

Mini Review on Adequate Management of Rib Fractures in Elderly Patients Victims of Blunt Chest Trauma to Prevent Pulmonary Infectious Complications. A Practical Guide for Emergency and Intensive Care Physicians

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Abstract

Many patients are victims of blunt chest trauma every day. In approximately 50 % of blunt chest traumas, rib fractures occur. This type of injury can generate many complications related to changes in lung function, such as pain and infections, especially pneumonias. Many populations around the world are composed of elderly people in their majority; for this reason, there are a great number of elderly victims of chest trauma in hospitals in these locations. In this kind of population, costal arch fractures may be severe and may even lead to death. Unfortunately, many doctors who work in emergency rooms do not have the knowledge and experience in chest trauma to ensure the adequate care of elderly trauma victims, reducing morbidity and mortality. In this context, the present review was prepared based on the literature produced from 2015 to the present moment found on the PubMed and Google Scholar databases to serve as a guide for professionals who work directly with traumatic patients.

Keywords: Rib Fractures; Elderly Chest Trauma; Blunt Chest Trauma; Costal Fractures; Elderly Rib Fractures; Pneumonia Due To Rib Fractures

Introduction

Every day, many patients over the age of sixty have accidents and suffer blunt chest trauma. A significant part of this population suffers from costal arch fractures. This type of injury generates many types of complications in the general population, with a mortality rate of 7 % due to respiratory failure, atelectasis, and pneumonia, especially in older patients [1]. The elderly patients are fragile and vulnerable to minor physiological changes like that experienced by patients who have rib fractures causing pain and respiratory restriction. Another key point is the adequate pain control to avoid atelectasis and pulmonary infections, however many painkiller drugs have adverse effects that could be so hazardous in elderly reinforcing the specific knowledge of this topic. ¹ In many countries, most of the population is already composed of patients aged over 60 years, and for this reason, most trauma patients who arrive at hospitals are elderly [2].

It is important that costal arch fractures are properly diagnosed and treated so that such complications are avoided, leading to mortality reduction in the general population especially in elderly patients because of the reasons mentioned previously. Unfortunately, many physicians who work in emergency rooms and many physicians specialized in geriatrics lack familiarity and expertise in the treatment of elderly patients with rib fractures and need some additional information to improve their skills on treating this part of population.

Objective

The objective of this article is to present a brief literature review on elderly rib fractures providing to medical doctors the basic knowledge essential to the adequate management of elderly patients with rib fractures resulting from blunt chest trauma.

Methods

The authors carried out a literary review based on a survey of articles published from January of 2015 to February of 2023 through the PubMed and Google Scholar databases. The authors included only articles written in English language of indexed journals. The selected papers were meticulously reviewed and the key points were identified, compiled and evaluated to create a synthesis that allow every physician interested on these subject that decide to read the present article to find the most important points in a single text.

Morbidity and Mortality

Chest trauma is responsible for 25.0 % of trauma-related deaths worldwide, and rib fractures are present in more than half of these patients.

A retrospective cohort study carried out in Taiwan involving patients between March 2005 and December 2013 evaluated participants who were victims of chest trauma treated at a trauma reference institution. A total of 1621 participants aged between 18 and 95 years (median 51.2 years) were included in the study; approximately 11.7 % of these patients had a lesion severity score greater than 16, and 78.5 % of them had rib fractures. In this group, 31.8 % had traumatic haemothorax, 15.6 % had pneumothorax, and 9.6 % had hydropneumothorax. Mortality related to chest trauma was 6.9%. In this study, it was observed that the number of rib fractures was directly associated with periods of prolonged hospitalization, the need for admission to the intensive care unit and advanced age ($p < 0.005$) [1].

Some studies relate fractures of the first rib with increased mortality, which can reach 36%, and fractures of seven or more costal arches with mortality rates of up to 29.0 % [2].

