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DÖYÜŞ ZAMANI ALINAN DÖŞ QƏFƏSİ XƏSARƏTLƏRİNİN DİAQNOSTİKASINDA RENTGENOQRAFİYA VƏ ULTRASƏS MÜAYİNƏSİNİN NƏTİCƏLƏRİNİN MÜQAYİSƏLİ QİYMƏTLƏNDİRİLMƏSİ

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Xülasə. *Məqalədə döyüş zamanı alınan döş qəfəsi xəsarətlərinin diaqnostikasında rentgenoqrafiya və ultrasəs müayinəsinin nəticələrinin müqayisəli qiymətləndirilməsi məqsədilə aparılmış tədqiqat işi haqqında məlumat verilmişdir. Tədqiqata 94 xəstə cəlb edilmişdir. Göstərilmişdir ki, pnevmotoraks 45 (47,9%), plevra efüzyonu 36 (38,3%), qabırğa sınığı 34 (36,2%), perikardial efüzyon 11 (11,7%) xəstədə qeydə alınıb. Ultrasonoqrafiyanın həssaslığı pnevmotoraksın diaqnostikasında 89,7%, spesifikliyi – 83,3%, dəqiqliyi – 88,9%, qabırğa sınığında müvafiq olaraq – 90,3%, 66,7% və 88,2% təşkil edib.*

Əldə edilmiş məlumatlara görə, pnevmotoraksın və gabırğa sınığının diaqnostikasında ultrasonoqrafiya yüksək həssaslığa, spesifikliyə və dəqiqliyə malikdir. Ultrasəs müayinəsi travma nəticəsində yaranan istənilən həcmdə plevral və perikardial ekssudatın diaqnostikası üçün dəqiq və əlverişli üsuldur.

Açar sözlər*: rentgenoqrafiya, ultrasonoqrafiya, döş qəfəsinin döyüşlə əlaqəli zədələnməsi*

Ключевые слова*: рентгенография, ультрасонография, боевая травма грудной клетки*

Key words*: radiography, ultrasonography, combat chest injuries*

COMPARATIVE ASSESSMENT OF THE RESULTS OF RADIOGRAPHY AND ULTRASONOGRAPHY IN THE DIAGNOSIS OF COMBAT CHEST INJURIES

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Summary. *The article presents the results of a comparative assessment of X-ray and ultrasound examinations in the diagnosis of chest wounds received during combat operations in 94 patients. It was shown that pneumothorax was registered in 45 (47.9%), pleural effusion – in 36 (38.3%), rib fracture – in 34 (36.2%), pericardial effusion – in 11 (11.7%) patients. The sensitivity of ultrasound in diagnosing pneumothorax was 89.7%, specificity – 83.3%, specificity – 88.9%, and for rib fractures – 90.3%, 66.7% and 88.2%, respectively.*

According to the results, ultrasound has high sensitivity, specificity and accuracy in the diagnosis of pneumothorax and rib fractures. Ultrasound is an accurate and useful method for diagnosing pleural and pericardial effusions of any size caused by trauma.

In terms of frequency of occurrence, chest injuries during combat occupy a leading place. According to a number of authors, mortality from general chest trauma is 8.6–16.0% [1, 2]. The consequences of thoracic injuries are fractures of the chest bones, the appearance of pleural and pericardial effusion, and pneumothorax [3]. Thanks to improve-

ments in modern body armor, blunt chest injuries are much more common during combat than penetrating injuries [4, 5]. Modern body armor is capable of protecting the body from high-speed (>300 m/s) shots [6 – 8].

As you know, radiography is the most commonly used method for diagnosing pathologies of the chest organs. However, according to some authors, the sensitivity of the method in diagnosing damage to the pleura, pulmonary parenchyma, heart and large vessels is not high [9]. In recent years, computed tomography (CT) has become the main method (gold standard) for diagnosing pathologies of the chest organs of various types [10]. Compared with conventional radiography, CT is better at detecting pulmonary contusions, pneumothorax, rib fractures and injuries to large vessels [11]. The presence of high radiation exposure to the patient and the high cost of the study are considered relative disadvantages of the method [12].

Ultrasound examination differs from x-ray methods in accessibility, low cost, and the absence of ionizing radiation. Ultrasound can also provide information about the presence of rib fractures, pleural and pericardial effusions, thereby reducing the number of chest x-rays performed in intensive care units. However, there is still a pessimistic attitude among doctors regarding the possibility of ultrasound for assessing chest pathologies [13, 14].

The purpose of the study is a comparative assessment of the capabilities of radiography and ultrasonography in the diagnosis of injuries to the chest organs resulting from combat trauma.

