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Surgical tactics for chest trauma accombined by flail chest

Y. L. Zarutskyi, O. O. Melnychenko

Ukrainian Military Medical Academy

✉ Oleksandr Melnychenko: melaleksandr705@gmail.com

Y. L. Zarutskyi, http://orcid.org/0000-0003-0339-3607
O. O. Melnychenko, http://orcid.org/0009-0009-2660-8990

Thoracic trauma, often characterised as closed, comprises 23 % to 56.9 % of polytrauma cases.According to our research, flail chest in thoracic trauma occurs in approximately 7.9—8.9 % of cases. The primary factors contributing to this instability are car accidents or falls from a height.

Objective — to enhance the outcomes of surgical treatment for patients with flail chest by applying novel techniques for assessing the severity of injuries and implementing improved surgical tactics.

Materials and methods. The study included a total sample of 123 patients who had flail chest. The participants were divided into 2 groups: the control group (n = 56) and the comparison group (n = 67). The ATS scale was used to assess the severity of the condition in the groups. The injury severity score was determined using a point-based system and categorised as minor, severe, or extremely severe. The control group was additionally evaluated using the AdTS scale, while the perfusion index was measured.

Results. The injury severity score determined using the AdTS scale and the perfusion index formed the basis of an algorithm for differential diagnosis that influenced the indication area and scope of diagnostic procedures. The choice of surgical tactics was based on the results of an additional examination and the injury severity score. For a minor injury, the full range of medical procedures was carried out. For a severe injury, a shortened list of procedures was prescribed. In the case of an extremely severe injury, care was provided using the principles of DCS technology. The chest stabilisation procedure was conducted using the suggested approach for assessing the severity of the injury: less traumatic operations were performed for severe injuries, while full-scale operations were carried out for minor injuries. The selection of the method for stabilising floating segments was based on the established classification of chest instability. The stabilisation of flail chest was carried out either during the first or third phase of the DCS technology or after the patient had been brought out of a state of shock, in accordance with delayed indications.

Conclusions. The application of the AdTS anatomical and functional scale and the determination of the perfusion index allowed for a rapid and objective evaluation of the injury severity score (minor, severe, and extremely severe). Additionally, these tools helped in identifying the appropriate diagnostic procedures and deciding on the method for stabilising the flail chest. The differential diagnostic programme implemented in the control group made it possible to reduce the examination time for patients with an extremely severe injury by 9.8 ± 1.1 minutes. Implementing the proposed injury severity assessment and stabilisation tactics decreased the number of late purulent-septic complications by 19.8 % and mortality by 17.4 % (from 38.8 % to 21.4 %).

Keywords
flail chest, costal valves, chest injury, polytrauma, combat surgical trauma.

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In the last decade, there has been a trend towards an increase in injuries, and injuries have become one of the leading causes of mortality [2]. Injury to chest organs makes up 10—12 % of all mechanical injuries [6, 8]. At the same time, flail chest occurs in 5—11 % of patients with a closed chest injury [19, 20]. The problem of injuries in Ukraine became even more urgent in connection with the armed aggression of the Russian Federation.

Surgical tactics, timing, scope, and sequence of operations should correspond to the nature of the injury and its severity [7].

The generally accepted gradation of injury severity into mild, moderate, severe, and extremely

severe is based on the subjective experience of clinicians and requires objectification [1, 5].

The severity of the injury should be assessed not only upon admission but also during the entire period of treatment to identify the dynamics and predict the course of the traumatic disease [21].

Anatomical scales for assessing the severity of injury are focused on determining the number of morphological disorders of organs and systems that occur during trauma. Functional severity scales are based on the assessment of clinical and laboratory indicators. However, in the acute period of a traumatic illness, these scales do not always reflect the severity of the injury, so anatomical and functional scales were proposed [9, 24].

In 2017, the Department of Military Surgery introduced the AdTS (Admission Trauma Scale) anatomical and functional scale, which assesses three groups of indicators: cardiovascular system work, respiratory system work, and anatomical damage to the head, trunk, and limbs. The methodology involves rating the severity of the injury in points, defining the indication area of diagnostic procedures, and determining the scope of surgical interventions [6].

According to our research, more than 80 % of cases of flail chest fall under the category of severe or extremely severe. This necessitated the optimisation of surgical tactics on admission in accordance with the principles of DCS (damage control surgery) technology, which prioritises the severity of physiological diseases over anatomical ones. The majority of studies on DCS tactics focus on abdominal trauma, while thoracic trauma is underrepresented [16, 21]. And there are practically no publications on the application of DCS technology in the case of sternocostal framework instability [26]. The significant increase in combat surgical trauma, both in the military and in the civilian population, with massive admissions in an underequipped, resource-constrained environment draws attention to DCS tactics.

