

## STERNAL FRACTURE DUE TO BLUNT TRAUMA

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**Abstract:** Sternal fractures caused by blunt trauma are uncommon, complex, and have the potential to affect soft tissues and vital organs. Non-surgical, conservative treatment is typically preferred, but there are instances where surgery becomes necessary, especially in cases of instability, overlapping fractures, respiratory failure, persistent pain, and cardiac or vascular injuries, among others. This article aims to present a patient case involving a sternal fracture from closed chest trauma, treated with a modified surgical fixation technique at the Lourenço Jorge Municipal Hospital in Rio de Janeiro, Brazil. This retrospective study is based on a review of medical records, patient interviews, surgical reports, and literature review. The patient, a 57-year-old male, was admitted to the hospital following a fall from a 6-meter-high scaffold. He was diagnosed with a transverse fracture in the sternum accompanied by a laminar hemothorax, but no other injuries. He underwent successful surgery involving the placement of two transverse titanium plates at the fracture site, with limited screw penetration, leading to a complication-free recovery and regular discharge after 16 days. The study concludes that the surgical technique used was safe and effective, with the patient recovering within the expected timeframe. It emphasizes the importance of thorough pre-operative patient assessment and careful surgical planning, supported by imaging techniques for enhanced precision.

**Keywords:** Sternal Fracture due to Blunt Trauma. Surgery. Trauma. Surgical Technique. Diagnostic Imaging.

## INTRODUCTION

Fracture of the sternum due to blunt trauma causes discontinuity of bone integrity in the region, due to the compressive force applied to the chest wall, from anteroposterior or lateral origin (Tomas et al., 2017). The epidemiology of these fractures suggests their rarity, largely resulting from trauma involving high speed.

About 70% of thoracic traumas are blunt and, of all blunt traumas, sternal fracture occurs in about 3%-8% of cases, most of which are treated non-surgically. The rare condition arises from the common flexibility and bone resilience of the sternum, however, fractures in this region tend to be complex, due to the severity of the trauma necessary for their presentation (Harston, Roberts, 2011; Şimşek et al., 2022).

The risk of injuries extending to internal organs is increased, as is the presence of bone fragments. Although rare and due to their complexity factors, these fractures are often associated with lethal injuries or chronic pain. Since the sternum is aligned with the spine, as well as transferring forces to the mediastinum, cardiac complications can be associated with these fractures, as well as pneumothorax. The trauma present in the region is absorbed beyond the sternum, which implies possible injuries to the viscera, although bone fractures are not always evident (Akgul Ozmen; Onat; Aycicek, 2017; Mongenstern et al., 2016).

The pathophysiology of this type of trauma involves absorption and transfer of kinetic energy to the sternum, superior to bone biomechanical resistance. This is a fracture that can affect any part of the sternum (body, manubium or xiphoid process), however the body-manubium dyad presents greater vulnerability (Campisi; Bertocaccini; Stella, 2020; Tornerini et al., 2018).

Morphologically, these fractures are classified as types A, B or C: A, when simple and with a single fracture line; B, when they

present multiple fracture lines, without significant displacement, and C, comminuted, with instability and displacement (Van de Wall et al., 2020). The most common signs of sternal fractures caused by blunt trauma are intense pericardial pain (increased during inspiration and movement of the trunk) and bone crepitus on palpation. Diagnostic confirmation can be made by chest X-ray, in lateral and anterior cases, but the use of Computed Tomography (CT) increases diagnostic accuracy in cases without displacement, as well as highlighting possible intrathoracic injuries present, with greater refinement of the surgical plan when indicated to the patient. CT also helps identify whether there is no displacement and the direction of the fracture. Magnetic Resonance Imaging (MRI) also makes it possible to track any suspected soft tissue injuries, especially those of a vascular nature or oriented to the mediastinum (Aylyarov; Kyo; Kim, 2021; Davis, 2022).

