A Case of Traumatic Flail Chest Requiring Stabilization with Surgical Reconstruction

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Abstract

Background Flail chest is the most serious complication that may occur after thoracic trauma. In this article, we present a case of flail chest caused by blunt chest trauma, which presented dramatic clinical improvement following rib fixation and chest wall reconstruction.

Case Description A 53-year-old male patient with flail chest because of the trauma who had been followed in intensive care unit for mechanical ventilatory support underwent chest wall stabilization with titanium reconstruction plate and screws.

Conclusion The main objective is surgical stabilization of the chest wall in cases of flail chest with a parenchymal damage because of the severe rib fracture, which need prolonged mechanical ventilation.

Keywords
- thoracic trauma
- flail chest
- chest wall stabilization

Introduction

Flail chest is the most serious complication that may occur after thoracic trauma and refers to a segment of the chest wall resulting from at least two fractures of more than two consecutive ribs and moving in an asynchronous manner with the robust rib cage. In this article, we present a case of flail chest caused by blunt chest trauma who underwent rib fixation and chest wall reconstruction.

Case Description

Our case is a 53-year-old male patient who was admitted to the emergency department because of the drop of a construction material from a height to the right shoulder and chest area. Initial physical examination showed superficial abrasions and diffuse subcutaneous emphysema at right shoulder level, approximately 10 × 15 cm flail chest area on the right anterior chest wall, and a dyspneic respiration. The chest radiograph showed multiple fractures of right ribs, clavicle and scapula, right hydropneumothorax, and diffuse subcutaneous emphysema (►**Figs. 1** and **2**). Therefore, we inserted a 32 CH tube for thoracostomy and took the patient to the intensive care unit for follow-up. The patient was intubated at 72 hours due to respiratory failure, and despite the cessation of the drainage and air leak, surgical stabilization was planned because of the persistence of the need for mechanical ventilation on day 14. A right-sided, high posterolateral thoracotomy incision revealed fractures from 2nd to 7th ribs, of which some were comminuted fractures compressing into the thoracic cavity. All fracture lines were deperiosted and the chest wall stabilization was completed with titanium reconstruction plate and screws (Biomet Microfixations, Jacksonville, Florida, United States) (►**Fig. 3**). The patient was extubated on postoperative day 3 and discharged with a good general condition and stable vital signs on postoperative day 8 (overall total of 22 days) (►**Fig. 4**).

Discussion

Thoracic injuries may lead to serious consequences that have the potential to cause intrathoracic organ injuries.[1,2] Flail chest is one of these serious consequences.[3,4]

Blunt thoracic traumas generate 70 to 80% of traumas seen in traffic accidents.[3] Other causes of chest injuries include nature and sports injuries and falls from a height. Rib

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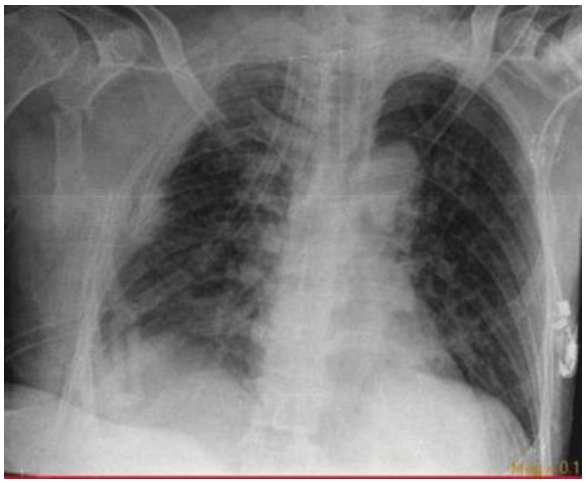

Fig. 1 The X-ray of the patient with a chest tube placed.

