

## Case Report

# An unexpected fracture of a titanium rib plate in a patient with traumatic brain injury

Ki Tae Kim, Sung Wook Chang\*

Department of Thoracic and Cardiovascular Surgery, Dankook University Hospital, Cheonan, Republic of Korea

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## ABSTRACT

Surgical stabilization of rib fractures has been accepted and successfully performed for the management of patients with multiple rib fractures. Several types of devices, such as titanium bar, plate, and screws, are used for rib stabilization. Titanium devices provide a strong support for rib fixation and chest wall reconstruction and are rarely associated with complications. Herein, we report an unusual case of mechanical failure associated with a broken titanium plate. A 47-year-old man was treated with surgical stabilization of rib fractures using titanium plates after blunt trauma leading to epidural hematoma and massive hemothorax. After decompressive craniectomy, bleeding control, and rib fixation for chest trauma, he developed hyperactive delirium, which was not well controlled. On the 17 day of operation, a chest radiograph showed a broken rib plate. Surgeons who perform surgical rib stabilization should be aware that titanium plates are vulnerable to breakage under some conditions, such as hyperactive delirium.

## 1. Introduction

Approximately 10% of patients who visit trauma centers have multiple rib fractures; among these, 3%–5% also have flail chest [1–3]. In a patient with flail chest, rib fixation is usually considered because it provides several advantages including reduction of intensive care unit (ICU) stay, lower risk of mechanical ventilator involvement, decrease of tracheostomy, and pain relief [1–4]. However, several side effects such as infection, loosening, and delayed plate fracture are also reported [5–7]. Herein, we report a case of an unexpected broken titanium plate in a patient with uncontrolled hyperactive delirium associated with traumatic brain injury. This case report presents preliminary evidence that surgeons need to exercise caution as titanium elements might be susceptible to mechanical damage under certain conditions, such as hyperactive delirium.

## 2. Case report

A 47-year-old man with an unremarkable medical history presented at an emergency department with chest pain after a fall from a height of 4 m. At admission, he was hemodynamically stable and his Glasgow Coma Scale was 14 (E3M6V5) with prompt pupil response of 3 mm. Chest radiograph revealed displaced fractures of multiple ribs with paradoxical movement and hemothorax therefore closed thoracostomy and intubation were performed (Fig. 1). He deteriorated significantly to a Glasgow Coma Scale of 4T (E1M3VT) and fixed pupils of 3 mm. A brain computed tomography (CT) revealed a large epidural hematoma with brain edema.

\* Corresponding author. Department of Thoracic and Cardiovascular Surgery Dankook University Hospital, 201 Manghyangro, Dongnam-gu, Cheonan-si, Chungcheongnam-do, 31116, Republic of Korea.

E-mail address: [changsw3@naver.com](mailto:changsw3@naver.com) (S.W. Chang).

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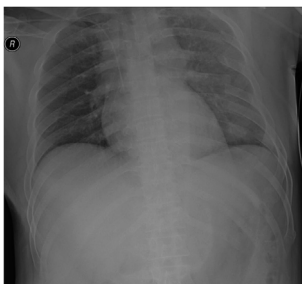


Fig. 1. Initial chest radiograph showing displaced fractures of the left fifth to eighth ribs with paradoxical movement and hemothorax.

We performed an emergency craniectomy, which revealed a massive hematoma with active bleeding foci. Intracranial bleeding was controlled; however, 2000 ml of blood had to be drained out of the operative field through a chest tube. Subsequently, the patient underwent emergency thoracotomy to locate the bleeding focus and stabilize displaced rib fractures. Following the lateral thoracotomy, active bleeding from the left upper lobe was seen due to multiple lung lacerations. Multiple sites of active bleeding were also seen from the chest wall specifically due to the segmental rib fracture sites. The lacerated lung was repaired, and segmental fractured ribs (5–8th) were fixed using an 8-hole straight plate (SternaLock; Biomet Microfixation, Jacksonville, FL, USA).

The patient was continuously managed in the intensive care unit (ICU) under deep sedation protocol with Richmond Agitation-Sedation Scale (RASS) of  $-3$  using propofol and remifentanyl. On the third postoperative day, his vital signs and follow-up brain CT were stable. To withdraw the mechanical ventilator, the administered sedative was changed to dexmedetomidine under protocol for light sedation with targeted RASS of 0 to  $-2$ . One day later, the patient suffered from hyperactive delirium and removed his own chest tube. Afterwards, he received intermittent intravenous propofol and oral quetiapine for sedation. On the ninth postoperative day, he was taken off the ventilator although his delirium was not well controlled as it continued to wax and wane. A routine follow-up chest radiograph revealed a broken sixth titanium plate on postoperative day 17, however, the fractured plate posed no serious problems (Fig. 2A). He received conservative management and was placed under observation because he did not experience any discomfort. On postoperative day 37, he was discharged without any complaints. A follow-up chest radiograph on postoperative day 43 showed a more severe dislocation of the fractured titanium plate; however, the patient had no pain or other complaints and therefore we have continued to observe him as an outpatient (Fig. 2B).

