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Review Article

An Overview of the Management of Rib Fractures in Elderly Patients who have Suffered Blunt Chest Trauma, Preventing Complications Related to Pulmonary Infections.

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ABSTRACT

Many patients are victims of blunt chest trauma every day. In about 50% of blunt chest traumas, ribs fractures occurs. This type of injury can generate many complications related to changes in lung function such as pain and infections, specially pneumonias. In many populations around the world there are composed of elderly people in their majority, for this reason there are great number of elderly victims of chest trauma in hospitals of 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 the emergency rooms do not have the knowledge and experience in chest trauma to ensure the adequate care of elderly trauma victims, reducing it 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.

Key words: *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]

In many countries, the vast majority of the population is already composed of patients with age over 60 years and for this reason the majority of trauma patients who arrive at hospitals are elderly. [2]

It important that costal arch fractures are properly diagnosed and treated so that such complications are avoided leading to mortality reduction. Unfortunately, many physicians who work in the emergency rooms and many physicians specializing in geriatrics lack familiarity and expertise in the treatment of elderly patients with rib fractures.

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 adequate management of elderly patients with rib fractures resulting from blunt chest trauma.

Methods

The author carried out a literary review based on a survey of articles published from the year 2015 through the PubMed and Google Scholar databases.

The articles were compiled, evaluated, and the most important points were gathered for the elaboration of this synthesis.

Morbidity and Mortality

Chest trauma is responsible for 25% 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 were included in the study aged between 18 and 95 years (median 51.2 years), 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 hemothorax, 15.6% pneumothorax and 9.6% had hydropneumothorax. Mortality related to chest trauma was 6.9%. In this study was observed that the number of rib fractures was directly associated with periods of prolonged hospitalization, 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%. [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 this patients are based on acting on these factors correcting 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 in particular are very susceptible to the adverse effects of medications used for pain control, especially GABAergic drugs, clonidine and opioids painkillers. For this reason, it is important to associate different methods of pain control with systemic analgesia reducing 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 infuse local anesthetic into the epidural space of the patient so that the levels corresponding to the dermatomes affected by the fractures are included in the block.

This guarantees an excellent level of analgesia for these patients and also 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 as long as 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 hemothorax. A systematic review study published in 2021 performs a meta-analysis that investigates 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, totaling n of 5184 participants. When evaluating the postoperative pain outcome, it was verified that the use of intercostal blocks ensured

postoperative pain control similar to that of epidural anesthesia in the first 24 hours after the surgical procedure and an 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 are posterior root blocks. In this block category there are two blocks in particular 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, the periosteum of the ribs and the parietal pleura) and more superficial branches that are responsible for innervating the outermost muscles and the skin of 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, this causes the anesthetic to infiltrate the facet planes contained therein reaching the intercostal root. In 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 compares 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 of rescue of opioid. [5]

Another double-blind randomized study, published in September 2022, compares 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 treating chest

pain resulting from rib fractures. In elderly patients the authors recommend the use of the erector spinae muscle plane block because it is a safe, easy-to-perform, and can be performed by physicians who are not anesthesiologists, such as thoracic surgeons, in addition to generate 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 for this purpose the same drugs used in the management of postoperative chest pain.

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 non-steroidal painkillers such as paracetamol, specific inhibitors of cyclooxygenase 2, in cases of persistence of pain the 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 rib fractures pain is very important to associate non-pharmacological methods for pain control. Among these methods, we can highlight the use of transcutaneous electrical stimulation (TENS), acupuncture, application of low-power laser, physiotherapy and application of focused ultrasound. Studies suggests that the use of such treatments has the ability to reduce mortality and the risk of complications such as pneumonia in this specific population. [10]

- Transcutaneous electrical stimulation (TENS): It consists of applying an electric field on the patient's skin through the use of 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=1346 participants) showed a reduction in acute pain

with the application of TENS compared to the use of placebo. [11] Studies also suggests that the use of this analgesic modality in patients with rib fractures increases peak expiratory flow and blood oxygen saturation. [12]

- Acupuncture: It involves stimulating dots on the body surface using pressure, puncture, heat application or laser. These points are called acupuncture dots that consists on 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 the pain sensation. In addition, acupuncture has the ability to 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 laser 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 shows that this type of laser is capable of accelerating the healing process of fractures, in addition to reducing the inflammatory process and pain. [16] Although there are huge practical application and practical results visible and reported by patients with this modality of treatment, there are still no clinical study in the literature evaluating the effects of using low-power laser 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 study, this time randomized 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, in group B patients were treated with concomitant analgesia and physiotherapy. Patients in group A had a 5% incidence of hemothorax while those in group B had a 49% incidence of hemothorax. Only 5 patients in group B needed to receive a chest tube due to pleural effusion. As a conclusion of the study the investigators determined that physiotherapy increases the chances of delayed hemothorax 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 hemothorax.

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 number 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 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.

It leads the costal framework to lose its ability to support the chest wall, causing collapse during inspiration and projection during expiation. The current level of recommendation for rib fixation in this condition is IIA (Oxford Center for Evidence-based Medicine and GRADE). [21, 22]

In addition to the indication mentioned above, we can highlight other conditions such as fractures greater than 3 costal ribs, fractures with misalignment between the stumps, fractures that causes pneumothorax or hemothorax, 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 Center for Evidence-based Medicine and GRADE). [22, 23]

Regarding the delay of time for performing the surgery, it is recommended to do the procedure within 72 hours in patients who are clinically stable. In patients who have some type of instability is recommended to stabilizes the patient and perform the ribs repairs after it 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 cortical 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]

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 a rib fracture fixation in an elderly patient, the authors recommends use the cortical application device that is fixed to bone by clamps. This type of device guarantees a firm and reliable fixation without the need to use screws that can crack the bone of patients who have a thin cortical bone due to osteoporosis. Although it's so important to perform an adequate dissection to isolate the intercostal vessels and nerve from the area of fractured rib that receives the cortical plate with clamps. This atittude avoids an accidental involvement of this 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 hemothorax. 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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