fractures generate 35 to 40% of thoracic traumas, whereas flail chest constitutes 10 to 15%.[3] Flail chest presents with at least two fractures of at least three consecutive ribs, which are caused by the injuries of anterior or lateral thorax, or sternal fractures and decompositions of multiple costochondral joints. In trauma scoring systems, flail chest is considered as one of the most serious cases and the mortality rate can reach 40% with the addition of extrathoracic serious problems.[4]

Flail chest movements are caused by the paradoxical movement characterized by an inward compression of fractured segment on inspiration and an outward shift on expiration.[5,6] In the flail chest, the affected area has no connections with the bone structure.[5] Sternal flail occurs because of the instability caused by bilateral multiple rib fractures or the separation of the costochondral junction in the anterior portion.[6] Paradoxical movement creates a negative inspiratory force on the side of flail chest with or without pneumothorax and prevents the expansion of ipsilateral lung. As a result, because of the bending of superior and inferior vena cava due to the resulting change in the intrapleural pressure gradient, the venous return to the heart is reduced,

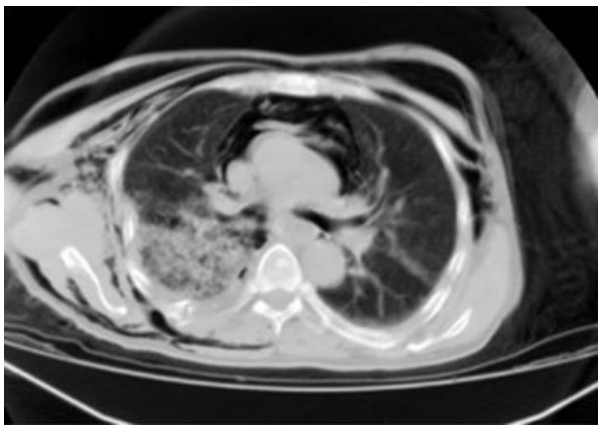

Fig. 2 The thorax computed tomography of the patient.

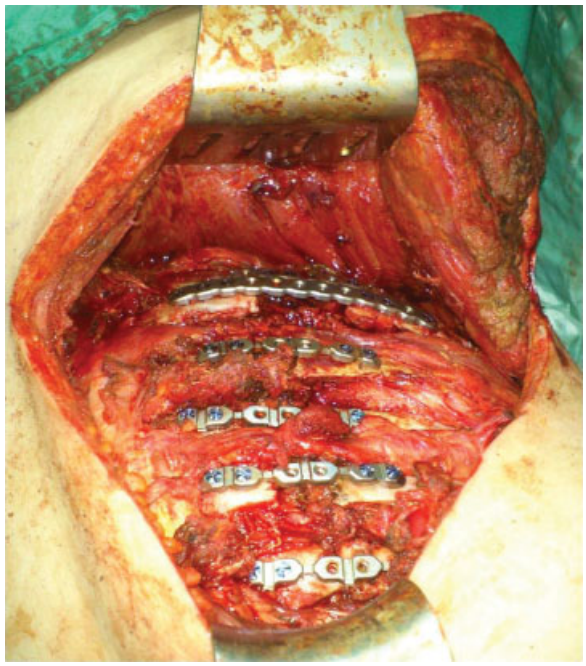

Fig. 3 Stabilized ribs with titanium reconstruction plate and screws.

cardiac output decreases, and hypotension, syncope, and sudden cardiac death may occur. This is the most important pathophysiological condition affecting hemodynamics.[1]

Functional residual capacity decreases with the expansion defect caused by paradoxical movements and eventually and consequently, alveolar collapse, atelectasis, hypoxia/hypoxemia occurs. The unoxygenated blood is sent to the peripheral circulation due to alveolar dysfunction, which is called as "the A–V shunt." The hemorrhage and edema in the area of contusion spread in 24 hours.[1,5]

Pneumothorax, hemothorax, pulmonary contusion, pneumonia, and atelectasis are concurrent pulmonary complications that may be encountered in patients with flail chest.[7] Massive hemothorax or pulmonary contusion is the