Objective — to enhance the outcomes of surgical treatment for patients with flail chest by applying novel techniques for assessing the severity of injuries and implementing improved surgical tactics.

Materials and methods

A retrospective-prospective study was conducted at the National Military Medical Clinical Centre «Main Military Clinical Hospital» and the Kyiv City Clinical Emergency Medical Hospital from 2010 to 2023. During the course of the research, a total of 1,488 case histories of patients with both isolated and combined chest trauma accompanied by rib fractures were analysed. A total of 123 patients with flail chest were selected from the general sample of patients and formed a separate group.

The control group (n = 56) included patients who received surgical chest stabilisation. The comparison group (n = 67) was formed on the basis of a retrospective analysis of the medical records of patients who did not undergo surgery on the rib cage. The mean age of patients in the control group was 47.4 ± 13.1 years, while in the comparison group, it was 51.9 ± 15.8 years. The gender distribution in the groups was as follows: the control group consisted of 78.6 % males and 21.4 % females, whereas the comparison group included 77.6 % males and 22.4 % females.

Flail chest in 75.0 % patients of control group and in 70.2 % of cases in comparison group occurred as a result of a combined injury. Damage to one AFA (anatomical and functional area) was observed in 25.0 % and 29.8 %, two AFAs were affected in 35.7 % and 38.8 %, and three or more AFAs were damaged in 39.3 % and 31.3 % of patients in the study groups, respectively.

The distribution of patients by character of injury is given in Table 1.

To compare the study groups, an injury severity score was assessed using the ATS (Anatomic Trauma Score) scale (Table 2).

The incidence of minor injuries was 19.6 % in the control group and 23.9 % in the comparison group. Severe and extremely severe injuries consistently resulted in traumatic shock during the acute phase of the traumatic illness, with rates of 80.4 % and 76.1 % in the study groups, respectively.

The control group was additionally evaluated using the AdTS scale (Admission Trauma Scale). Furthermore, the perfusion index was determined, which also served as a means for monitoring peripheral blood flow compensation (Table 3).

The distribution of subgroups based on the AdTS scale showed no significant difference compared to the ATS scale. However, we observed a rise in the prevalence of severe and extremely severe injuries, accompanied by a decrease in minor injuries by 3.6 %.

Correlation analysis revealed a strong direct correlation (r = 0.95) between the degree of shock and the AdTS score and a strong inverse correlation between injury severity and the perfusion index (r = 0.94).

In the control group, diagnostic procedures were planned, and a floating segment stabilisation approach was selected, taking into account the injury severity score at admission and the perfusion index.

The statistical processing of the obtained data was carried out using the IBM SPPS Statistics 22 statistical package. Descriptive statistics were

Table 1. **General characteristics of the research array by character of injury**

Character of trauma		Control group (n = 56)	Comparison group (n = 67)
Isolated trauma		14 (25.0 %)	20 (29.8 %)
Chest + 1 AFA	Head	12 (21.4 %)	15 (22.3 %)
	Abdomen	1 (1.8 %)	2 (3.0 %)
	Skeleton	6 (10.8 %)	6 (8.9 %)
	Spine	1 (1.8 %)	3 (4.5 %)
Chest + 2 and more AFAs	Head + Skeleton	7 (12.5 %)	3 (4.5 %)
	Head + pelvis	4 (7.2 %)	5 (7.5 %)
	Head + spine	3 (5.3 %)	5 (7.5 %)
	Head + abdomen + Skeleton	5 (8.9 %)	3 (4.5 %)
	Head + abdomen + Pelvis	3 (5.3 %)	5 (7.5 %)

Note. p = 0.835 (chi-square criterion).

Table 2. **Average score (M ± m) and distribution of patients by severity of injury according to the ATS scale in the study groups**

Severity of injury	Control group (n = 56)		Comparison group (n = 67)	
	Number of patients	Score	Number of patients	Score
Minor injury	11 (19.6 %)	23.0 ± 0.95	16 (23.9 %)	21.1 ± 1.4
Severe injury	33 (59.0 %)	32.8 ± 4.9	38 (56.7 %)	31.9 ± 5.7
Extremely severe injury	12 (21.4 %)	45.6 ± 1.7	13 (19.4 %)	45.2 ± 2.0

Note. p = 0.845 (chi-square criterion).