Mortality in patients with rib fractures is basically due to 3 factors:

- 1) Hyperventilation and pulmonary atelectasis secondary to pain
- 2) Change in ventilatory mechanics due to structural instabilities generated by fractures
- 3) Lesions of the lung parenchyma

The proposed treatments for these patients are based on acting on these factors to correct the changes [2].

Multimodal Analgesia

Certainly, the pain resulting from costal fractures in blunt chest trauma is the great villain when we talk about the complications that afflict these patients. Elderly patients are very susceptible to the adverse effects of medications used for pain control, especially GABAergic drugs, clonidine, and opioid painkillers. For this reason, it is important to associate different methods of pain control with systemic analgesia to reduce the need to administer these drugs.

Blocks

Local anesthetic blocks are an important weapon against pain that can be easily offered to trauma patients. In this category, we can highlight epidural analgesia, which is currently the gold standard of analgesia in this situation. In this type of block, we infused local anesthetic into the epidural space of the patient so that the levels corresponding to the dermatomes affected by the fractures were included in the block.

This guarantees an excellent level of analgesia for these patients and allows the passage of an epidural catheter and installation of a *patient-controlled analgesia* (PCA) device. However, epidural analgesia has adverse effects that must be considered, especially in elderly patients. The main adverse effects related to these patients are postural hypotension and the consequent immobility, which can contribute to the appearance of atelectasis and pulmonary infections [3].

Intercostal blocks can also be used in the treatment of these patients if they are performed by professionals who have experience with this type of block due to the risk of inadvertent puncture of the pleural space and the intercostal vascular bundle, which can lead patients to pneumothorax or haemothorax. A systematic review study published in 2021 performed a meta-analysis that investigated the outcome “postoperative pain requiring the use of rescue analgesic medication” in patients undergoing thoracic surgical treatments. Three different block modalities were evaluated: thoracic epidural anesthesia, paravertebral block, and intercostal block. In this study, 66 clinical trials were included, for a total of 5,184 participants. When evaluating the postoperative pain outcome, it was verified that the use of intercostal blocks ensured postoperative pain control like that of epidural anesthesia in the first 24 hours after the surgical procedure and analgesia very similar to the analgesia of the paravertebral block [4]. Even though this study was performed on surgical patients, we can extrapolate the information contained therein to patients who are victims of blunt chest trauma, especially elderly patients who are more vulnerable to the deleterious adverse effects of systemic analgesia.

Another type of block that has special prominence in cases of multiple costal fractures is the posterior root block. In this block category, there are two blocks that are worth mentioning: the retrolaminar block and the erector spinae muscle plane block. Both blocks are intended to block the intercostal nerve roots. The intercostal nerves bifurcate, issuing deeper branches (responsible for innervating the intercostal muscles, periosteum of the ribs and parietal pleura) and more superficial branches that are responsible for innervating the outermost muscles and skin of the involved dermatome. The difference between these two blocks is that in the retrolaminar block, the anesthetic solution is infused into the space between the paravertebral musculature and the transverse process of the vertebra, which causes the anesthetic to infiltrate the facet planes contained therein, reaching the intercostal root. In the case of blockade of the erector spinae muscle plane, this infiltration is performed in the plane below the erector spinae muscle, leading the anesthetic solution to infiltrate the site where the intercostal nerve bifurcates.

A randomized double-blind study conducted in 2021 compared the effectiveness of the retrolaminar block and the erector spinae muscle block, drawing a parallel between these two blocks in patients with multiple rib fractures. Although both blocks were effective for this purpose, retrolaminar block was more effective in ensuring that these patients did not need opioid rescue [5].

Another double-blind randomized study, published in September 2022, compared the efficiency of these 2 blocks in terms of reducing pain and opioid consumption in patients with multiple costal fractures. In this study, 60 participants were randomized into 2 groups. In one group, the participants were treated with an erector spinae muscle plane block and in the other group, the participants were treated with a paravertebral block (retrolaminar). The outcomes “reduction in the level of pain on the visual analogue scale” and “reduction in consumption of rescue opioids” were evaluated. Both blocks were efficient in promoting pain reduction and preventing the need for rescue opioids, with no statistically significant difference between these two groups [6].

