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CLINICAL AND INSTRUMENTAL FEATURES OF DIAGNOSTICS OF COMBAT SURGICAL CHEST INJURY WITH TISSUE DEFECTS

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Retrospective analysis of the results of comprehensive diagnostic examination of 127 injured persons with combat surgical chest injuries and their complications (bronchopleural fistula and pleural empyema) was conducted. Injured military servicemen with thoracic wall tissue defects in combat thoracic trauma at the III and IV levels of medical care were analyzed. Two clinical groups were defined: the main group and the comparator group. Clinical, laboratory, microbiological and instrumental research methods were used to examine injured servicemen and monitor clinical course of traumatic disease. To identify anatomical and morphological features of chest injuries, instrumental methods were used, with preference given to X-ray and ultrasound methods. During diagnostic examination of lungs and pleural cavities using computed tomography, compared to chest X-ray examination, 8.6 % more cases of pneumothorax/pneumohydrothorax, 14.1 % more cases of hydrothorax, 22.8 % more cases of pneumonia were identified, as well as new syndrome categories were identified: subpleural hematoma, pleural thickening.

Key words: combat thoracic trauma, thoracic wall defects.

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КЛІНІКО-ІНСТРУМЕНТАЛЬНІ ОСОБЛИВОСТІ ДІАГНОСТИКИ БОЙОВОЇ ХІРУРГІЧНОЇ ТРАВМИ ГРУДНОЇ КЛІТИНИ З ДЕФЕКТАМИ ТКАНИН

Проведено ретроспективний аналіз результатів комплексного діагностичного обстеження 127 поранених з бойовою хірургічною травмою грудної клітини та її ускладнень (бронхо-плевральні нориці та емпієма плеври). Аналізу підлягали поранені військовослужбовці з дефектами тканин грудної стінки при бойовій торакальній травмі на III та IV рівнях медичного забезпечення. Визначено дві клінічні групи: основну та групу порівняння. Для діагностики поранених та моніторингу перебігу травматичної хвороби застосовували клінічні, лабораторні, мікробіологічні та інструментальні методи дослідження. Для визначення анатомо-морфологічних особливостей ушкоджень грудної клітини, застосовували інструментальні методи, перевагу надавали рентгенологічним та ультразвуковим методам. Під час діагностичного обстеження легень та плевральних порожнин за допомогою комп'ютерної томографії, у порівнянні з рентгенографією грудної клітини, виявлено та визначено більше випадків пневмотораксів/пневмогідротораксів на 8.6 %, гідротораксів на 14.1 %, пневмоній на 22.8 %, а також визначити нові синдромальні категорії: субплевральна гематома, плевральні нашарування.

Ключові слова: бойова торакальна травма, дефекти грудної стінки.

The study is a fragment of the research project "Development of modern methods of diagnostics and treatment of purulent-septic complications of combat surgical trauma", state registration No. 0120U101834

Specific features of diagnostic examination and treatment of injured persons with combat thoracic trauma (CTT) with soft tissue injuries are one of the most important issues in modern military field surgery and are the critical point of study for various experts [1, 2]. Over the last year, during the full-scale invasion of Russia with the use of modern aggressive weapons, a large number of injured persons have been reported

with chest trauma, which is characterized by injuries to vital organs and structures of the chest, massive damage to thoracic wall soft tissues, with further development of thoracic wall tissue defects (TWTD) [3, 4]. Clinical course of traumatic disease in such injured persons is accompanied by the development of mutual aggravation syndromes, purulent-septic complications, multiple organ failure, and long-term treatment process, which requires a large number of different medical and diagnostic measures [5, 6]. Therefore, such patients are challenging to diagnose due to the fact that most of them have severe or extremely severe multiple or combined injuries, so the task is to make full examination using ultrasound diagnostics (US) and multispiral computed tomography (MSCT) in the shortest possible time in order to identify life-threatening injuries, prevent early and late complications, assess the severity of the injury, and evaluate the time, sequence, and scope of intensive care and surgical treatment required for the successful treatment of injured persons with CTT [7, 8].

The purpose of the study was to analyze the results of diagnostic examination of injured persons with thoracic tissue defects and possible complications at the III and IV levels of medical care, depending on the severity.