Table 3. **Indicators of the degree of traumatic shock, AdTS score, and perfusion index, depending on injury severity, in patients in the control group**

Severity of injury	Degree of traumatic shock*	AdTS score	PI on admission
Minor injury (n = 9)	0	4.7 ± 0.45	2.9 ± 0.54
Severe injury (n = 34)	1	6.2 ± 0.4	2.3 ± 0.48
	2	7.6 ± 0.95	1.44 ± 0.47
Extremely severe injury (n = 13)	3	10 ± 1.13	0.87 ± 0.18
	4	12.8 ± 1.0	0.5 ± 0.14

Note. * The degree of shock was assessed using the scale of Zarutskyi et al. [6, p. 83].
PI — Perfusion Index.

performed. The normality of the data distribution was checked using the chi-square test. Quantitative data, depending on the nature of the distribution, are presented as the arithmetic mean (M) ± the mean error of the mean value (m). For data, the distribution of which does not differ from normal, the comparison was carried out using the paired Student's t-test. For data whose distribution differs from normal, the comparison of variables was carried out using the Wilkson-Mann-Whitney U-test. Relative values were compared using the Pearson chi-square test. Correlation analysis was performed using the Spearman method. The null hypothesis of equality of variables was rejected at $p < 0.05$.

Results

The surgical tactics used in the study groups varied. The primary distinctions among the patients in the control group included: an algorithm for differential diagnosis; implementation of DCS (damage control surgery) tactics to reduce the duration of the first operation; stabilisation of the patient's condition; and subsequent intervention within a timeframe of 24—36 hours. An early tracheostomy was performed within 2—3 days when extended mechanical ventilation of the lungs was required in order to minimise complications related to prolonged endotracheal ventilation. All patients in the control group received therapeutic bronchoscopies to maintain the patency of the tracheobronchial tree and monitor the development of infectious complications. The comparative characteristics of surgical tactics in the study groups are presented in Fig. 1.

The patients in the control group underwent diagnostic procedures based on the injury severity score according to the AdTS scale and perfusion index indicators, which determined the indication area, scope, and sequence of the procedures.

The diagnostic approach involved a comprehensive evaluation of patients with minor injuries, including clinical examination, analysis, an ECG, an X-ray of all affected anatomical and functional areas, ultrasound, and SCT screening. This examination was conducted in the reception department and took an average of 51.2 ± 2.4 minutes. For severe injuries, a limited range of screenings were conducted simultaneously (physical examination, analysis, ECG, ultrasound, and SCT of the affected areas) within the anti-shock ward. This enabled a reduction in the duration of the examination to 40.0 ± 2.3 minutes. For extremely severe injuries, a minimal set of examination procedures (physical examination, FAST protocol, chest x-ray) was carried out in the operating room, lasting an average of 16.0 ± 0.9 minutes.

The surgical approach was determined based on the results of the additional examination, the injury severity score, and the perfusion index. For minor injuries, the full scope of surgical interventions (thoracentesis, thoracoscopy, and installation of external fixation devices with repositioning of fragments) was performed. For severe injuries, a shortened set of procedures (thoracentesis, thoracoscopy, laparotomy, and immobilisation of fractures without repositioning) was carried out. For extremely severe injuries, surgery was performed according to the principles of DCS technology (thoracentesis, DCS thoracotomy, DCS laparotomies, and immobilisation of fractures without reduction).

The stabilisation of the flail chest was carried out either during the DCS I phase (7.2 %), DCS III phase (12.5 %), or after complete recovery from traumatic shock (80.3 %).

The surgical stabilisation resulted in a rise in the occurrence of early postoperative complications. However, it effectively prevented the development of late purulent-septic complications (Table 4).

