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A CASE OF RIB VALVE FIXATION USING COMBINED METAL PLATES AND STEEL WIRE IN SEVERE CHEST AND ABDOMEN COMBINED EXPLOSIVE TRAUMA

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The purpose of the study was to provide demonstration of chest and abdomen severe combined explosive trauma diagnosis and surgical treatment peculiarities with primary combined thoracoplasty using metal plates and steel wire. The clinical case concerns an injured L., 49 years, who received an explosive injury being in a bulletproof vest and helmet. 1 hr after the injury he was admitted for further examination and treatment. The diagnosis was established: severe combined explosive trauma of the chest and abdomen. Closed chest trauma. Multiple closed fractures of the III-X ribs on the right side. The following surgery was performed: thoracocentesis, drainage of the right pleural cavity by Buelau. Laparoscopy, the abdominal organs revision, conversive laparotomy, suturing of the diaphragm, "sandwich-type" liver tamponade. The following surgical intervention was performed next day: right-side thoracoplasty, bone fragments removal, reposition, the VII, VIII and XI ribs metal osteosynthesis with the help of adaptive titanium plates. A "Second Look" was performed on the third day together with abdominal organs revision, napkins removal, abdominal cavity sanitation and re-drainage and laparostomy closure. Authors suppose the use of adaptive titanium plates in combination with a metal thread is possible at the third and fourth levels of medical care.

Key words: explosive trauma of the chest and abdomen, costal valve fixation, metal plates, metal thread.

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ВИПАДОК ФІКСАЦІЇ РЕБЕРНОГО КЛАПАНУ КОМБІНОВАНО МЕТАЛЕВИМИ ПЛАСТИНАМИ ТА СТАЛЕВОЮ НИТКОЮ ПРИ ВАЖКІЙ ПОЄДНАНІЙ ВИБУХОВІЙ ТРАВМІ ГРУДЕЙ ТА ЖИВОТА

Метою дослідження було демонстрація особливостей діагностики та оперативного лікування важкої поєднаної вибухової травми грудей та живота з фіксацією реберного клапану комбіновано металевими пластинами та сталевою ниткою. Клінічний випадок стосується пораненого Л., 49 років, отримав вибухову травму в бронежилеті та шоломі. Доставлений через 1 годину після травми для подальшого обстеження та лікування. Встановлено діагноз: Важка поєднана вибухова травма грудей та живота. Закрита травма грудей. Множинні закриті переломи III-X ребер справа. Виконана операція: Торакоцентез, дренування правої плевральної порожнини за Бюлау. Лапароскопія, ревізія органів черевної порожнини, конверсійна лапаротомія, ушивання діафрагми, тампонування печінки по типу "сендвіч". Наступної доби виконано оперативне втручання торакопластика справа, видалення кісткових уламків, репозиція, металоостеосинтез адаптивними титановими пластинами VII, VIII, XI ребра. На третю добу виконано «Second Look», ревізія органів черевної порожнини, видалення серветок, санація та редренування черевної порожнини, закриття лапаростоми. За думкою авторів, застосування адаптивних титанових пластин в комбінації з металевою ниткою можливо на третьому та четвертому рівні надання медичної допомоги.

Ключові слова: вибухова травма грудей та живота, фіксація реберного клапана, металеві пластини, металева нитка.

The study is a fragment of the research project "Development of modern methods of diagnosis and treatment of purulentseptic complications in combat surgical trauma", state registration No 0120U101834.

The chest gunshot wounds equal to 8–12 % in modern military conflicts [1, 3, 11]. Chest penetrating gunshot wounds were reported to be the cause of death in one third of the wounded on the battlefield during the II World War [9]. Chest gunshot wounds incidence during Antiterrorist Operation in Eastern Ukraine accounted for 11.7 % of surgical casualties. The structure of penetrating chest wounds is the following: lungs are damaged in 80 % of cases, pericardium, heart and large vessels – in 10–15 %, trachea, esophagus and diaphragm – in 5 % [2]. Such wounds are characterized by both sternocostal cage

and chest organs significant damage, bacterial contamination, severe complications and high mortality (up to 37 %) due to massive blood loss, traumatic shock and acute respiratory failure [5].

Floating rib fractures occur in 10 % of cases of closed chest trauma and are a life-threatening condition due to severe complications development (mediastinal flotation, respiratory and cardiovascular failure, pleuropulmonary and traumatic shock). Even with urgent and adequate treatment, mortality can reach 39 % [3, 10, 15].