Material and methods. A comparative analysis of the results of radiography and ultrasonography of the chest organs was carried out in 94 patients with blunt trauma received during combat operations. The types of injuries were determined using computed tomography (CT), which is considered the gold standard for assessing chest pathologies. The age of the patients ranged from 28-46 years (mean 38±4 years). X-rays were performed in anterior and lateral projections, with patients in a vertical or horizontal position. Ultrasonography was performed on a Philips HD 11 ultrasound machine using various sensors in the frequency mode 5-10 and 2-5 MHz.

Statistical analysis was performed using the nonparametric Mann-Whitney method. The sensitivity, specificity, and accuracy of radiography and ultrasonography in diagnosing various types of chest injuries were determined.

Results and discussion. In 36 (38,3%) cases the injury was right-sided, in 32 (34,0%) – left-sided, in 26 (27,7%) – bilateral. Pneumothorax was recorded in 45 (47,9%) cases, pleural effusion – in 36 (38,3%), rib fracture – in 34 (36,2%), pericardial effusion – in 11 (11,7%) cases. In 32 cases there was a combined injury. In 27 cases, pneumothorax, and in 5 cases, pericardial effusion was combined with rib fracture (Table 1). Effusion in the pericardium was not determined radiologically, but in all cases was confirmed by **USG.**

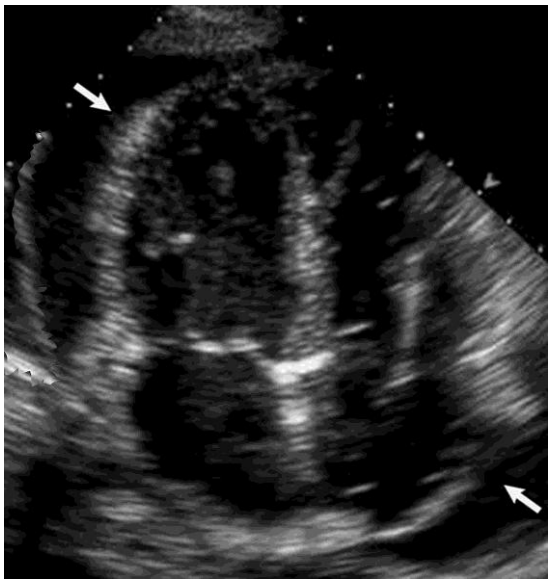

Fig. 1. 4-chamber apical view of the heart. Arrows show pericardial effusion in a patient due to blast combat trauma.

Table 1 presents the results of radiography and USG in the diagnosis of pneumothorax, which was detected by CT. In 23 cases, the results of radiography were true positive (TP), in 9 cases false negative (FN), in 11 cases true negative (TN), in 2 cases false positive (FP). The sensitivity of radiography was 71.9%, the specificity was 84.6%, and the accuracy was 75.6%. In 35 cases, the results of USG were TP, in 4 cases FN, in 5 cases TN and in 1 case FP. The sensitivity of USG was 89.7%, specificity – 83.3%, accuracy – 88.9%, respectively **(Table 1).**

Table 1. Results of radiography and USG in the diagnosis of pneumothorax

Pneumothorax, diagnosed by CT (n=45)							
X-ray				USG			
Yes		No		Yes		No	
32		13		39		6	
TP	FN	TN	FP	TP	FN	TN	FP
23	9	11	2	35	4	5	1
Sensitivity		71,9%		Sensitivity		89,7%	
Specificity		84,6%		Specificity		83,3%	
Accuracy		75,6%		Accuracy		88,9%	

Note: TP – true positive, FN – false negative, TN – true negative, FP – false positive.

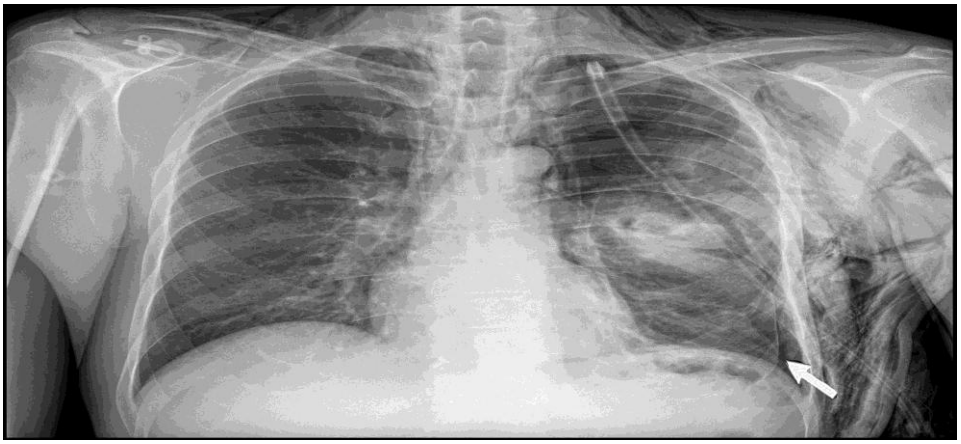

Fig. 2. The arrow shows a local absence of the vascular pattern and separation of the pleural layers, which indicates a small pneumothorax

