

Sternal fractures in a level III trauma intensive care unit.

Fraturas de esterno em uma unidade de tratamento intensivo especializada em trauma.

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ABSTRACT

Objective: to evaluate epidemiology, anatomical characteristics, management, and prognosis of critical patients with sternum fractures. **Methods:** retrospective analysis of patients admitted to intensive care unit (ICU) of a Level III trauma center in Sao Paulo, Brazil. **Results:** 1552 trauma patients were admitted from January 2012 to April 2016. A total of 439 patients had thoracic trauma and among these, 13 patients had sternum fracture, making up 0.9% of all trauma admissions and 3% of all thoracic trauma cases. Three of these 13 patients had unstable chest, two underwent surgical management for fracture fixation, and three died (mortality was of 29%). In one of the deaths, sternum fracture was assessed as the main contributor to the outcome. **Conclusion:** sternum fracture was diagnosed in 0.9% of critical trauma patients in a specialized ICU. Only 15% of patients required specific surgical management in the acute phase. In most cases, mortality was due to other injuries.

Keywords: Thoracic Injuries. Critical Care. Flail Chest. Intensive Care Units.

INTRODUCTION

Ribcage lesions are a common type of injury in trauma patients¹ and their presence is related to morbimortality increase, with rates reaching 60% in this population². Motor vehicle accident is the most common trauma mechanism and closed chest trauma is the predominant type of injury¹. Within this subgroup of patients, sternum fractures were considered uncommon, with incidence ranging from 0.3% to 3.7%³. However, this incidence has been increasing in recent decades, fact which may be related to the increased use of seat belts⁴.

In this context, computed tomography (CT) has increased diagnostic accuracy, since up to 94% of all sternum fractures are not diagnosed in initial chest X-ray examination⁵. The use of whole-body CT protocols allows the accurate diagnosis of associated lesions and other complications⁶. The most common associated lesions in these patients are costal arch fractures, traumatic brain injury (TBI), spinal injuries, and pulmonary contusions⁴. Data from the United States show that mortality rate is low (2.4%) in patients with isolated sternal fracture. However, this rate can increase up to 8.8% in the presence of other associated lesions⁷. In this population, the independent risk factors associated with mortality are thoracic lesion, pulmonary contusions, acute respiratory distress syndrome (ARDS), age, and days of mechanical ventilation.

Literature describes a topographic division of the sternum in four distinct anatomical regions, a specific subdivision for manubrium fractures^{4,8,9} (types A, B, and C fractures, depending on the generated instability — sagittal, rotational, or combined, respectively), and the sternal body, divided into these portions: upper (Part I), mid (Part II), and distal, including xiphoid process (Part III). This division becomes relevant because fractures in certain areas of the sternum are more related to specific associated lesions⁴. Remarkably, manubrium fractures are associated with thoracic spine, scapular, and TBI lesions, while Part III fractures are more related to lumbar spine fractures.

Most sternum fractures are stable and without obvious misalignments, and have conservative management¹⁰. Surgical options may be considered in patients with unstable sternal fractures, unsatisfactory pain control despite optimized clinical treatment, or difficulty in ventilation weaning attributed to fracture. A strategy of late surgical approach may be useful in cases of patients with chronic pain, no fracture consolidation, or aesthetic reasons¹¹. However, in selected groups of patients, such as those with pericardial effusion and possible vascular lesions due to sternum trauma, emergency surgical stabilization is indicated.

METHODS

We conducted a retrospective analysis of adult patients admitted to Intensive Care Unit (ICU) of a Level III trauma center in Sao Paulo, Brazil, from January 2012 to April 2016. This observational study had the objective of describing epidemiology, anatomical characteristics, and outcomes of patients with sternum fracture in this population.

Continuous variables were described as median and interquartile range (IQR) or mean and standard deviation, as appropriate. Categorical data were expressed as percentages and absolute values. Due to the descriptive epidemiological nature of this study, no other statistical analysis was performed.

This work was approved by the Institutional Ethics Committee with the following reference number 63077116.6.0000.0068.

RESULTS

During this study period, 2667 patients were admitted to our ICU, 1522 of which were trauma victims. A total of 439 patients had thoracic trauma (ribcage lesions) and among these, 13 patients had sternum fracture, making up 0.9% of all trauma admissions and 3% of all thoracic trauma cases. Sternum fractures were more common in men (84.6%), with median age of 32 years. The most common trauma mechanisms were motor vehicle accidents (46%), falls from a height (38%), and trappings (15%). Associated with thoracic lesions, 38% of patients had TBI; 38%, pelvic trauma; 38%, extremity trauma; 31%, spinal trauma; and 23%, abdominal trauma. Admission characteristics of these patients are shown in table 1. Median Simplified Acute Physiology Score III (SAPS III) was 54, median Injury Severity Score (ISS) was 34, and median New Injury Severity Score (NISS) was 43. Median duration of mechanical ventilation in these patients was six days, with median hospitalization duration in ICU of ten days and median length of hospital stay of 29 days. Hospital mortality was of 23%.

Table 1. Patients' characteristics.

Median age (IQR)	32 (27-38) years
Men	84.6%
Median SAPS III* (IQR)	54 (35-65)
Trauma mechanism	
Motor vehicle accidents	46%
Falls from a height	38%
Tramplings	15%
Associated lesions	
TBI**	38%
Pelvic trauma	38%
Extremity trauma	38%
Spinal trauma	31%
Abdominal trauma	23%
Median ISS*** (IQR)	34 (25-43)
Median NISS**** (IQR)	43 (41-50)
Median hospitalization duration in ICU/ days (IQR)	10 (5-22)
Median length of hospital stay/ days (IQR)	29 (13-36)
Hospital mortality	23%

*SAPS III: Simplified Acute Physiology Score III; **TBI: traumatic brain injury; ***ISS: Injury Severity Score; ****NISS: New Injury Severity Score.