The frequency of chest wounds in general structure of combat surgical trauma in Antiterrorist Operation/ Joint Force Operation in the range of 7.5–11.7 %. The shrapnel wounds prevailed according to mechanism of occurrence – in 43.4 % cases, non-penetrating wounds according to nature – in 38.9 %, combined chest wounds according to type – in 40.3 %, the first degree of traumatic shock expression according to the severity of traumatic shock – in 42.7 % of cases [2].

Thoracotomy frequency reaches till 10 % of cases after chest penetrating gunshot wounds. In case of sternocostal cage trauma with rib valves formation, their temporary fixation using subcutaneous, subfascial wire insertion is indicated [1]. The other methods of rib valve fixation are known additionally to rib valve fixing using wires that are available at the III and IV levels of medical care [5, 6, 13].

Sternocostal trauma with costal valves formation diagnosis is based predominantly on radiological methods [1, 2, 4, 10].

We use the following classification according to fractures localization for diagnostic purposes before performing surgical intervention: frontal bilateral, anterolateral, posterolateral, back bilateral. According to surgical laws the chest cage restoration required in cases of frontal bilateral and anterolateral valvular fractures. This manipulation, as a rule, is not required after back and posterolateral valvular fractures [3, 6].

Therefore, summarizing everything mentioned above, it is extremely important to develop a method for floating rib fractures comprehensive surgical treatment after an explosive injury that is complex according to mechanism of its influence on human body.

The purpose of the study was to provide demonstration of chest and abdomen severe combined explosive trauma diagnosis and surgical treatment peculiarities with primary combined thoracoplasty using metal plates and steel wire.

Materials and methods. The wounded L., 49 years, received an explosive injury being in a bulletproof vest and helmet at about 1:00 p.m. as a result of enemy (artillery) shelling. 1 hr after the injury he was admitted to the Military Medical Clinical Center of the Northern Region for further examination and treatment.

The wounded was examined clinically and laboratory (complete clinical blood and urine analysis, biochemical blood test, coagulogram). The ultrasound examination was performed according to the “FAST protocol” (upon admission and during control examinations) using ultrasound device “Logiq P8P910” (USA, 2021), multispiral computed tomography of the head, neck, chest and abdominal organs was performed using “Revolution EVO” device with a tomograph step of 0.5 mm. Chest and abdominal organs radiographic examinations were performed using the X-ray diagnostic complex KRD-50 “INDIASCOP-01” (Ukraine).

The diagnosis was established: severe combined explosive trauma of the chest and abdomen. Closed chest trauma. Multiple closed fractures of the III–X ribs on the right side. Right-sided hemopneumothorax, pneumonitis. Subcutaneous emphysema of the right chest. Closed abdominal trauma with right side diaphragm and liver damage. Hemoperitoneum. Traumatic shock of the III degree.

The following surgery was performed: thoracocentesis, drainage of the right pleural cavity by Buelau. Laparoscopy, the abdominal organs revision, conversive laparotomy, suturing of the diaphragm, “sandwich-type” liver tamponade. Abdominal cavity sanitation and drainage. Closed laparostomy.

The following surgical intervention was performed next day: right-side thoracoplasty, bone fragments removal, reposition, the VII, VIII and XI ribs metal osteosynthesis with the help of adaptive titanium plates. Sanitation and re-drainage of the right pleural cavity by Bulau. A “Second Look” was performed on the third day together with abdominal organs revision, napkins removal, abdominal cavity sanitation and re-drainage and laparostomy closure.

Results of the study and their discussion. According to our data, the frequency of costal valve in combat chest trauma ranges from 0.5 % to 5 % during the last 10 years.

The pleural and abdominal cavities multispiral computed tomography data are presented in Fig. 1.

Diagnosis after the first stage of treatment: severe combined explosive trauma of the chest and abdomen. Closed chest trauma. Multiple closed fractures of the III–X ribs on the right side (V–VIII double). Right-sided hemopneumothorax, pneumonitis. Subcutaneous emphysema of the right chest. Heart

contusion of moderate severity. Closed abdominal trauma with diaphragm damage on the right side and liver Sg V–VIII (Moore III). Hemoperitoneum. Traumatic shock of the III degree.