### 3. Discussion

Rib fractures are painful and potentially disabling. Up to 40% of patients with rib fractures require hospital admission [2,3]. Among them, the patient with the paradoxical chest wall movement accompanied by pulmonary contusion could have high morbidity and mortality [4]. In a patient with flail chest, an operative repair of severe chest wall injury could restore chest wall integrity therefore it is associated with lower rates of long-term morbidity [1,2]. As a result, the frequency of surgical stabilization of rib fractures has increased leading to reduction of ventilation need and fewer days in the intensive care unit for patients with flail chest.

Titanium devices for rib stabilization can provide strong rigid support for rib fixation and chest wall reconstruction [2,6]. In addition, they could strengthen the reconstruction while being resistant to infection [6]. However, implant-related complications may occur. According to Beks et al. [1], implant-related complications, such as irritation, implant removal, and implant-related infection, occur in 3% of cases. Several studies have revealed that the plates or clips used to stabilize rib fractures are broken [5,6]. In our patient, an unexpected fracture of titanium rib plate was also shown in the short-term follow-up period.

There are several causes of mechanical failure of a titanium plate. First, traumatic brain injury (TBI) patients could be at a high risk of post-traumatic cognitive impairment, and up to two-thirds of patients who survive TBI may develop agitation and delirium [8]. Uncontrolled delirium and agitation caused by TBI may also cause hyperactivity. For example, Ng et al. [6] reported a case wherein fracture of a titanium rib plate occurred after chest impact during soccer. Although different to delirium at first sight, sports activity as an aspect of physical movement could be similar to an uncontrolled hyperactive delirium; this may be a risk factor for

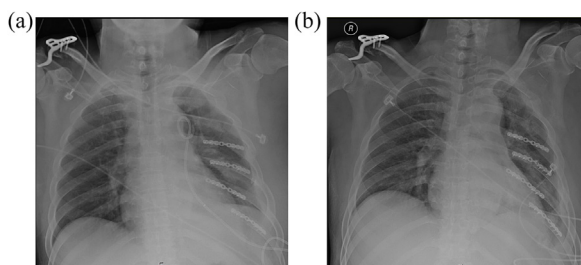


Fig. 2. A, On postoperative day 17, a fractured line is observed on the sixth rib plate. B, On postoperative day 43, the fractured rib plate was more severely displaced.

device failure. In the present case, even though physical restraints to prevent self-harm were introduced, the patient removed his chest tube and twisted his trunk severely. Therefore, a patient with TBI should be closely observed and managed properly for pain, agitation, and delirium in the ICU.

Second, technical errors during trimming to fit the shape may have weakened the titanium plate. Each rib has a unique curvature and angulation. The rib in posterolateral segment is more horizontally curved than the rib in costochondral junction, which is relatively straight. At the same time, the rib in the posterolateral segment is less vertically angulated than the rib in costochondral junction, which is relatively more angulated. Because manipulation of the plate is required to fix the shape of the fractured rib, over exertion and excessive manipulation during the procedure may occur and therefore lead to instability of the rib plate. Subsequently, this could damage the titanium plate.

Third, the fixed rib cannot be totally stabilized because normal respiration results in up-and-down movements of the ribs. This movement may cause plate fracture after excessive manipulation.

In this case report, we described an unexpected broken titanium plate in a case of rib stabilization. Although it is difficult to know the exact cause of titanium rib fracture in the present case, there were several suspected reasons such as delirium and agitation, both of which were not well controlled after a TBI, and technical errors associated with excessive strength and manual manipulation of the plate during insertion. Delirium and anxiety should be managed carefully in the ICU and the exact operative technique should be followed to reduce the risk of damage to the titanium plate. Finally, surgeons who perform surgical rib stabilization should keep in mind that titanium plates are susceptible to breaking under some conditions.

### Meetings

None.

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### Ethics statement

The need for ethics approval and consent of the present study was waived by Institutional Review Board of the Dankook University Hospital.

### Declaration of competing interest

None.

### Acknowledgments

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