Therefore, there is no consensus in the literature about the superiority of one block to another; however, studies indicate that both blocks are efficient and can be adopted in these patients as tools to treat chest pain resulting from rib fractures. In elderly patients, the authors recommend the use of the erector spinae muscle plane block because it is safe, easy to perform, and can be performed by physicians who are not anaesthesiologists, such as thoracic surgeons, in addition to generating fewer adverse effects than the thoracic epidural. The authors also recommend the use of solutions containing local anesthetics and drugs that prolong such anesthetic effects, such as the PTAS solution, which is already used to perform anesthesia in thoracic procedures [7,8].

Pharmacological Treatment

There are no articles that describe how pharmacological analgesia should be used to manage pain in elderly rib fractures; however, we know that pain related to blunt chest trauma has the same pathophysiology as pain related to surgical trauma. Therefore, we can use the same drugs used in the management of postoperative chest pain for this purpose.

According to the guideline published in March 2022, adequate analgesia for surgical chest trauma should first be performed through one of the locoregional blocks described above and adjuvant nonsteroidal painkillers such as paracetamol, specific inhibitors of cyclooxygenase 2. In cases of persistent pain, intravenous administration of dexmedetomidine can be used. Opioids should only be used as rescue drugs in cases of pain breakouts despite all the analgesic measures adopted [9].

Non Pharmacological Analgesic Measures

To treat patients with neuropathic pain, such as rib fracture pain, it is very important to combine non pharmacological methods for pain control. Among these methods, we can highlight the use of transcutaneous electrical stimulation (TENS), acupuncture, application of low-power lasers, physiotherapy, and application of focused ultrasound. Studies suggest that the use of such treatments can reduce mortality and the risk of complications such as pneumonia in this specific population [10].

- **Transcutaneous electrical stimulation (TENS):** TENS consists of applying an electric field on the patient's skin using a generator connected to electrodes. These electrodes must be positioned to encompass the dermatome affected by pain. This method of pain control is particularly useful in cases of acute pain such as pain caused by trauma. A systematic review published in 2015 with the inclusion of 19 randomized studies in traumatic patients (n=1,346 participants) showed a reduction in acute pain with the application of TENS compared to the use of placebo [11]. Studies also suggest that the use of this analgesic modality in patients with rib fractures increases peak expiratory flow and blood oxygen saturation [12].
- **Acupuncture:** Acupuncture involves stimulating dots on the body surface using pressure, puncture, heat application or laser. These points are called acupuncture dots and consist of small areas of the body that concentrate nerve receptors. The stimulation of acupuncture dots can generate pain modulation effects in the posterior horn of the spinal cord and the release of peptides such as dynorphin and enkephalin in the thalamus, leading to inhibition of the pathways responsible for

pain sensation. In addition, acupuncture can stimulate the secretion of hormones and lipid autacoids that act as natural anti-inflammatories over traumatic tissues [13]. There are some studies that support the use of acupuncture for pain control in trauma patients with rib fractures. The randomized study published in 2022 with 109 participants shows that the use of traditional acupuncture with needles and laser presented better results in terms of pain control than the use of sham acupuncture (placebo) [14].

- **Low-Power Laser Application:** The use of low power lasers at wavelengths ranging from red to infrared has been a growing trend for the management of acute and chronic musculoskeletal pain [15]. Experimental studies with animal models show that this type of laser can accelerate the healing process of fractures, in addition to reducing the inflammatory process and pain [16]. Although there are huge practical applications and practical results visible and reported by patients with this modality of treatment, there are still no clinical studies in the literature evaluating the effects of using low-power lasers on costal fractures.

Physiotherapy in Patients with Rib Fractures

Physiotherapeutic care is essential in trauma patients, especially in those who suffer thoracic trauma with rib fractures.