Materials and methods. A retrospective analysis of 127 injured persons with TWTD accompanying CTT was conducted. The patients' age ranged from 19 to 59 years and the average age was 40.82±5.35 years. Two clinical groups were defined: the main group and the comparator group. The main group included 54 patients who, along with a full diagnostic examination, underwent emergency and planned surgical treatment involving vacuum therapy, ultrasound cavitation, and assessment of wound size changes. The comparator group included 73 injured persons who were treated according to the traditional method with repeated surgical debridement. Clinical groups of injured persons were compared by age, gender, mechanism of injury, and stereometric characteristics of traumatic defects of thoracic wall.

Initial clinical and certain diagnostic examinations of injured persons were carried out in medical institutions where forward surgical teams were located and in military mobile hospitals, which corresponded to the II level of medical care with evacuation to medical institutions of the III and IV levels of medical care.

The list of diagnostic examinations done for injured persons at the III and IV levels of medical care is shown in Table 1.

Table 1

Characteristics of the general data on examination of injured persons with TWTD and CTT, who underwent diagnostic procedures at the III and IV levels of medical care

Diagnostic procedures	Main group (n=54)		Comparator group (n=73)	
	Abs.	%	Abs.	%
Clinical examination	54	100	73	100
Laboratory tests	54	100	73	100
Chest X-ray examination	54	100	73	100
Repeated chest X-ray examinations	54	100	73	100
Computed tomography of the chest	54	100	73	100
Repeated computed tomography of the chest	52	96.3	58	79.5
Repeated ultrasound examinations of the chest and pleural cavities	54	100	18	24.7
Microbiological examination of the wound	54	100	43	50.9
Diagnostic bronchoscopy	19	24.5	8	11.0

Diagnostic examinations of injured persons with TWTD accompanying CTT were always performed with the involvement of a number of instrumental methods of examination: radiography, fiber optic bronchoscopy, ultrasound and MSCT of thoracic organs. Sometimes, instrumental methods of examination of injured persons with thoracic trauma were performed simultaneously with intensive care anti-shock treatment. In the main group, in contrast to the comparator group, it was done to better monitor the state of lungs, visualizing the occurrence and amount of exudate and determining the degree of parenchymal expansion. Microbiological examination of injured persons with TWTD involved microbiological culture testing of the wound surface of thoracic wall to identify microflora and the number of colony forming units (CFU), as well as determination of sensitivity to antibiotics and antimicrobial agents – antibogram.

Three metric characteristics were used for the stereometric evaluation of TWTD: largest linear wound dimension (l) – the largest distance between the wound edges (cm); wound area (S) in cm ^{2} and volume (V) in cm ^{3}. The following formula was used to measure the wound area: $S=l\times h/2$, where “l” is the largest distance between the wound edges, and “h” is the width of the wound.

In practice, the method of measuring the wound area using digital photoplanimetry with analytical processing by Image J software was more commonly used. This method made it possible to accurately measure the area of irregularly shaped wounds, as well as to monitor the dynamics of changes in the wound area in the course of treatment.

The following formula was used to measure the volume of wound defects: $V=S\times d/4$, where "S" is the wound area, and "d" is the depth of the wound.

Most of TWTD in both comparator groups were medium, there were a small number of large and extra-large ones, and patients with small defects were excluded from the research.

Results of the study and their discussion. Chest X-ray examination, MSCT of thoracic organs, and ultrasound diagnostics of the pleura and lungs were used for diagnostic examination of injured persons. Such a comprehensive approach made it possible to ensure highly accurate assessment of the state of the chest and respiratory system of injured persons, which served as the basis for emergency medical care and development of individual treatment strategies.

The combination of the said methods, including X-ray, MSCT and ultrasound diagnostics, allows medical experts to examine physical status of injured persons in detail, detect possible damage to lungs, pleura, ribs and other structures of the chest, and makes it possible to make an accurate and comprehensive diagnosis, which is an important step in developing individual treatment plan and further rehabilitation aimed at full recovery and high-quality life of injured patients.

Some patients underwent repeated plain radiography of thoracic organs (TO) to detect any possible complications in pleural cavities and lung disorders. This additional stage of the examination was essential to obtain more detailed and up-to-date information on the dynamics of the disease and recovery. In the case of grave and extremely grave conditions of patients, radiography of TO was made in some special positions. For example, this procedural method can be applied in supine position or in the left lateral position. This approach makes it possible to obtain specific images that can be more informative for identifying certain pathological processes and for monitoring the dynamics of treatment in case of severe clinical scenarios. This comprehensive approach to patient examination ensures accurate and timely diagnosis, and provides the ability to monitor changes in patients' condition for better treatment and rehabilitation.