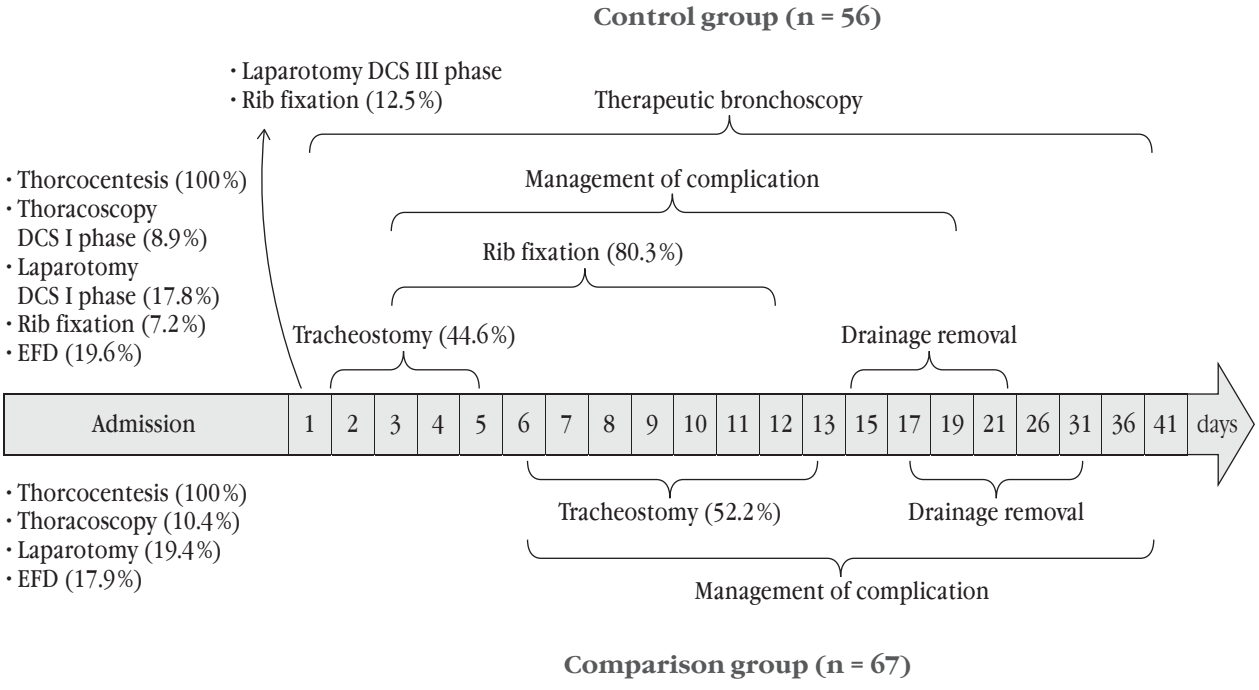

Figure 1. **Peculiarities of surgical tactics in cases of chest injuries accompanied by flail chest**

Table 4. **Characteristics of study groups based on the presence of purulent-septic complications**

Complications	Control group (n = 56)	Comparison group (n = 67)	p*
Chest wall conditions			
Suppuration of postoperative wound	8 (14.3 %)	2 (3.0 %)	0.011
Osteomyelitis of ribs	6 (10.7 %)	3 (4.5 %)	
Chondrite	5 (8.9 %)	2 (3.0 %)	
No complications	42 (75.0 %)	62 (92.5 %)	
Early complications of the clinical course			
Pneumonia	48 (85.7 %)	59 (88.0 %)	0.790
Late complications of the clinical course			
Endobronchitis	17 (30.3 %)	41 (61.1 %)	0.026
Destructive pneumonia	5 (8.9 %)	16 (23.9 %)	
Lung abscess	2 (3.6 %)	6 (9.0 %)	
Bronchopleural fistula	3 (5.4 %)	9 (13.4 %)	
Pleural empyema	5 (8.9 %)	12 (17.9 %)	
Sepsis	4 (7.1 %)	11 (16.4 %)	
No complications	27 (48.2 %)	19 (28.4 %)	

Note. * Fisher's exact test.

Table 5. **Mortality rates in the study groups depending on the initial injury severity score**

Severity of injury	Control group		Comparison group		p*
	Number of patients	Mortality	Number of patients	Mortality	
Minor	11	0	16	1 (6.3 %)	0.398
Severe	33	7 (21.2 %)	38	18 (50.0 %)	0.013
Extremely severe	12	5 (41.7 %)	13	7 (53.8 %)	0.543
Total	56	12 (21.4 %)	67	26 (38.8 %)	0.038

Note.* Calculation of the p value for mortality. Pearson's χ^2 test.

The data in the table show that chest wall conditions occurred substantially more frequently in the control group, which is likely due to increased traumatization during stabilisation. The number of post-traumatic pneumonias did not differ statistically. Furthermore, the number of late purulent-septic complications in the control group was significantly lower, which is associated with less dependence on ventilators, a shorter length of stay in the intensive care unit, and faster activation of patients after rib fixation.

