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Review

Surgical fixation of the chest wall in traumatic fracture: an integrative review

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Abstract

This article proposes to carry out an integrative literature review on the different types of chest wall fixation after traumatic fracture and on the indications for such a procedure. There is still no clear consensus on when fixation should be performed or not, since the conservative approach is still widely used and has its advantages and disadvantages, as does the surgical procedure. This study was based on a bibliographic search on the PubMed platform from January to February 2022, using the strategy: (Rib cage) AND (Osteosynthesis) OR (Fracture Fixation, Internal) NOT (Spine) NOT (Cardiovascular Surgical Procedures), resulting in 22 articles, of which 7 were chosen. Most of the selected articles were of a retrospective nature, and also, all of them referred to an approach with early surgical intervention. Early fixation showed pain relief, shorter hospitalization and intubation time, reduced physical limitations, and better range of thoracic motion. Although no consensus was found on all indications, the literature analyzed points to the superiority of surgical fixation of the costal arches in the prevention and reduction of secondary outcomes, such as chest pain and length of hospital stay and mechanical ventilation in patients with respiratory complications is evident, corroborating the indication of this procedure for this group.

Keywords:
Trauma
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Introduction

Chest trauma is an important etiology of life-threatening injuries, with physiological consequences such as hypercapnia, hypoxemia, and respiratory acidosis.[1] The traumatic mechanism classifies such traumas as blunt, penetrating, and complex, and influences the approach to this pathology.[2] The main complications are related to injuries to the organs located in the region and to the structures of the rib cage, which interfere with respiratory and circulatory dynamics and may represent a great risk to life.[2] Trauma that affects the chest wall, in turn, also represents a major factor of morbidity and mortality, relating to intense pain, chest instability, development of infections, and failure of respiratory mechanics.[3]

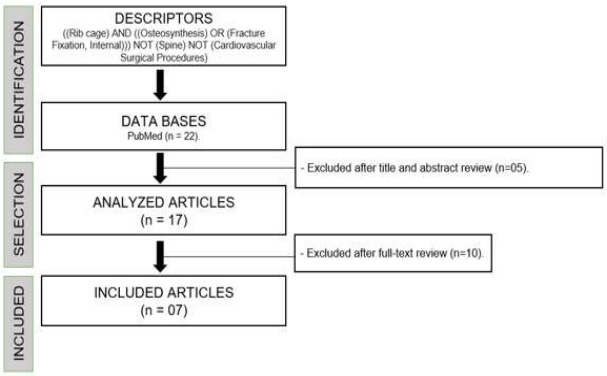
Flail chest, defined as 3 or more consecutive ribs fractured in multiple locations, can cause paradoxical chest wall motion, leading to high rates of need for intensive care and mechanical ventilation.[4] The mortality rate of patients with flail chest reaches 15% and is directly correlated with the approaches adopted and with the complications resulting from the trauma, which vary according to the degree of trauma energy and the quality of care provided.[5,6] In patients who underwent rib fixation, there is a lower need for mechanical ventilation, in addition to a decrease in ICU stay and a lower risk of acquiring pneumonia and present persistent pain in the medium term.

The management of chest wall trauma is roughly divided into two types: conservative and surgical. The conservative approach involves adequate pain control, with the use of enteral or intravenous medications and oxygenation, in addition to stabilization of the injured segment without the use of invasive procedures. The surgical approach, on the other hand, encompasses surgical fixation of the chest wall fractures, using plates or intramedullary nails, in procedures that, despite being more invasive, have evolved with low rates of complications.[7,8]

However, conservative management of chest wall fractures has been associated with several discomforts for patients, with frequent complaints of chest pain, a higher frequency of complications such as pneumonia, and longer hospital stay among those undergoing this approach. On the other hand, surgical treatment has been increasingly performed, as it has been shown as an alternative to the unwanted effects of the conservative approach, as it reduces hospitalization time, pain levels, and the incidence of complications.[9,10] Therefore, the present integrative review proposes to analyze the evidence in the literature on the indications for chest wall fixation.

Method

The bibliographic search was carried out on the PubMed search platform in the period from January to February 2022, using the strategy: (Rib cage) AND (Osteosynthesis) OR (Fracture Fixation, Internal) NOT (Spine) NOT (Cardiovascular Surgical Procedures). Initially, after the execution of the descriptors, the inclusion criteria were applied: (I) original articles published in the last 10 years; (II) studies about chest wall fixation; (III) written in Portuguese, English, or Spanish. A total of 22 articles were found in the PubMed platform. Of the 17 articles found and selected based on the title, abstract, and inclusion criteria, 7 studies were chosen.



Results

The results found from the 7 articles are seen in Table 1 demonstrated as follows: author/year, method including the sample and type of study, and results. Most studies are retrospective. The majority points out early surgical intervention as a recommended conduct in fractures with displacement and certain degrees of complexity.