Conservative treatment of these fractures is widely accepted in types A and B, characterized by restrictions on movement that worsen pain, in addition to respiratory physiotherapy to prevent pneumonia and atelectasis. Although used for a long time, chest straps are no longer recommended due to the possibility of ventilatory compromise (Akgul Ozmen; Onat; Aycicek, 2017; Mongenstern et al., 2016; Van de Wall et al., 2020). This type of treatment is indicated for the management of most cases; however, there are specific situations that lead to the indication of surgical management.

Surgery is indicated for the treatment of type C and some type B fractures, in cases of instability, overlapping fractures, persistent pain, respiratory failure, significant displacement and cardiac or vascular injuries. In these cases, the aim of open reduction with internal fixation is to obtain post-fracture anatomical balance, as well as recover thoracic function. The option for osteosynthesis with

plates and screws suitable for the sternum requires careful surgical access to preserve vital organs and adjacent soft tissues, in order to provide stable fixation for better bone healing and recovery of mobility. The decision for surgical fixation of the sternum is based on clinical and radiological criteria, as well as the extent of the fracture and the patient's general condition (especially hemodynamic) (Kalberer et al., 2020; Van de Wall et al., 2020).

During surgery, if bone fragments are present, removal must be careful to preserve lung parenchyma, pericardium and large vessels. As constant care, it is essential to ensure hemostasis in order to prevent postoperative hemorrhages and mediastinitis. If cardiac or pulmonary lesions are present, the surgical approach must be interdisciplinary, with attention to obtaining hemodynamic stability prior to sternal fixation. When well indicated, surgical fixation of the sternum brings benefits to the patient, such as easier weaning from mechanical ventilation (Kalberer et al., 2020; Pereira et al., 2019).

Considering the complexity of management and approach to this type of fracture, this article aimed to report a case of a patient with a sternum fracture caused by blunt thoracic trauma, who underwent surgical fixation with modification of the technique, at the Lourenço Jorge Municipal Hospital (Rio de Janeiro, RJ, Brazil).

The methodology for preparing this report was retrospective, with the review of the patient's medical records, added to complementary approaches such as the surgical report, interview with the patient and literature review.

## CASE REPORT

A 57-year-old male patient, with no comorbidities, was admitted to the emergency room at Hospital Municipal Lourenço Jorge (Rio de Janeiro, Brazil), after falling from scaffolding (with an estimated height of around 6 meters). The patient had moderately severe retrosternal pain and an unstable chest, with no other changes on physical examination.

After initial treatment for polytrauma, a CT scan of the skull, chest, total abdomen and cervical, thoracic and lumbosacral spine was performed to evaluate the trauma. The result showed a transverse fracture of the sternum with laminar hemothorax, with no other injuries identified.

According to the institution's general surgery service protocol, serial cardiac enzymes and an electrocardiogram (ECG) were requested. The patient's cardiac enzymes were increased, with an ECG without changes. The investigation continued with a transthoracic echocardiogram, with results also within normal limits. The patient remained stable during the first week of hospital stay, with persistent pain refractory to escalated intravenous analgesia.

As a result, the patient underwent intensive support until clinical and laboratory improvement, and was subsequently prepared for surgical approach. Preoperatively, a tomographic study was carried out for surgical planning, in which the ideal positioning of the plate in relation to the fracture was established and the depth of the sternum was calculated for correct drilling of the screws.

In the perioperative stage, the sternum was fixed with two titanium plates transverse to the lesion. Screw drilling was carried out in a limited manner, as scheduled (Figures 1 to 3).



Figure 1 – Preoperative marking of the sternum anatomy

Source: the authors (2023).



Figure 2 – Exposure of the sternal body fracture through the median access

Source: the authors (2023).



Figure 3 – Titanium plates after fixation during the operation

Source: the authors (2023).