The radiological sign of pneumothorax is the loss of the pulmonary pattern between the collapsed lung or its lobe and the parietal layer of the pleura. A large pneumothorax is characterized by a wide separation of the parietal and visceral layers of the pleura in the form of a wide vertical zone with the complete disappearance of the X-ray vascular pattern (Fig. 2).

Ultrasound diagnosis of pneumothorax was carried out using linear or convex sensors in M and B modes. In the absence of pneumothorax during inspiration, the visceral pleura shifts (slides) in the caudal direction and a small dotted image is formed on the screen, called the "sea shore" sign. Diagnosis of pneumothorax is based on identifying the "barcode" symptom, which is formed by the absence of sliding of the visceral pleura during the patient's inhalation. The appearance of this symptom is based on the reverberation effect (Fig. 3).

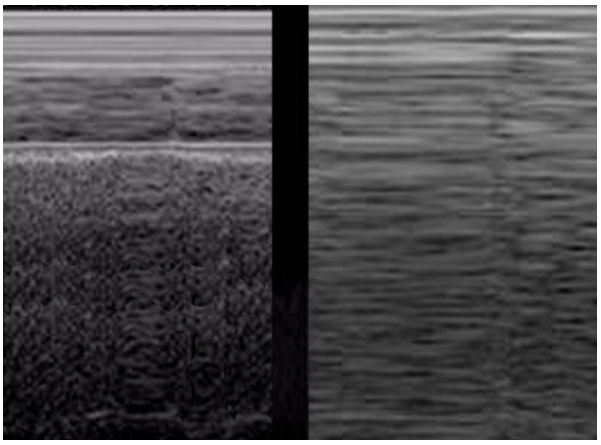

Fig. 3. Ultrasound diagnosis of pneumothorax in M-mode. On the left side of the echogram, the "sea shore" symptom is recorded in the form of granular inclusions, on the right side – the "bar code" symptom in the form of horizontally located linear inclusions, which is formed during inspiration due to the lack of sliding of the visceral pleura in the zone of pneumothorax

Table 2. Results of radiography and USG in the diagnosis of pleural effusion

Pleural effusion, diagnosed by CT (n=36)							
X-ray				USG			
Yes		No		Yes		No	
32		4		35		1	
TP	FN	TN	FP	TP	FN	TN	FP
29	3	3	1	34	1	1	0
Sensitivity		90,6%		Sensitivity		97,1%	
Specificity		75,0%		Specificity		100,0%	
Accuracy		88,9%		Accuracy		97,2%	

Note: TP – true positive, FN – false negative, TN – true negative, FP – false positive

Table 3. Results of radiography and USG in the diagnosis of fractured ribs

Fractured ribs, diagnosed by CT (n=34)							
X-ray				USG			
Yes		No		Yes		No	
33		1		31		3	
TP	FN	TN	FP	TP	FN	TN	FP
32	1	1	0	28	3	2	1
Sensitivity		97,0%		Sensitivity		90,3%	
Specificity		100,0%		Specificity		66,7%	
Accuracy		97,1%		Accuracy		88,2%	

Note: TP – true positive, FN – false negative, TN – true negative, FP – false positive

Table 2 presents the results of radiography and USG in the diagnosis of pleural effusion. In 29 cases, the X-ray results were true positive, in 3 cases false-negative, in 3 cases true-negative, in 1 case false-positive. The sensitivity of radiography was 90.6%, the specificity was 75.0%, and the accuracy was 88.9%. In 34 cases, the results of USG were TP, in 1 case FN, in 1 case TN. The sensitivity of USG was 97.1%, specificity – 100.0%, accuracy – 97.2%, respectively **(Table 2).**

Ultrasound examination allows to detect a minimal amount of effusion in the pleural sinus, which is not determined radiographically, especially in the supine position of the patient. Hemothorax differs from hydrothorax by the presence of hyperechoic inclusions (Fig. 4).