The reduction in the occurrence of late purulent-septic complications resulted in a notable decrease in mortality in the control group, with 12 patients (21.4 %) compared to 26 patients (38.8 %) in the comparison group, a statistically significant difference (p = 0.038). This was due to a decrease in the incidence of fatal outcomes in patients with severe injuries. In the control group, 7 cases (21.2 %) were observed, compared to 18 cases (50.0 %) in the comparison group (p = 0.013). However, for minor and extremely severe injuries, the implemented tactics did not have a significant impact on mortality rates (Table. 5).

Among minor injuries, there was one fatal case in the comparison group, which occurred as a result of myocardial infarction and the subsequent development of acute cardiovascular insufficiency

associated with concomitant pathology. For extremely severe injuries, the relative number of deaths was practically the same. The control group exhibited a much lower mortality rate in cases of severe injury, suggesting that stabilization of flail chest is a viable approach.

The effectiveness of the developed diagnostic and treatment tactics, including stabilisation of flail chest, is demonstrated by the following two clinical cases.

Clinical case 1

Patient K., 54 years old, case history No. 18783. Diagnosis: severe cranio-thoracic-abdomino-skeletal injury. Closed traumatic brain injury. Brain concussion. Closed chest injury. Fractures of 3—10 ribs on the left without displacement of fragments; fractures of 3—12 ribs on the right along the posterior axillary and paravertebral lines from the formation of the posterior-lateral costal valve. Right-sided large hemothorax. Left-sided post-traumatic pneumothorax. Closed abdominal injury. Rupture of the spleen, colon, and hemoperitoneum. Skeletal trauma. Closed fracture of the right clavicle with displacement. Closed fracture of the right tibia with displacement of fragments. Traumatic shock III degree.

Delivered in critical condition 1.2 hours after being injured in a road accident (pedestrian). On admission: consciousness — sopor, blood pressure 70/50 mm Hg, heart rate 128/min, SpO_2 = 88 % with oxygen support, PI = 0.9. According to the ATS scale, a score of 44 indicates an extremely severe injury.

The patient was transported to the operating room, where the FAST protocol was executed, revealing the presence of free fluid in the right pleural cavity and pelvis. The operation commenced 16.0 minutes after the patient's admission.

Thoracopuncture, thoracentesis, and drainage of both pleural cavities were performed. On the right, 850 ml of non-clotting blood was obtained; on the left — air. Laparocentesis: blood was obtained; laparotomy. Damage to the spleen and rupture of the left half of the colon were revealed. DCS I phase: splenectomy, obstructive resection of the colon. Installation of the external fixation device on the right tibia without repositioning the fragments. The duration of the operation was 70 minutes. DCS II phase: ICU. 3 hours after admission, PI = 1.3, which indicated the effectiveness of intensive therapy. CT scan of the head, chest, abdomen, and pelvis was performed (Fig. 2).

36 hours after the first surgical intervention, the patient was operated on again. DCS III phase: relaparotomy, restoration of intestinal patency. The duration of the operation was 80 minutes. On the

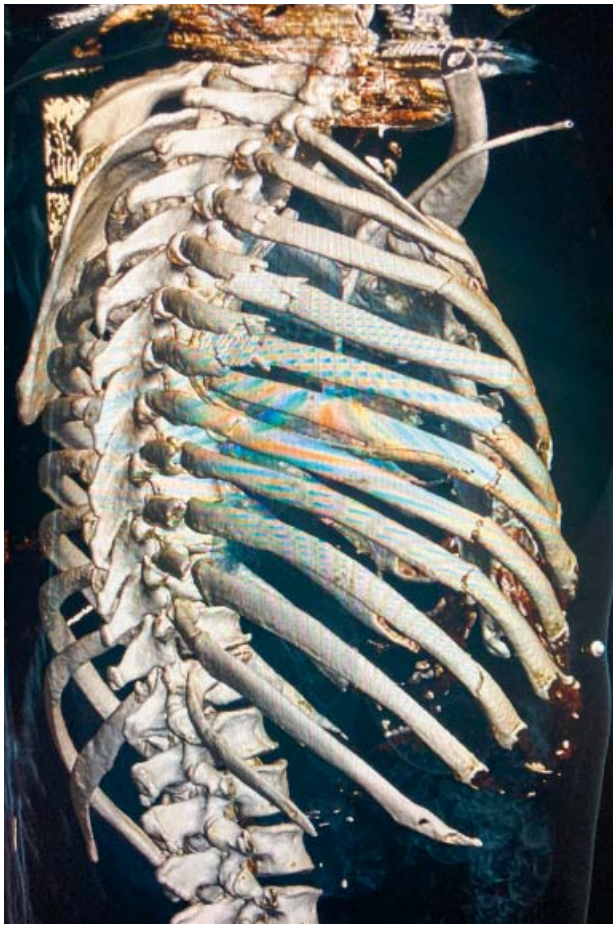

Figure 2. **Patient K., case history No. 18783. Multiple rib fractures on the right along the posterior axillary and paravertebral lines**