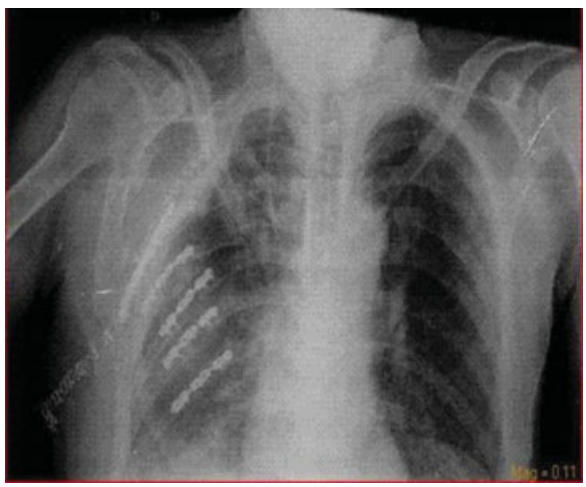

Fig. 4 The postoperative chest X-ray of the patient.

underlying cause of early mortality in the flail chest, whereas acute respiratory distress syndrome (ARDS) is often the cause of late mortality.

The classical treatment of flail chest includes analgesia and respiratory support. Tracheobronchial cleaning and early mobilization are provided with adequate and effective analgesic support. Thus, the duration of hospitalization is significantly reduced.[1,3]

In 75% of patients with flail chest, mechanical ventilator therapy is required. The paradoxical movement is not the only indication for mechanical ventilation, as the patient should also be intubated and mechanically ventilated in case of respiratory failure.[4] Mechanical ventilation should be continued until the end of paradoxical movement.[1,3,4]

Tracheostomy should be done in the earliest period for fast weaning and to be protected from damage of prolonged intubation.[8] With the tracheostomy, dead space is reduced and tracheobronchial secretions are easily aspirated, so that the relationship between alveolar ventilation and perfusion is improved.

In rib fractures, the location and timing of surgical treatment have not yet reached a consensus. Nevertheless, flail chest is the leading among potential surgical indications.[6,7] The aim of the surgery is to elevate the compressed segment and to fix and stabilize the defect. The generally accepted indications for stabilization reported in the literature include an uncontrollable respiratory failure despite aggressive medical treatment, a large flail chest covering the anterior and lateral portions of the chest wall, failure to terminate the ventilatory treatment, and a thoracotomy performed for any other indication. Early surgical stabilization is also indicated in selected elderly patients without respiratory failure and severe pulmonary contusion.[7] Surgical intervention is recommended within the first 36 to 48 hours. Surgical exploration and stabilization are recommended in cases with paradoxical movement area larger than 10 $\times$ 10 cm due to the risk of pulmonary herniation even without the need for mechanical ventilation therapy.[1,4]

For internal fixation, cerclage wires, plates, intramedullary fixation, vertical bridge, and Kirchner wires can be used.[4,8] Regardless of the type of surgical technique, the ends of fractured ribs should be curetted and revitalized and the fracture line should be stabilized with at least two screws from both sides. In addition, necrotic materials, bone, muscle, skin, and foreign particles in the fracture site must be removed.[6–8]

Stabilization of three or four consecutive fractures is sufficient to ensure full recovery of the flail chest, while plating all the ribs is not absolutely essential.[8] The reconstruction of the first two ribs is not recommended to avoid potential neural and vascular injuries. Permanent intercostal pain may occur because of the permanent damage of neurovascular structures on the rib surface during the stabilization.[6] Intercostal neurovascular compartment must be excellently preserved regardless of the type of surgical technique. The need for mechanical ventilation and the length of stay in intensive care have a decreasing trend in patients who underwent surgical stabilization.[6]

The main objective is surgical stabilization of the chest wall in cases of flail chest with a parenchymal damage due to severe rib fracture, who need prolonged mechanical ventilation, however, the technique used is at the discretion of the surgeon.

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