Tabela 1 - Result of selected studies

Citation	Methods	Results
Ergene et al.[11]	Randomized trial with 15 patients who suffered from sternal nonunion.	Of the 8 patients who underwent surgery, all treatment was successful, with pain improvement being the parameter with the most significant response.
Tarng et al.[12]	Prospective study with 12 patients who suffered from blunt chest trauma with acute respiratory failure.	All patients presented union of the ribs within one year, without complications and deaths.
Zhao et al.[13]	Retrospective study with 64 patients who had sternum fixation with titanium plate after traumatic injury.	A statistically significant difference (P<0.05) was found between preoperative and postoperative pain severity scores (7.74 ± 0.89 vs. 3.80 ± 0.79, respectively)
Granhed et al.[14]	Consecutive therapeutic cohort, level III, with historical controls. Compares results obtained by modern techniques and when these were not used	Mean time on mechanical ventilation was 9.01 days for non-operated patients compared to 2.7 for operated patients (p<0.001). No clear pneumonias were found.
Schulz-Drost et al.[15]	Retrospective study emphasizing the management of different types of FS in FCI.	All SF (n=15) were fixed by osteosynthesis of locked plates through a median approach in the supine position. Three main regions of the sternum showed the need for different fixation strategies: the superior manubrium, the central and inferior sternum. Concurrent rib fractures were addressed through the same approach or through additional limited incisions.
Fagevik et al.[16]	Cross-sectional study comparing patients treated conservatively and patients undergoing stabilizing surgery.	Long-term results regarding lung function, shoulder function, and physical activity level were similar in both groups.
Drost et al.[17]	Cohort study with 10 patients that were treated by anterior plating in sternal fractures. Follow-up was performed after 6 weeks, 12 weeks, and 6 months.	There were no serious complications revealed in the follow-up and no problems were caused by the plates.

Discussion

Sternal fractures have as their main mechanism direct blunt trauma to the anterior chest wall, with a direct relationship to the use of seat belts in automobile accidents.[18] Although relatively uncommon, such fractures are life-threatening and can have a poor prognosis due to injury to adjacent organs[19] showing a higher incidence in the elderly population and a common association with the presence of costal arch fractures.[20] However, complications related to sternotomy in cardiac surgery can also lead to sternal injury.[21]

The most common treatment for this condition is conservative, with the use of a corset and rest, or surgical fixation using steel wires. However, both tend to fail due to loss of traction or wire cutting. Fixation with plates proved to be efficient in the study by Ergene et al.[11], where 8 patients with traumatic sternal fractures underwent early fixation, with success in all operations and significant pain relief compared to patients with conservative management.

In another study, Zhao et al.[13] observed a statistically significant difference (P<0.05) between preoperative and postoperative pain intensity scores in 64 patients undergoing sternal fixation with plates (7.74 ± 0.89 vs. 3.80 ± 0.79, respectively). In addition, sternal union was confirmed in all cases. A significant increase in lung function was also observed by measuring the forced vital capacity (FVC) before surgery and on the seventh postoperative day (39.18 ± 9.18% and 52.91 ± 10.98% respectively of the predicted value). At three months postoperatively, the FVC obtained was 88.19 ± 8.82% of the predicted value.

In addition, Schulz-Drost and coworkers[15] studied a method of anterior sternal plating using one plate or two parallel plates, and the fixation was conducted through a median approach. In all patients, stable osteosynthesis was achieved, indicating that this method is highly safe and reliable. Also, it was observed that this surgical fixation provided noticeable comfort to the patients. In another study, Schulz-Drost and colleagues[17] found that the high-risk injury represented by the combination of SF and FCI can be adequately addressed by the locked plate osteosynthesis technique, with the use of different types of plate depending on the complexity of the injury.

Fractures of costal arches are frequent in trauma and can result from blunt or penetrating mechanisms, with severity varying according to the energy of the trauma and with complications related to injuries to adjacent structures.[22]Flail chest is considered among the most widely accepted indications for operative management, being rib fixation conditionally recommended by recent practice guideline from the Eastern Association for the Surgery of Trauma (EAST) in these patients. In general, other conditions such as pain refractory to drug treatment, chest wall deformity and non-union of fractures are relatively recommended for surgical treatment.[23]

In that regard, Tarng et al.[12] found shorter hospitalization and intubation times in a prospective study with 12 patients submitted to fixation by TEN after blunt thoracic trauma followed by acute respiratory failure, as well as Granhed et al.[14] who found a mean time of approximately three days of mechanical ventilation among those submitted to surgical fixation of the chest wall, while those submitted to conservative treatment remained intubated for a mean of nine days. However, Fagevik et al.[16] found no long-term differences between conservative treatment and the surgical approach to costal arch fractures in a sample of 31 patients, except for reduced limitations of physical function, improved range of thoracic motion, lower pain levels, shorter hospital stays, and lower short-term complication rates found in those who underwent costal arch fixation.

Thus, the superiority of surgical fixation of the costal arches in the prevention and reduction of secondary outcomes, such as chest pain and length of hospital stay and mechanical ventilation in patients with respiratory complications is evident, corroborating the indication of this procedure for this group.[22]

Conclusion

Among the selected studies, except for flail chest, no wide consensus was reached on the surgical fixation of rib fractures. Two studies indicated that surgical treatment presented shorter intubation time compared to conservative treatment, while in another study, there were no significant differences. In addition, studies point to significant pain relief in early fixation compared to conservative follow-up. Therefore, there is still no established consensus in the literature, which makes it necessary to carry out more observational studies in these patients.

No **conflict of interest**

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Authors' contribution
Pedro Pinheiro Barros, Henry Marins Soares Fortes, Beatrice Martins da Costa e Silva e Yne Kivia Dikauá Santos Feitosa - aquisição, análise e interpretação dos dados
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