The results of X-ray and MSCT examination of the state of lungs and pleural cavity of injured persons on admission are shown in Table 2.

Table 2

Results of X-ray and MSCT examination of thoracic organs to assess the state of lungs and pleural cavity

Identified changes of X-ray examination	Main group (n=54)		Comparator group (n=73)		Total number (n=127)	
	Abs.	%	Abs.	%	Abs.	%
pneumothorax, pneumohydrothorax	10	18.5	25	34.2	35	27.6
fluid in the pleural cavity	9	16.7	17	23.2	26	20.5
lung fields shadowing – pneumonia	31	57.5	49	67.1	80	63.0
lung fields shadowing – atelectasis	4	7.4	3	4.1	7	5.5
undifferentiated hemothorax shadowing	5	9.3	9	12.3	14	11.0
elevated hemidiaphragm	4	7.4	7	9.6	11	8.7
gas within the mediastinum	1	1.9	2	2.7	3	2.4
Identified changes of MSCT examination	**Abs.**	**%**	**Abs.**	**%**	**Abs.**	**%**
pneumothorax, pneumohydrothorax	29	39.7	17	31.5	46	36.2
fluid in the pleural cavity	28	38.4	16	29.6	44	34.6
lung fields shadowing – pneumonia	64	87.7	45	83.3	109	85.8
lung fields shadowing – atelectasis	5	6.8	4	7.4	9	7.1
gas within the mediastinum	6	8.2	3	5.6	9	7.1
subpleural hematoma	4	5.4	1	1.9	5	3.9
pleural thickening	6	8.2	1	1.9	7	5.5

The main method of TO diagnosing which we considered the most informative and useful was computed tomography (MSCT) with intravenous contrast enhancement. This method made it possible to obtain high-quality and detailed images of the chest cavity, thoroughly assessing the state of lungs, pleural membranes and other structures. MSCT was used for all injured patients in the main and comparator groups immediately after their inclusion in the research. It was a crucial moment for promptly making a diagnosis and finding out the condition of injured patients. During the subsequent treatment, 22 (40.7 %) patients in

the main group and 29 (39.7 %) in the comparator group were regularly examined. Such check-up examinations were essential for assessing the efficacy of treatment, timely detection of possible complications, and ensuring the fullest possible medical support for patients at every stage of their recovery and rehabilitation.

Unlike plain chest radiography, MSCT enables more detailed and accurate assessment of patients' condition. This study revealed 8.6 % more cases of pneumothorax, 14.1 % more cases of hydrothorax, and 22.8 % more cases of pneumonia compared to the results of plain radiography. Moreover, MSCT revealed new syndrome categories, such as subpleural hematoma and pleural thickening, which made it possible to more thoroughly and effectively assess injuries and pathological conditions in the chest cavity of injured persons. Such additional information is essential for accurate diagnosis and development of effective treatment plan for each patient.

We also widely used ultrasound examination of lungs and pleural cavities in the diagnosis and monitoring of combat thoracic trauma. This method provides additional information about the condition of injured patients, as well as identifies potential complications that may be missed during other examinations. While in the comparator group, this examination was made in only 18 (24.7 %) injured patients, in the main group, which was provided with more comprehensive medical care, ultrasound examination was made in all 54 (100 %) patients. Such a difference in diagnostic approach demonstrates the importance of using ultrasound examination in the assessment and monitoring of thoracic trauma patients, as it can significantly improve diagnostic accuracy and timely detection of medical problems.

Due to the accessibility and non-invasiveness of this method, the examination was made several times, and it made it possible to identify the following abnormal changes:

– hydrothorax, its volume, localization, and loculation;

– the method allowed to choose the most suitable point for pleural puncture;

– pleural empyema (localization, dimension);

– pneumonia (localization, extension, structures of pneumatic focus);

– state of the pleural cavity, degree of lung expansion, fibrothorax development.

The examination was carried out according to the BLUE protocol (B – bedside, L – lung, U – ultrasound, E – emergency) with a curvilinear transducer in B- and M-mode. The method was to examine structures of the chest in ultrasound windows of intercostal spaces sequentially from the anterior area along the parasternal line from the top and down to diaphragm. This systematic approach made it possible for us to obtain accurate and complete information about the state of various chest structures. Thus, the examination was performed along the anterior, posterior axillary and paravertebral lines, covering the entire chest and lung area. These procedures allowed us to identify possible injuries, abnormalities or complications in any segment of the chest and ensured complete diagnostic assessment of the injured patients' condition. Such a thorough approach helped us make reasonable decisions and provide appropriate treatment in each case.