The performance of the physiotherapist professional ranges from adequate ventilation in the most serious patients with respiratory repercussions. In addition, physiotherapy plays a very important role in mobilizing these patients, avoiding the most common complications in bedridden patients, which are hospital pneumonia and venous thrombosis. Conditions that can be extremely dangerous, especially for elderly patients. A historical cohort study that evaluated patients with blunt chest trauma treated at a specialized center showed that the variables that had a positive impact on the survival of these patients were immediate pleural drainage in patients with pleural collections, early adequate analgesia, and early physiotherapy [17].

However, in another randomized study published in 2019, 114 participants with blunt chest trauma with 3 or more rib fractures and no injuries to other organs were divided into 2 groups. In group A, patients were treated only with adequate analgesia, and in group B, patients were treated with concomitant analgesia and physiotherapy. Patients in group A had a 5.0 % incidence of haemothorax, while those in group B had a 49.0 % incidence of haemothorax. Only 5 patients in group B needed to receive a chest tube due to pleural effusion. In conclusion, the investigators determined that physiotherapy increases the chances of delayed haemothorax in patients with 3 or more rib fractures [18].

Physiotherapy has a beneficial effect on patients with thoracic trauma; however, its application in this population has to be very well planned using movements and exercises that are effective and that do not cause additional stress in the fractures, as this can lead to an increased risk of haemothorax.

Application of Focused Ultrasound

Despite its wide application in physiotherapy, the use of focused ultrasound as a therapy aimed at accelerating the healing of fractures is very controversial.

A systematic review published in 2014 involving 12 studies with a total of 622 participants with 648 treated fractures evaluated the effects of low-intensity focused ultrasound and extracorporeal shock waves on fracture healing time and rehabilitation time. There was no benefit compared to the control group [19]. Another systematic review article shows that there are benefits in terms of reducing healing time and bone callus maturation with the use of focused ultrasound; however, these effects are only perceptible when it is used in patients at risk of delayed bone healing, such as seniors [20].

Surgical Treatment

Indications

Indications for the fixation of rib fractures are variable. The main and most classic indication is the so-called flail chest. This condition occurs when concomitant fractures occur in adjacent ribs at more than one point. This leads the costal framework to lose its ability to support the chest wall, causing collapse during inspiration and projection during expiration. The current level of recommendation for rib fixation in this condition is IIA (Oxford Centre for Evidence-based Medicine and GRADE) [21,22].

In addition to the indications mentioned above, we can highlight other conditions, such as fractures greater than 3 costal ribs, fractures with misalignment between the stumps, fractures that cause pneumothorax or haemothorax, when we are unable to contain the pain resulting from rib fractures or even when the patient has diseases that hinder the healing of fractures such as osteoporosis. The current level of evidence for the approach in these conditions is IIB (Oxford Centre for Evidence-based Medicine and GRADE) [22,23].

Regarding the delay of time for performing the surgery, it is recommended to perform the procedure within 72 hours in patients who are clinically stable. In patients who have some type of instability, it is recommended to stabilize the patient and perform rib repairs preferably within seven days after the trauma. The recommendation has evidence level IIB [22,23]. Regarding the techniques used for this purpose, we can highlight the fixations with the application of cortical devices and the fixation techniques with the use of medullary devices. In the first technical modality, a fixation device (plate) is applied to the cortex of the fractured bone. This can be fixed by means of screws or through clamps that embrace the stumps of the fractured bone. Level of Evidence IIA [22,24].