The pre-operative control radiograph demonstrated good positioning of the plate and sternal fixation (Figure 4):

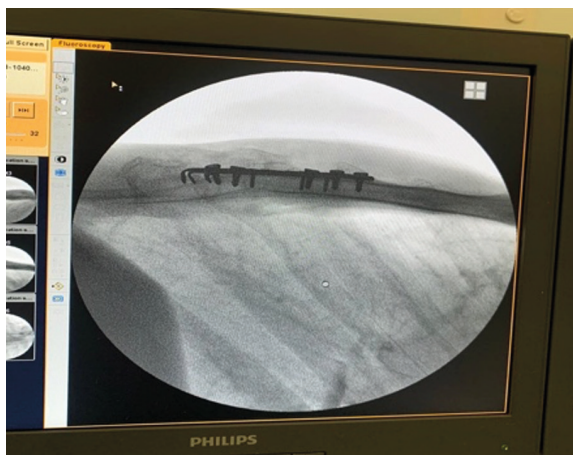


Figure 4 – Per-operative control radiograph, showing adequate positioning of the plates in relation to the sternum

Source: the authors (2023).

As an outcome, the patient had a satisfactory postoperative period in the Intensive Treatment Center (ICU), with no pain complaints. He was discharged after

sixteen days of hospital stay and continued to be monitored on an outpatient basis by the service, with no postoperative complications.

## DISCUSSION

The patient in this case report exemplifies the extreme conditions in which sternum fractures due to blunt trauma occur, in a situation different from accidents involving speed, but consistent with forces and movements that transcend the common resilience present in this region and which are serious, with frequent intensive referral (Harston; Roberts, 2011; Simsek et al., 2022; Tomaset al., 2017). The body of the sternum was the area affected in the patient, in accordance with the common greater vulnerability of this region to trauma (Campisi; Bertocaccini; Stella, 2020; Tornerini et al., 2018).

The assessment of the patient's condition followed a careful investigation of the trauma and repercussions, with the adoption of CT scans of the skull, abdomen and chest, with the aim of tracking possible insidious repercussions of the trauma to the sternum. The possibility of these injuries is raised in the literature due to the risk that fractures of this nature compromise vital organs, viscera and tissues in general, as well as the need to plan the approach precisely to obtain the best outcome for the patient (Akgul Ozmen; Onat; Aycicek, 2017; Mongenstern et al., 2016).

Laboratory tests were carried out to determine the patient's general conditions for trauma management, during which the patient remained stable (Kalberer et al., 2020; Van de Wall et al., 2020). CT confirmed the diagnosis of a transverse sternum fracture with laminar hemothorax, ruling out additional impairments to the condition, consistent with the symptoms reported by the patient, especially intense pericardial pain. Additional imaging exams were discarded due to the lack of suspicion of additional impairments

(Aylyarov; Kyo; Kim, 2021; Davis, 2022; Van de Wall et al., 2020).

The CT results, added to the refractory pain presented by the patient, as well as the clinically favorable condition, led to the choice of a surgical approach, with the use of plates and screws to stabilize the fractured area and functional recovery (Akgul Ozmen; Onat; Aycicek, 2017; Kalberer et al., 2020; Mongenstern et al., 2016; Van de Wall et al., 2020). A titanium plate was fixed, with a satisfactory result for the procedure, with no complications for the patient (Kalberer et al., 2020; Pereira et al., 2019). The adaptation to the use of transverse plates proved to be efficient, as well as limited perforation, resulting in the patient being discharged during a regular recovery period, without complications or adversities linked to the procedure.

## **CONCLUSION**

Sternal fractures due to blunt trauma are worrying events, which can cause concomitant and diffuse severity. The conservative approach is the most common for most cases; however, cases in which the patient presents conditions such as refractory pain may lead to a surgical approach, aiming to preserve respiratory functionality, comfort and safety against the adversities of long-term immobility and faster functional recovery. Fixation of a titanium plate in transverse orientation and limited drilling of the screws indicated effectiveness in the reported case, with recovery without adversities and a high average recovery time. The importance of clinical and general examinations to investigate the patient's systemic condition, the need for hemodynamic stability during the procedure and an intensive period of postoperative follow-up to obtain better outcomes is reinforced.

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