Figure 3. **Patient K., case history No. 18783. 18 days after the injury. Osteosynthesis of the 5th, 6th, 7th ribs on the right side and right clavicle along paravertebral lines**

3rd day, a tracheostomy was formed. Regular therapeutic bronchoscopies were performed on a daily basis. The left pleural drain was removed on the 7th day. On the 8th day, he underwent the operation on the rib cage: metal-osteosynthesis of the right clavicle and intramedullary osteosynthesis using Ilizarov spikes on the 5th, 6th, and 7th ribs on the right side. Two days after stabilisation of the chest, signs of independent breathing appeared, so the patient was gradually weaned from the ventilator. On the 18th day, the drain was removed from the right pleural cavity. The patient was transferred to a specialised department. A control X-ray of the chest organs was done (Fig. 3).

Discharged in satisfactory condition.

Clinical case 2

Patient M., 51 years old, case history No. 21211. Diagnosis: severe cranio-thoracic-abdominal-skeletal injury. Closed traumatic brain injury. Mild cerebral contusion. Closed chest injury. Fractures of the 3—9 ribs on the left along the mid-axillary and paravertebral lines from the formation of the posterior-lateral costal valve. Left-sided large hemothorax. Right-sided post-traumatic pneumothorax. Closed abdominal injury. Rupture of the spleen, damage to the small intestine, and hemoperitoneum. Closed injury of the pelvis. Fracture of both hip bones, left ilium. Closed fracture of the left tibia with displacement of fragments. Traumatic shock III degree.

Delivered in critical condition 1 hour after being injured in a road accident (pedestrian). On admission: consciousness — stupor, blood pressure 80/60 mm Hg, heart rate 114/min, SpO_2 = 90 % with oxygen support. According to the ATS scale, a score of 42 indicates an extremely severe injury. He was transported to the operating room, where Ro of the chest organs (Fig. 4) and an ultrasound of the pleural cavity and abdomen (Fig. 5) were performed.

The operation commenced 26.5 minutes after the patient's admission.

Thoracopuncture, thoracentesis, and drainage of both pleural cavities were performed. On the left, 900 ml of non-clotting blood was obtained at once;

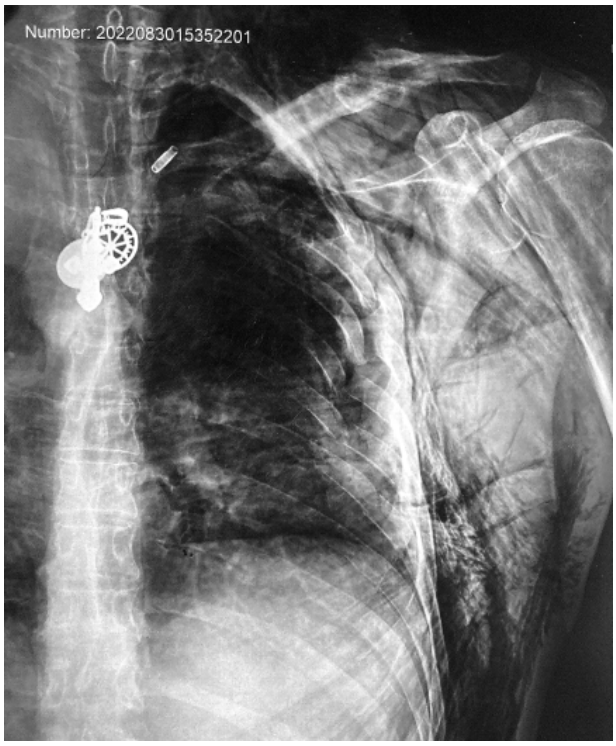

Figure 5. **Patient M., case history No. 21211. Multiple rib fractures on the left**