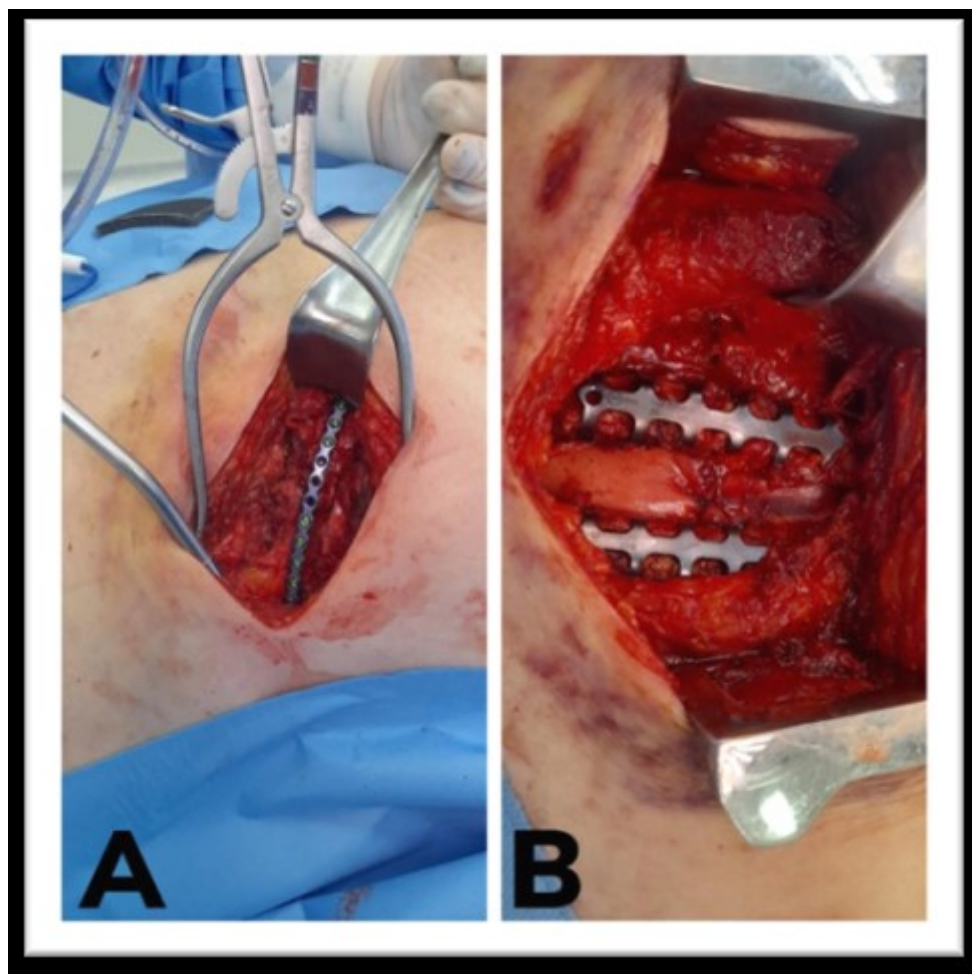


Figure 1: Difference between the types of cortical fixation devices: A) device fixed by screws; B) device fixed by clamps. (obtained from the author's particular photo collection)

Figure 1 shows the difference between the types of cortical fixation devices (A the device fixed by screws and B the device fixed by clamps).

In the case of medullary fixations, a medullary rod is used for this purpose.

It is recommended to not perform intramedullary fixation in cases of comminuted rib fractures. Level of Evidence III [22,24].

There is no concrete evidence to support the superiority of video-assisted thoracoscopy fixations over open surgery [24].

When performing rib fracture fixation in an elderly patient, the authors recommend using a cortical application device that is fixed to bone by clamps. This type of device guarantees firm and reliable fixation without the need to use screws that can crack the bone of patients who have thin cortical bone due to osteoporosis. It is important to perform an adequate dissection to isolate the intercostal vessels and nerves from the area of the fractured ribs that receives the cortical plate with clamps. This approach avoids accidental involvement of these structures by the clamps leading to bleeding or chronic pain development.

Conclusion

Rib fractures are common injuries in victims of blunt chest trauma, with high morbidity and mortality when not properly treated. Strict pain control through combined multimodal analgesia is the main clinical measure to be adopted and should be practiced in all cases. Physiotherapy and pulmonary rehabilitation exercises are essential to avoid infectious complications and embolisms; however, when poorly performed, they can increase the risk of haemothorax. Surgical treatment is reserved for specific conditions such as flail chest, patients with more than three fractures, presence of bone misalignment and osteoporosis with no superiority of video approaches in relation to open surgeries.

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