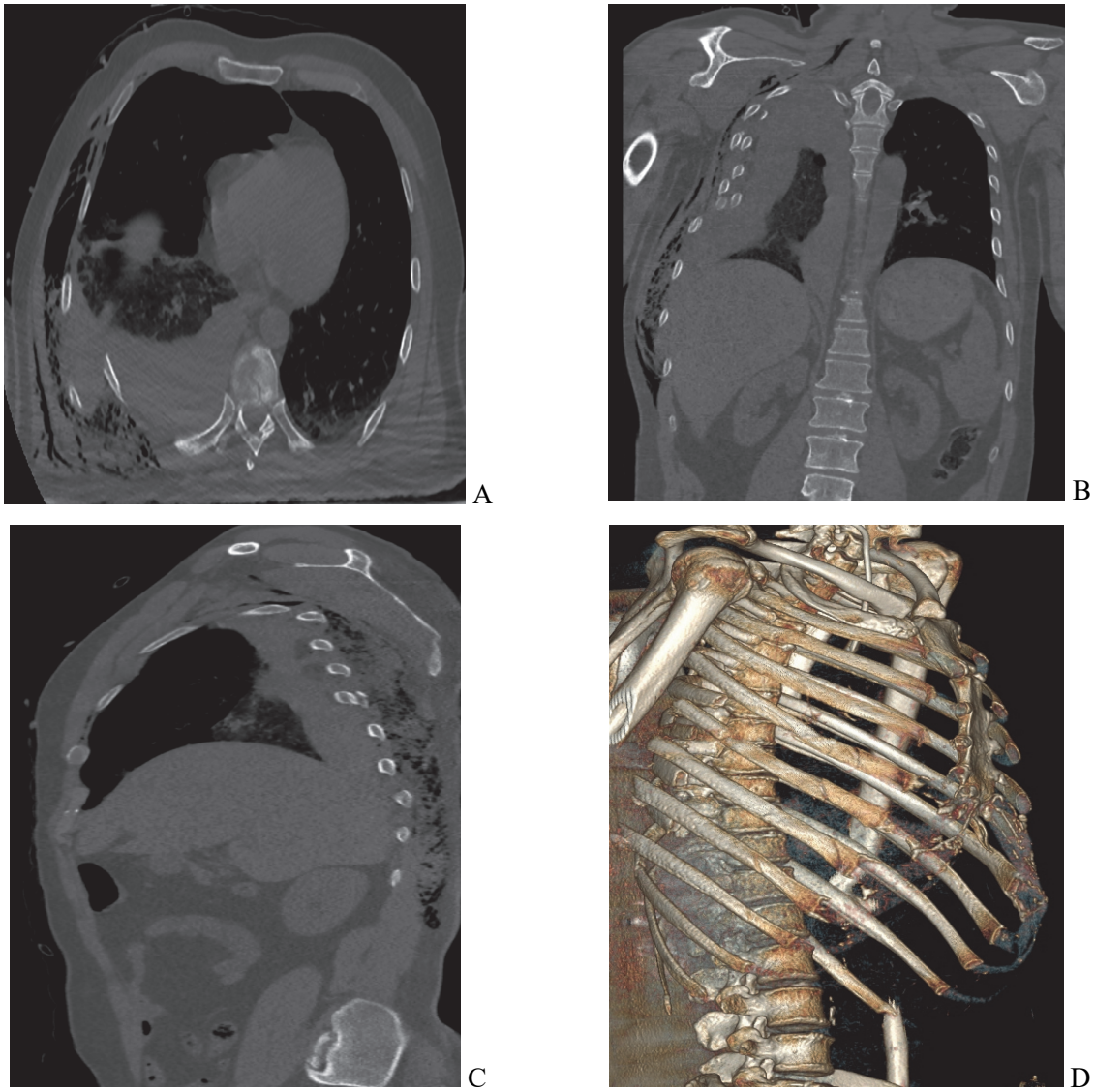


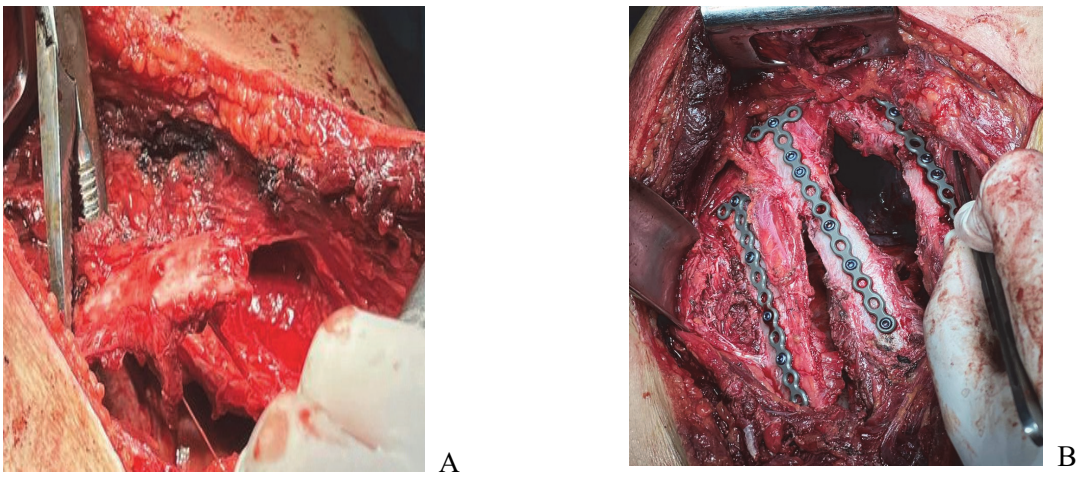
Fig. 1. Data of pleural and abdominal cavities multispiral computed tomography of patient L., 49 years. The 1st day after injury: closed fractures of the III-X ribs on the right side (V–VIII ribs – double). Right-sided hemopneumothorax, pneumonitis. Subcutaneous emphysema of the right chest. Free fluid around the spleen: A – axial projection; B – coronal projection; C – sagittal projection; D – 3D modelling.

The following operative manipulations were done: thoracocentesis. The right pleural cavity drainage by Buelau. Laparoscopy, abdominal organs revision, conversive laparotomy, the diaphragm suturing, "sandwich-type" liver tamponade. The abdominal cavity sanitation and drainage. Closed laparostomy.

The following day, the operation was performed under general anesthesia: right-side thoracoplasty, bone fragments removal, reposition, the VII, VIII and XI ribs metal osteosynthesis with the help of adaptive titanium plates. Sanitation and re-drainage of the right pleural cavity by Bulau. The surgical intervention lasted for 60 min.