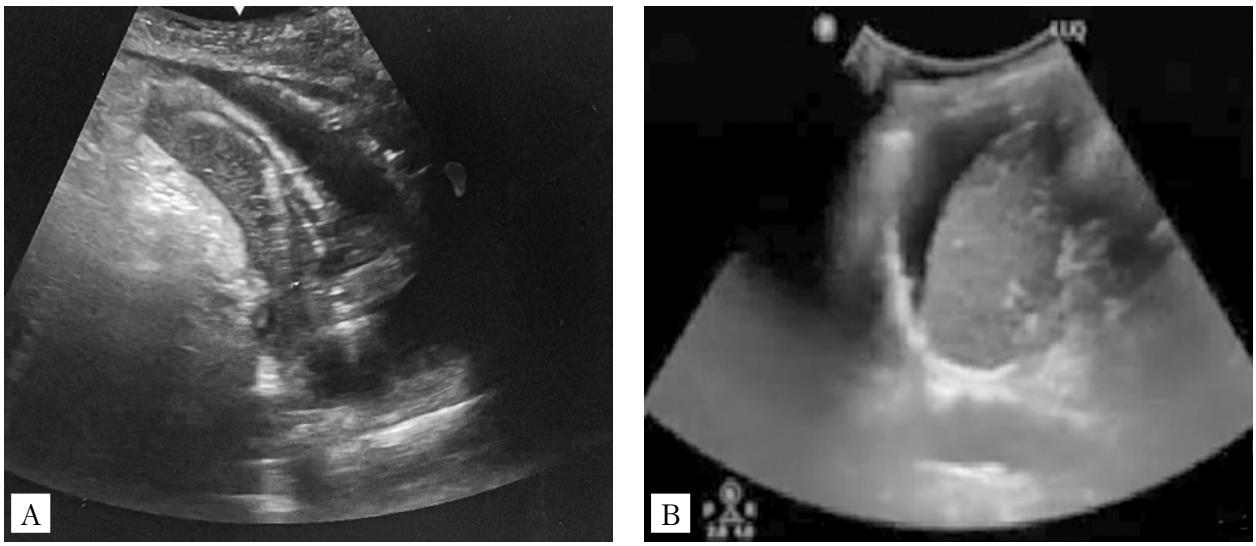

Figure 4. **Patient M., case history No. 21211.** Ultrasound of the left pleural cavity — free fluid in the sinus (A); abdominal ultrasound — free fluid around the spleen (B)

on the right — air under pressure. Laparocentesis: blood was obtained; laparotomy. Damage to the spleen was detected, rupture of the small intestine up to 1/2 diameter in 2 places, splenectomy was performed, and the intestine was sutured. Installation of the external fixation device on the left tibia with repositioning of fragments. The duration of the operation was 145 minutes.

The patient was on a ventilator in the resuscitation and intensive care unit. On the 6th day, a tracheostomy was formed by the classic method, and bronchoscopy was performed — signs of serous-purulent endobronchitis. Pleural drainage on the right was removed on the 9th day. On the 12th day, cloudy secretions appeared on the left side — signs of pleural empyema. A large amount of viscous, purulent sputum was released from the tracheostomy, and an X-ray was performed; bilateral polysegmental pneumonia was diagnosed. Switched to hard ventilation mode. Signs of multiple organ failure progressed. The patient died on the 21st day.

Discussion

There are three primary approaches to treating individuals with flail chest: surgical, traumatological, and intensive care. Consequently, the management of this condition includes the treatment of internal organ injuries (surgical approach), the treatment of deformations of the bone (traumatological approach), and the treatment of acute respiratory failure (intensive care). Thoracic and general surgeons primarily focus on treating internal organ damage and typically have limited expertise in osteosynthesis procedures. Traumatologists specialise in repairing the damaged structure of the skeleton and have a restricted scope when it comes to procedures involving the chest [15]. This accounts for the absence of a unified perspective on the approach to addressing this issue [23, 25].

In the world, the debate on the effectiveness of operative and conservative treatment continues, which is highlighted in numerous articles devoted to this problem. The conclusions are often diametrically opposed. Surgeons with extensive expertise in stabilising the flail chest strongly emphasise the necessity of surgical intervention and report a reduction in complications, duration of mechanical ventilation, and mortality rates [14, 17]. Some studies do not report a statistically significant difference in the occurrence of complications and death rates in relation to stabilisation [18]. Some trials totally omit surgical stabilisation and demonstrate positive treatment outcomes in the presence of mechanical ventilation and sufficient analgesia [25].

The timing of the surgical procedure is also significant. The majority of scientists claim that early stabilisation, occurring within a 72-hour timeframe, is the most justified [11, 27]. But the expediency of early stabilisation in case of traumatic shock is questionable. The literature lacks comprehensive coverage on the assessment of the severity of a chest injury accompanied by sternocostal framework instability.

