

**SURGICAL TACTICS IN CLOSED CHEST TRAUMA WITH
MULTIPLE FRACTURES OF THE RIBS****KOSOV E.V.¹, SHEVCHENKO A.N.^{2*}, PEREYASLOVA L.V.¹, YARMAK E.I.¹, GUSEINOV Z.F.¹**¹ Department of Surgical Diseases, Operative Surgery and Topographical Anatomy, V. N. Karazin
Kharkiv National University, Kharkiv, Ukraine² Department of Surgery No. 1, Kharkiv National Medical University, Kharkiv, Ukraine*Received 21/3/2018; accepted for printing 18/07/2018***ABSTRACT**

The defeat of the chest wall as a result of closed injuries, are the most common thoracic lesions, which amount to 50 - 70%, and it makes 90.8% for combined injuries. Thoracic injury is the direct cause of death of every third victim with combined injuries, and in 25% of inpatients with this pathology serious diagnostic and tactical errors are made. Rib fracture is the most frequent injury in the case of chest injuries, which is considered to be a significant indicator of the severity of injuries, as it reflects the main impact on the chest wall. Fractures of the ribs from 3 to 9 are more common. For fractures of the lower ribs (below 8), concomitant abdominal injuries are possible. Fractures of the first 3 ribs, as a rule, cause severe injury with possible damage to the mediastinum, neurological, vascular, and extra-thoracic lesions. A fracture with more than 3 ribs and extra-thoracic injuries significantly increases the risk of complications and death, so the number of broken ribs is an indication for hospitalization. The risk of these undesirable outcomes also increases with multiple and bilateral rib fractures. In cases involving fragmented rib fractures, mortality is about 50%. Different types of external fixation, skeletal traction, or pneumatic stabilization of the floating portion of the chest wall are more often used to stabilize the chest wall skeleton.

The results of treatment of 160 victims with closed chest trauma are presented, among them 54 (33.75%) are patients with severe chest injury. The severity of damage of the internal organs of the chest in patients with multiple and fragmented rib fractures also confirms the significant frequency of hemo- and pneumothorax. The most important prerequisite for the use of reconstructive surgery for multiple and fragmented rib fractures is an accurate diagnosis of posttraumatic morphofunctional changes identified by clinical, radiological, instrumental and endoscopic diagnostic methods - thoracoscopy and tracheobronchoscopy. Surgical intervention with the use of osteosynthesis promotes earlier activation of patients, reduces to the minimum the severity of the pain factor, in turn, leads to a more rapid recovery.

KEYWORDS: chest injury, multiple fractures of the ribs, osteosynthesis.**INTRODUCTION**

The problem of diagnosis, surgical treatment and prevention of the consequences and complications of chest damage is important not only in the surgical, but also in the socio-economic terms [Olefirov A.S. et al., 2011; Belokonev V.I. et al., 2013]. The number of victims with injuries of the chest does not have a significant tendency to decrease [Usha-

kov N.G., 2011; Dongel I. et al., 2013]. On the contrary, in recent years there has been an increase in the number of severe injuries of the chest, which are accompanied by multiple, fragmented and bilateral fractures of the ribs, sternum, costal arches, clavicle, shoulder blades, thoracic spine, and severe destruction of soft tissues [Yang Y. et al., 2010; Berthet J.-P., et al., 2015]. Lesions of the chest wall, developing as a result of closed injuries, are the most common thoracic lesions, which make up 50-70%, and for combined injuries - 90.8% [Kolkin Y et al., 2009; Freixinet Gilart J et al., 2011; Ushakov N, 2011]. Fractures of the bone and cartilage skeleton

