in patients with rib fractures and associated displaced costal cartilage.

AUTHOR AFFILIATIONS

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