In the course of the research, we came to the conclusion that this problem should be dealt with by trauma surgeons (thoracic surgeons), who are proficient in osteosynthesis methods and simultaneously solve the issue of damage to internal organs and stabilisation of rib fractures. Assessment of the injury severity using the AdTS scale and determination of the perfusion index allow for quick and objective assessment of the injury severity, which is graded as minor, severe, or extremely severe, as well as management of a number of clinical and organisational issues. For minor injuries, a full range of diagnostic and treatment procedures are conducted. Stabilisation of the flail chest can be achieved using any method, including their combination. For severe injuries, a limited range of diagnostic and therapeutic procedures is indicated. Extra- and intrapleural methods are used to stabilise the flail chest. For extremely severe injuries, the examination is carried out in a minimal volume in the operating room, and surgical tactics are selected using DCS technology. Extrapleural methods are most commonly used to stabilise the flail chest.

Conclusions

An algorithm for differential diagnosis was created using the proposed method of injury severity assessment, resulting in a 37.5 % reduction in examination time for patients with extremely severe injuries.

The implementation of the injury severity assessment approach served as the foundation for selecting the sternocostal framework stabilisation method, resulting in a reduction in late purulent-septic complications by 19.8 % and death by 17.4 % (from 38.8 % to 21.4 %).

Declaration of interests

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics approval and written informed consents statements

The study was conducted in accordance with the Helsinki Declaration of Ethics. The study protocol was approved by the ethics committee of Ukrainian Military Medical Academy.

Authors contributions

Y. L. Zarutskyi: idea, design, formalization, conclusions; O. O. Melnychenko: materials and methods, design, data processing, statistics.

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Хірургічна тактика при травмі грудної клітки, що супроводжується нестабільністю грудинно-реберного каркасу

Я. Л. Заруцький, О. О. Мельниченко

Українська військово-медична академія

В структурі політравми торакальна травма становить від 23 % до 56,9 % і, як правило, носить закритий характер. За даними нашого дослідження нестабільність грудинно-реберного каркасу в структурі торакальної травми зустрічається у 7,9—8,9 % випадків і, в основному, є результатом ДТП або кататравми.

Мета — поліпшити результати хірургічного лікування постраждалих з нестабільністю грудинно-реберного каркасу шляхом впровадження оригінальних методик оцінки тяжкості травм та удосконаленої хірургічної тактики.

Матеріали та методи. Загальний масив дослідження становив 123 пацієнти з нестабільністю грудинно-реберного каркасу. Вони були розділені на 2 групи: основна (n=56) та порівняння (n=67). Тяжкість стану в групах оцінювали на підставі шкали ATS. Тяжкість травми виражалась в балах і категоріях: нетяжка, тяжка та вкрай тяжка. Основну групу додатково оцінювали за шкалою AdTS та вимірювали перфузійний індекс.

Результати. Оцінка тяжкості травми за шкалою AdTS та визначення перфузійного індексу були основою диференційованого діагностичного алгоритму на підставі якого визначалось місце і обсяг діагностичних процедур. На даних додаткових методів обстеження та оцінці тяжкості травми базувався вибір хірургічної тактики. При нетяжкій травмі виконували повний обсяг лікувальних заходів, при тяжкій травмі скорочений, а при вкрай тяжкій допомогу надавали за принципами технології DCS. Стабілізацію грудної клітки виконували із врахуванням запропонованої методики оцінки тяжкості травми: при тяжкій травмі виконували менш травматичні операції, не тяжкій травмі виконували операції в повному обсязі. Методику стабілізації флотуючих сегментів вибирали на підставі розробленої класифікації нестабільності грудної клітки. Стабілізацію грудинно-реберного каркасу виконували в ході реалізації першої або третьої фази технології DCS або після виведення пацієнта зі стану шоку за відтермінованими показаннями.

Висновки. Анатомо-функціональна шкала AdTS з визначенням перфузійного індексу дозволяла швидко і об'єктивно оцінити тяжкість травми (нетяжка, тяжка, і вкрай тяжка), визначити місце проведення діагностичних заходів і методику стабілізації грудинно-реберного каркасу. Запроваджена в основній групі диференційована діагностична програма дозволила скоротити час обстеження пацієнта при вкрай тяжкій травмі на 9,8 ± 1,1 хв. Впровадження запропонованої тактики оцінки тяжкості та методик стабілізації дозволили зменшити кількість пізніх гнійно-септичних ускладнень на 19,8 % та летальність на 17,4 % (з 38,8 % до 21,4 %).

Ключові слова: нестабільність грудинно-реберного каркасу, реберні клапани, травма грудної клітки, політравма, бойова хірургічна травма.

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