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are the indicators of severe injury in which more than 90% of patients have associated lesions, and 12% die from the injuries themselves [Ushakov N, 2011; Igai H et al., 2012]. Thoracic injury is the direct cause of death of every third victim with combined injuries, and serious diagnostic and tactical errors are allowed in 25% of inpatients with this pathology [Belokonev V et al., 2013; Kamiyoshihara M et al., 2015]. In cases involving fragmented rib fractures, mortality is about 50%. Various types of external fixation, skeletal traction or pneumatic stabilization of the floating chest wall section are often used to stabilize the skeleton of the chest wall [Bhatnagar A et al., 2012; Farquhar J et al., 2016]. However, these treatment methods have significant drawbacks: inadequate repositioning and unstable content of broken fragments, development of bedsores and suppurations in the locations of fixators, pneumothorax and pneumomediastinum, purulent-inflammatory lesions of the upper respiratory tract and pleuropulmonary complications [De Moya M et al., 2011; Zaitsev D et al., 2011]. In 80–90% of cases, closed chest injuries (CCI) with multiple and floating rib fractures are accompanied by the inner pleural complications due to injury of the intercostal vessels or injuries of the lungs by a fragment of a broken rib [Kolkin Y et al., 2009; Doben A et al., 2014]. Surgical methods of chest wall injury corrections are applied with too limited indications, even in those cases when it is possible to expect a favorable result from their use [Bansal V et al., 2011; Dongel I et al., 2013]. To date, there is no consensus not only about the need for surgical treatment of such patients, but also about the indications and contraindications to it, its scope and methods. The main feature of the injury of the chest with fractures of the ribs is that, in addition to damage to the tissues by fragments of the ribs at the time of the action of a directly traumatic factor, the trauma continues later during respiratory movements [De Moya M et al., 2011]. In addition, there are significant violations of the biomechanics of respiration due to significant changes in the physical characteristics of the musculoskeletal structure of the chest [Doben A et al., 2014]. The issue of fixation of fractures of the bony skeleton of the chest is one of the keys in the complex of therapeutic measures for this category of victims [Bansal V et al., 2011]. Many technologies for surgical reconstruction of the chest with se-

vere fractures of the ribs and sternum have been proposed since the 20s of the last centuries [Farquhar J et al., 2016]. The evolution of methods for fixing fractures of the ribs and sternum is currently at the stage of applying various special anatomical reconstructive plates to perform osteosynthesis [Freixinet Gilart J et al., 2011]. There is a need to assess the effectiveness of the methods used for the subsequent objectification and develop optimal approaches to solving this problem.

The objectives of this study are to define a clear surgical tactics and to improve the results of surgical treatment in patients with multiple rib fractures with closed injury of the chest wall in order to avoid their consequences and complications.

MATERIAL AND METHODS

The presented study included the treatment results of 160 victims with closed chest trauma 54 (33.75%) of which were patients with severe chest injury. The injury causes included: traffic accidents - 52 (32.5%) victims, home accidents - 92 (57.5%), and catatrauma - 14 (8.75%). Among the studied, there were 131 (81.7%) men and 29 (18.3%) women aged 17 to 84 years. Multiple rib fractures were detected in 44 (27.5%) patients, and fragmentary damage to the ribs was diagnosed in 13 (8.2%) patients with formation of rib and sternal-costal valves. In 8 (5%) patients, there was a fracture of the sternum body with bone fragments displacement of varying severity. Amid 44 patients with multiple fractures of the ribs and sternum the number of patients who were operated was 21 (47.7%). Rib osteosynthesis was performed to 17 patients, and 4 patients underwent sternal osteosynthesis. The methods of rib fragments fixation were determined individually, but in the majority of cases the most universal methods of bone fragments retention were applied.

RESULTS AND DISCUSSION

Patients were examined in accordance with the standard protocols in thoracic surgery. Diagnostic methods were aimed at clarifying the nature of the damage and determining the state of vital organs and systems. General clinical methods were used to study the symptoms, clinical manifestations of chest damage and their consequences. Our clinical observations suggested that the destruction of the

chest cage with multiple rib fractures was accompanied by severe damage to the internal organs. For example, 36 (22.5%) patients had a rupture, 29 (18.13%) had a bruise, 8 (5%) had a lung atelectasis, and 4 (2.5%) had diaphragm injury. Shock was in 14 (8.75%) patients. The severity of damage to the inner organs of the chest in patients with multiple and fragmented rib fractures was also confirmed by the considerable frequency of hemothorax and pneumothorax. Different types of hemothorax were found in 29 (18.13%) patients, pneumothorax was revealed in 38 (23.75%) patients. The most important precondition for the use of reconstructive surgery for multiple and fragmented rib fractures was the accurate diagnosis of post-traumatic morphofunctional changes as identified by clinical, radiological, instrumental and endoscopic diagnostic methods, such as thoracoscopy and tracheobronchoscopy. Preoperative treatment of the patients with multiple and fragmented rib fractures in the acute period of chest injury included: puncture of the pleural cavity - 28 patients, drainage of the pleural cavity - 41 patients, thoracoscopy - 28 patients, and rehabilitation tracheobronchoscopy in 40 patients. Among 44 patients with multiple fractures of the ribs and sternum, 21 patients were operated. 17 patients had rib osteosynthesis and 4 had sternal osteosynthesis. We performed the osteosynthesis manually with the help of a previously prepared fragment of 10 cm long Kirschner pin - self-sharpening at one end, and ear-like crooked at the other. As trauma complications were observed in 14 patients, surgical interventions were accompanied by the elimination of coagulated hemothorax in 5 patients, decortication of the lung in 8 injured, and suturing the wound of the lung in 6 patients.