In order to detect and verify ultrasound symptoms that were crucial for accurate diagnosis and assessment of injured persons, we used thoroughly defined list of commonly accepted signs. This list included such important elements as:

1. Pleural line – this sign helped to determine the boundary between pleural sheets and monitor possible changes in this area.

2. Sliding symptom – DOI 10 26724/2079-8334-2023-3-85.

Using this sign, it was possible to detect pathological changes in pleural spaces while breathing.

3. A –lines and B –lines: these signs provided information about various acoustic artifacts that can occur during ultrasound examination of lungs and pleural cavities.

4. Seashore, barcode, quad, tissue-like and shred signs: these signs made it possible for us to assess textural and structural characteristics of objects in the ultrasound image and to detect such abnormalities as pleural thickening or other injuries as shown in Fig. 1.

This list of signs was extremely important for the detailed analysis of ultrasound images and facilitated accurate diagnosis and clinical assessment of injured patients, which is crucial for choosing the most appropriate treatment and rehabilitation. These signs enabled doctors to accurately determine the nature and extent of injuries in the chest, monitor the dynamics of the disease and develop treatment strategies based on proven and reliable diagnostic data. This information was used to determine further action plan and helped to individualize treatment and rehabilitation approaches for each patient, providing them with the best chance of full recovery and successful return to active life.

The results of the chest ultrasound examination of lungs and pleural cavity of injured patients in the main group are shown in Fig. 2.

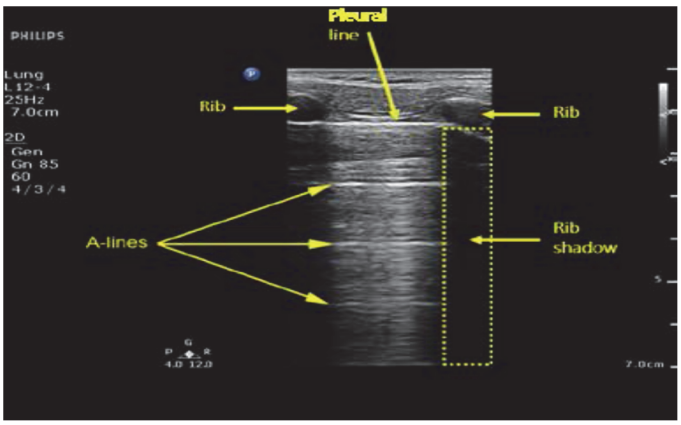

Fig. 1. Pleural A – lines of the normal lung.

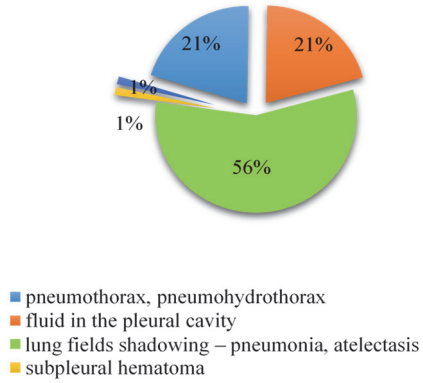

Fig. 2. Results of the chest ultrasound examination of lungs and pleural cavity of injured patients in the main group.

Patients in the comparator group were not analyzed due to the low coverage of this research method, and this limitation is related to the scope of available clinical data. However, the above data shows that the method of chest ultrasound examination performed according to the BLUE protocol demonstrates similar sensitivity to MSCT in detecting such pathological conditions as pneumothorax, hemothorax, subpleural hematomas and pleural thickening. This similarity in sensitivity indicates the possibility of successful use of ultrasound examination as an effective and safe alternative method of examining injured patients with thoracic injuries, while providing high degree of accuracy and reliability of the results.

Thus, ultrasound examination of TO, if widely implemented in clinical practice, has an extremely high method sensitivity reaching up to 93.1 % in repeated examinations. This method has great advantage of being easy to use at the bedside of injured patients, which makes it possible to conduct examinations even under extremely severe conditions [9].

Ultrasound examination of TO is the method of choice for diagnosing and monitoring pathological changes in lungs and pleural cavity in injured persons in road traffic accidents compared to other diagnostic methods. Its high accuracy and the possibility of repeated examinations make this method conducive to early detection and effective treatment of thoracic injuries in patients, which is extremely important for their further rehabilitation and recovery [10].