Most fractures affected the sternal manubrium (62%), followed by the body (30%) and sternoclavicular junction (8%). Only three patients (23%) had unstable chest attributed to sternal fracture, and two underwent surgical fixation of the fracture. Both patients had satisfactory outcomes at hospital discharge (Table 2).

Table 2. Fracture location, unstable chest, and surgical fixation.

Fracture location	Unstable chest	Surgical fixation
Manubrium	NO	NO
Body	NO	NO
Manubrium	NO	NO
Sternoclavicular junction	NO	NO
Body	YES	YES
Body	NO	NO
Body	YES	NO
Manubrium	NO	NO
Manubrium	YES	YES

Three patients with sternal fracture died during observation period, two due to nonrespiratory complications. One of these patients had a diagnosis of brain death on the 12th day of ICU admission due to TBI. One patient died nine days after admission due to

anoxic-ischemic encephalopathy after cardiorespiratory arrest at the scene. The third patient presented retrosternal hematoma caused by sternal fracture and died on the first day of hospitalization due to shock and respiratory failure (Table 3).

Table 3. Patients with fatal lesions.

Fracture	SAPS III*	NISS**	Cause of death	Day
Manubrium + retrosternal hematoma	50	50	Brain death (TBI***)	12
Body + retrosternal hematoma	63	50	shock + respiratory failure	1
Body (fracture)	65	41	anoxic-ischemic encephalopathy (cardiorespiratory arrest at the scene)	9

*SAPS III: Simplified Acute Physiology Score III; **NISS: New Injury Severity Score; ***TBI: traumatic brain injury.

DISCUSSION

There is a shortage of national studies on the epidemiology of sternal fractures in critically ill trauma victims. In our series, the prevalence of sternum fractures was 0.9% of total trauma, in agreement with international literature in which prevalence ranges from 0.3% to 3.7%³. Our data did not allow us to evaluate possible historical increase trends in the incidence of these fractures. This increased incidence in the last decades described in foreign literature is due to both a greater diagnostic accuracy and to the mandatory use of three-point seat belt for drivers and front passengers, which causes a point of greater pressure in the anterior chest region during deceleration.

The epidemiological characteristics of our series were also in line with international literature, in which most lesions are of sternal body, with motor vehicle accidents as the most common trauma mechanism. However, a considerable portion of our patients had other high-energy trauma mechanisms as causal agent, notably fall from a height and trampling. This reinforces that such mechanisms should not be underestimated as risk factors for traumatic lesion of the sternum, especially given the high prevalence of this trauma mechanism, both in developed and developing countries^{12,13}.

Considering that our study had as inclusion criteria only patients admitted to ICU, severity indexes and prognostic scores such as SAPS III, ISS, and NISS were higher than those found in literature. For the same reason, mortality in our population was higher than in other series. However, most of the deaths occurred in patients with other associated lesions, which had a direct contribution to the cause of death. In fact, only in one patient,

the cause of death was directly attributed to sternal fracture. Therefore, we consider that sternum fractures are a severity marker in patients admitted to ICU. By high-energy trauma mechanism, these fractures are most of the time associated with other severe lesions, such as TBI and pelvic and abdominal traumas.

For a very selected population of patients with sternal trauma, especially those with clinical instability of the fracture and unstable chest, surgical fixation, although little studied in clinical trials, seems to bring benefits to these patients, such as facilitating the withdrawal of invasive mechanical ventilation, the main benefit.

Our case series presents some limitations: it is a retrospective study, without an individual analysis of the significance of whole-body tomography in our population, which may increase the prevalence of lesions. The low number of events does not allow any analysis of the association of risk factors or prognostic predictors in our population. As far as we know, this is the first national historical series which evaluates the prevalence of sternal fractures in a population of trauma victims. The presence of sternal fracture and associated lesions may be related to the outcome of these patients. For a very specific group, surgical fixation may be indicated and beneficial. However, further studies on this topic are needed.

RESUMO

Objetivo: avaliar epidemiologia, características anatômicas, manejo e prognóstico de pacientes críticos com fraturas de esterno. **Métodos:** análise retrospectiva de pacientes internados em unidade de terapia intensiva (UTI) de emergências cirúrgicas e trauma de um centro de trauma Tipo III em São Paulo, Brasil. **Resultados:** foram admitidos 1552 pacientes traumatizados no período de janeiro de 2012 a abril de 2016. Desses, 439 apresentavam trauma torácico e 13 apresentavam fratura de esterno, configurando 0,9% das admissões de trauma e 3% dos traumas torácicos. Desses pacientes, três apresentavam tórax instável e dois foram submetidos à conduta cirúrgica para fixação da fratura. A mortalidade de pacientes com fratura de esterno foi de 29% (três pacientes). Em um dos óbitos pôde-se atribuir a fratura do esterno como contribuinte principal para o desfecho. **Conclusão:** a fratura de esterno foi diagnosticada em 0,9% dos pacientes críticos vítimas de trauma em UTI especializada. Somente 15% dos pacientes necessitou de conduta cirúrgica específica na fase aguda e a mortalidade foi decorrente das outras lesões na maior parte dos casos.

Descritores: Traumatismos Torácicos. Cuidados Críticos. Parede Torácica. Unidades de Terapia Intensiva.

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