Features of surgical intervention. All patients, with the exception of one, were operated from 6 to 72 hours after injury. A prerequisite was stable hemodynamic parameters. Contraindications to the fixation of the ribs were severe traumatic injuries of other organs and systems and the shock condition of the victims. The fixation of rib fractures was carried out using the rib fixation system. This system of bone and intraosseous anatomical titanium plates and locking screws is fully intended only for fixing the ribs. The main method of fixation of rib fractures was carried out using a set of

tools, extramedullary and intramedullary plates, involving osteosynthesis from the 3rd to the 9th rib. A certain numbered plate with the necessary pre-curvature corresponds to each rib. The extramedullary plates were used in 39 patients, intraosseous osteosynthesis in 5 patients. The osteosynthesis of ribs on the one side was performed in 34 patients, bilateral osteosynthesis was performed in 10 patients. The number of synthesized ribs was in the range from 2 to 6. Each second rib was fixed at multiple fractures of consecutive ribs. It is imperative to cover all fracture lines with mandatory fixation of the leaflet itself when stabilizing floating fractures. The advantages of the fixation method that was used should be noted. It is absence of the need for plate remodeling, the universal balance between the rigidity necessary for fixation, and the flexibility that ensures biodynamics during respiratory movements. The speed and simplicity of interventions, which are guaranteed by a set of special tools, are also extremely important. The average time spent on osteosynthesis of 1 rib is 5-7 minutes. Evaluation of the effectiveness of osteosynthesis of the ribs and sternum was carried out on the basis of the relief of respiratory failure in operated patients, as well as the possibilities of recovery and rehabilitation. The clinical manifestations of the positive effect of the operation were the absence of paradoxical breathing and airway obstruction, the cessation of air leakage through the drains. Laboratory and instrumental indicators were the normalization of the gas composition and the partial pressure of blood oxygen, the smoothing of lung tissue and the regression of foci of contusion is confirmed by X-ray. The average time of artificial lung ventilation after fixation was 2.5 days (from 20 minutes to 17 days). The tracheostomy was needed in 3 patients (6.8%). Most patients reported a significant reduction of pain syndrome in comparison with the preoperative period. Complications were observed in 4 patients (9.09%): of them 1 had septicemia, 2 had postoperative pleurisy and empyema, 1 had suppuration of a postoperative wound. Two repeated interventions were performed: removal of the plate in 1 patient and repeated thoracoscopy for the purpose of sanitation of empyema in 1 patient. 2 patients died (4.5%), all of them had combined injuries initially. Thus, it is obvious that the use of technologies for

reconstruction of the bone skeleton of the chest in the early period of traumatic disease helps to restore hemo- and aerodynamics, prevent the development of intrapleural complications, respiratory distress syndrome, reduces the time spent by patients on mechanical ventilation and creates conditions for earlier rehabilitation. However, it should be emphasized, that the possibilities of performing osteosynthesis are limited to such situations as features of fractures (for example, detachment of costal cartilages from the sternum), severe concomitant injuries, inability to transfer a patient to a specialized hospital. However, only osteosynthesis can be considered as the best way to reconstruct the chest at present. Surgical reconstruction of the chest in case of fractures of the ribs and sternum solves the problem of stabilizing the sternum-rib cage complex, weaning from artificial ventilation of the lungs, and eliminating chest deformities. The effectiveness of the applied osteosynthesis technology is manifested in such aspects as the improvement of surgical technique, the optimal ratio of fixation and flexibility, the improvement of the immediate results of treatment.

Surgical intervention with the use of osteosynthesis of rib debris contributed to earlier patient activation, minimized the severity of the pain factor, which in turn led to a reduction in the length of stay of the injured in a hospital, the absence of disability and quicker recovery.

CONCLUSION

Closed chest trauma with multiple fractures of the ribs and post-traumatic complications of the chest organs refers to severe and critical skeletal injury with lethality rate of 45-70%. Methods of fixing the rib fragments should be determined individually, but in the majority of cases, the most universal methods of bone fragment retention are to be used. In case of multiple rib fractures with significant fragment displacement, surgical repositioning of the rib fragments using osteosynthesis is rational in order to eliminate pain syndrome, restore the function of the respiratory movements of the chest wall, and prevent complications of the pulmonary system.

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