Based on all the data of instrumental methods of examination in injured patients of the main group, it can be noted that 11 decisions were made on the basis of MSCT of TO to change or correct treatment tactics, including potential use of surgical or minimally invasive interventions. Ultrasound diagnostics of thoracic organs (USD of TO) resulted in 13 similar decisions, while chest X-ray examination resulted in only 2 such decisions.

These findings have significantly influenced the tactics of complex surgical treatment in injured patients with thoracic wall tissue defects in thoracic trauma, emphasizing the importance of instrumental methods of examination with high sensitivity and accuracy. Identification of the existing injuries and their nature has become crucial for timely and effective treatment of patients, helping to choose the best treatment strategy and provide them with proper medical care.

Conclusions

1. Thus, comprehensive and timely diagnostic instrumental examination of injured persons with combat thoracic trauma significantly affects the tactics of complex surgical treatment and clinical course of traumatic disease, determination of the treatment period, prevention of early and late complications.

2. It has been found that the method of chest ultrasound examination according to the BLUE protocol is highly informative (sensitivity for detecting pathological syndromes is 93.1 %), safe for the patient, mobile and ergonomic, which gives it a leading position in the primary diagnosis and monitoring of pathological changes in the chest throughout the entire treatment period for injured patients with chest tissue defects.

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REGRESSION MODELS OF THE UPPER RESPIRATORY AREA IN YOUNG WOMEN AND YOUNG MEN WITHOUT AND TAKING INTO ACCOUNT THE TYPE OF FACE IN DEPENDENCE ON TELEROENTGENOMETRIC INDICES

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In Ukrainian young women and young men with an orthognathic bite without and taking into account the type of face, reliable ($p<0.001$ in all cases) regression models of the area of the upper respiratory tract depending on the total complex of teleroentgenometric indices of the upper respiratory tract were constructed and analyzed. All models of the upper respiratory area in young women without taking into account the type of face, with very wide and wide face types and in young men without taking into account the type of face and with a wide face type depend on the determined total complex of teleroentgenometric indices of the upper respiratory tract by more than 50 % (respectively, R^2=from 0.894 to 0.918 in young women and R^2=0.905 and 0.917 in young men).

Key words: teleroentgenography, cephalometry, respiratory tract, modeling, young men, young women, orthognathic bite, facial types.

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РЕГРЕСІЙНІ МОДЕЛІ ПЛОЩІ ВЕРХНЬОЇ ДИХАЛЬНОЇ ДІЛЯНКИ У ДІВЧАТ ТА ЮНАКІВ БЕЗ І З УРАХУВАННЯМ ТИПУ ОБЛИЧЧЯ В ЗАЛЕЖНОСТІ ВІД ТЕЛЕРЕНТГЕНОМЕТРИЧНИХ ПОКАЗНИКІВ

В українських дівчат і юнаків із ортогнатичним прикусом без і з урахуванням типу обличчя побудовані та проведено аналіз достовірних ($p<0,001$ в усіх випадках) регресійних моделей площі верхньої дихальної ділянки в залежності від сумарного комплексу телерентгенометричних показників верхніх дихальних шляхів. Усі моделі площі верхньої дихальної ділянки у дівчат без урахування типу обличчя, з дуже широким і широким типами обличчя та в юнаків без урахування типу обличчя та з широким типом обличчя залежать від визначеного сумарного комплексу телерентгенометричних показників верхніх дихальних шляхів більше, ніж на 50 % (відповідно, R^2=від 0,894 до 0,918 у дівчат і R^2=0,905 і 0,917 в юнаків).

Ключові слова: телерентгенографія, цефалометрія, дихальні шляхи, моделювання, юнаки, дівчата, ортогнатичний прикус, типи обличчя.

The study is a fragment of the research project "Teleroentgenographic characteristics of the upper respiratory tract in practically healthy young people", state registration No. 0121U113152.

The respiratory tract is a complex and heterogeneous complex of anatomical structures that provide a number of critically necessary functions of the body, such as gas exchange, filtration, air heating, etc., but also a number of other equally important things in our time, such as speech. The upper respiratory tract as a component of this system is an example of the multi-stage interaction of several regulatory mechanisms at once. Thus, the muscles of the upper respiratory tract respond to changes in pressure in the respiratory tract. Some muscles, such as the genioglossus muscle, also receive signals from the brainstem in the presence of hypo- or hypercapnia. In addition, changes in the size of the respiratory tract are influenced by