Course of the surgical intervention: after surgical field three times processing, an incision was made on the right parallel to the broad back muscle up to 15 cm. VII, VIII, XI ribs revision was performed with a comminuted fracture and a bone tissue defect. The right lung was visualized, and lower lobe contusion was determined. The right pleural cavity was sanitized with antiseptic solutions until clean washing waters were obtained. Bone fragments were removed, repositioned, and VII, VIII, IX ribs metal osteosynthesis using titanium plates was performed. The VI rib was fixed with a steel thread. Hemostasis was dry. Buelau drainage of the right pleural cavity in the 5th and 7th intercostal space along the posterior axillary line was done. The wound was sutured by layers according to the myoplasty type – the hermeticity was satisfactory. Iodine. Aseptic dressing.

The stages ribs osteometallosynthesis performing with adaptive metal plates are shown on Fig. 2.



A B

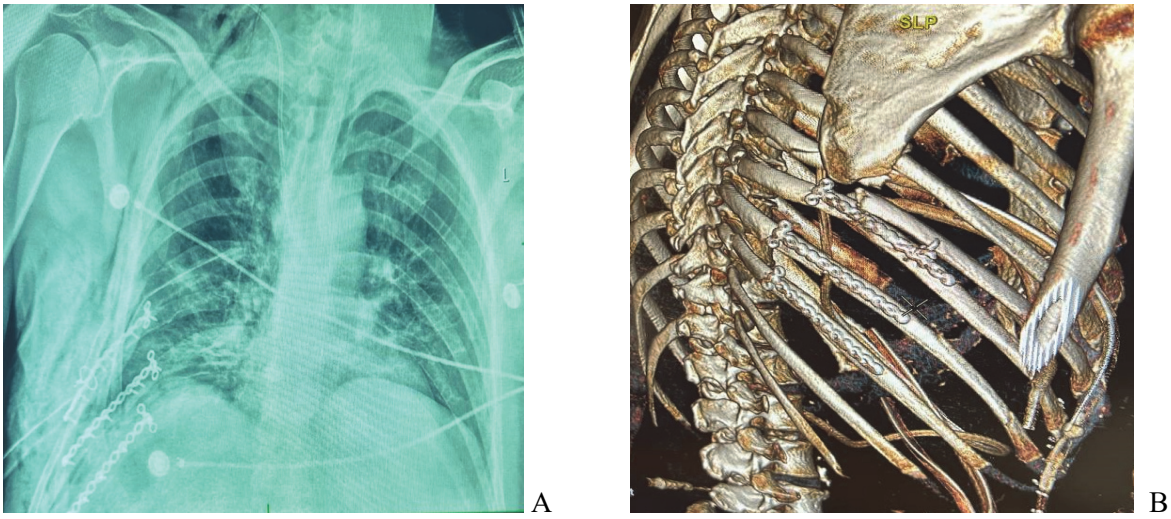
Fig. 2. Intraoperative view of the stages of rib osteometallosynthesis: A – rib fixation before metal plate applying and fixing; B – final wound view after plates fixation on the ribs.

Postoperative diagnosis was the following: severe combined explosive trauma of the chest and abdomen. Closed chest trauma. Multiple closed fractures of the III-X ribs on the right side (V-VIII double). Right-sided hemopneumothorax, pneumonitis. Subcutaneous emphysema of the right chest. Heart contusion, moderate severity. Closed abdominal trauma with right-side diaphragm damage and live Sg V–VIII (Moore III). Hemoperitoneum. Traumatic shock of the III degree.

Operations: thoracocentesis. Drainage of the right pleural cavity according to Beulau. Laparoscopy, the abdominal organs revision, conversive laparotomy, diaphragm suturing, "sandwich type" liver tamponade. The abdominal cavity sanitation and drainage. Closed laparostomy.

A "Second Look" was performed on the third day, abdominal organs revision, napkins were removed, the abdominal cavity was cleaned and drained, and the laparostomy was closed.

Data from control radiological examinations in the postoperative period are presented in Fig. 3.



A B

Fig. 3. Control radiological studies in the postoperative period: A – chest organs X-ray on the 1st day after surgical treatment: the bone fragments of the ribs position is satisfactory, the lungs are expanded, there is no free air and gas; B – 3D modelling on the 5th day after surgical treatment: the position of the rib bone fragments is satisfactory.

Drains from the abdominal cavity were removed on 4 and 5 days, the sutures from the laparotomy wound were removed on 10 day after the laparostomy closing. Drainage from the pleural cavity was removed on 5 day, sutures from the postoperative wound were removed on 14 day. Total bed-day consisted 18 days.

The wounded was on prolonged artificial ventilation for 5 days, received infusion therapy, antibiotics, pain relief therapy, vitamins, oxygen, wound dressings. The wounded later was admitted to a military medical commission, and has a vacation for health reasons during 30 calendar days.

Positive obtained result discussion with original variant of rib valve fixation after chest and abdomen severe explosive trauma can be carried out only from the standpoint of certain patient successfully performed multicomponent surgical tactics of treatment.

There are not so many such explosive combined injuries in the world now, and intensive military operations are carried out only in our country that's why such successful surgical operations description in the scientific literature is practically absent [10]. Therefore, first of all, we express confidence in our own

medical capabilities to promptly make a diagnosis and perform a complex operation to eliminate the consequences of explosive damage of the chest, abdomen and adjacent internal organs.

Surgical interventions performing by stages in severe explosive trauma allow to provide high-quality preoperative preparation and reduces the number of complications.

Various methods are used for rib valve fixation [1, 3, 13, 14], among which the most common are lavsanoplasty, fixation with pins, metal osteosynthesis with adapted titanium plates, metalized thread, extrafocal osteometal synthesis and their combinations. The frequency of these methods use varies and depends on the material and technical equipment and appropriate high-qualified specialists availability.

The "damage control surgery" principles implementation allows for adequate preoperative surgical preparation and to determine the sequence of surgical interventions [1, 7, 8, 12, 13]. In our case, osteometalosynthesis with metal plates and a steel wire of a floating rib fracture was performed for a right-sided anterolateral fracture.

The use of adaptive titanium plates in combination with a metal thread is possible at the third and fourth levels of medical care in case of necessary equipment and specialist's availability.

Conclusions

1. Rib valve fixation using combined methods among various methods of rib valve fixation allows to fix ribs reliably in the preferred position.

2. Surgical interventions performing by stages in severe explosive trauma allows to provide high-quality preoperative preparation and reduces the number of complications.

3. The use of adaptive titanium plates in combination with a metal thread is possible at the third and fourth levels of medical care in case of necessary equipment and specialist's availability.

Prospects for furthers researches include extension of the experience of similar staged operations performing in combined explosive chest trauma to analogous episodes in abdominal and pelvic organs explosive injuries. An additional perspective of this clinical case is the make possible to use the adaptive titanium plates together with a metal thread at the third and fourth levels of medical care.

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