Table 3 presents the results of radiography and USG in diagnosing of rib fractures. In 32 cases, the X-ray results were true positive, in 1 case false-negative, in 1 case true-negative. The sensitivity of the method was 97.0%, specificity - 100.0%, accuracy - 97.1%. In 28 cases, the results of USG were true positive, in 3 cases false-negative, in 2 cases true-negative and in 1 case false-positive. The sensitivity of USG was 90.3%, specificity – 66.7%, accuracy – 88.2%, respectively **(Table 3).**

Fig. 4. A right-side hemothorax (arrow) in the pleural sinus is caused by blunt chest trauma

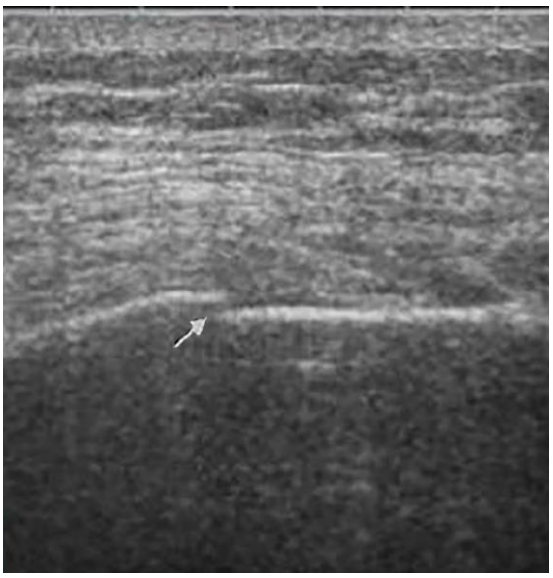

Fig. 5. Ultrasound visualization of a rib fracture in the form of interruption of its image and divergence of fragments (arrow)

Discussion. Considering that CT is currently the gold standard for diagnosing chest injuries, the results of radiography and ultrasonography are compared with tomography data [15]. Pneumothorax is recognized as the second leading cause of preventable death on the battlefield after blood loss [16]. According to Tran J. et al. (2021) thoracic trauma accounts for approximately 25% of all trauma-related mortality, and of these cases, almost 50% of patients experience pneumothorax [17].

A study by Y M. ousefifard et al (2016) showed that the sensitivity of ultrasound in diagnosing pneumothorax was 94%, and the specificity was 98% [18]. In our study, pneumothorax was diagnosed in 45 patients using CT. According to our data, the sensitivity of ultrasound in diagnosing pneumothorax was 89.7%, specificity 83.3%.

Ultrasound accurately detects minimal volumes of pleural effusion and fluid volumes up to 5 ml can be visualized, but a minimal volume of 20 ml is more reliably detected, and ultrasound is 100% sensitive for effusions >100 ml [19]. In our study, 36 patients had pleural effusions. In the diagnosis of pleural effusion, the sensitivity of ultrasound was 97.1% and the specificity was 100.0%.

Sabri Y.Y., et al. (2018) analyzed the results of ultrasound in 9 patients in whom CT was diagnosed with rib fractures. According to the authors, the accuracy of ultrasound was 88.9% [20]. We studied the results of ultrasound in 34 patients with rib fractures, and the accuracy of the method was 88.2%.

Ultrasound visualization of pericardial effusion in all 11 cases coincided with the results of computed tomography. The results of our studies once again confirm the high role of ultrasonography in assessing complications of blunt chest trauma and demonstrate sufficient sensitivity, specificity and accuracy in the diagnosis of pneumothorax and rib fractures. In addition, in identifying minimal pleural and pericardial effusions, the method is the most acceptable for both primary and final diagnosis.

Conclusions

1. Despite the limited use of ultrasonography in assessing complications of blunt chest trauma, the method has sufficient sensitivity, specificity and accuracy in the diagnosis of pneumothorax and rib fractures.
2. Ultrasonography is an accurate method for diagnosing pleural and pericardial effusion of any volume resulting from trauma.

Conflict of interest

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

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СРАВНИТЕЛЬНАЯ ОЦЕНКА РЕЗУЛЬТАТОВ РЕНТГЕНОГРАФИИ И УЛЬТРАСОНОГРАФИИ В ДИАГНОСТИКЕ БОЕВЫХ ТРАВМ ГРУДНОЙ КЛЕТКИ

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Резюме. В статье представлены результаты сравнительной оценки рентгенологического и ультразвукового исследования при диагностике ранений грудной клетки, полученных во время боевых действий у 94 больных. Показано, что пневмоторакс зарегистрирован у 45 (47,9%), плевральный выпот – у 36 (38,3%), перелом ребер – у 34 (36,2%), перикардиальный выпот – у 11 (11,7%) больных. Чувствительность ультразвукового исследования в диагностике пневмоторакса составила - 89,7%, специфичность – 83,3%, точность – 88,9%, при переломе ребер – 90,3%, 66,7% и 88,2%, соответственно.

По мнению авторов, в диагностике пневмоторакса и переломов ребер УЗИ обладает высокой чувствительностью, специфичностью и точностью. Ультразвуковое исследование является точным методом диагностики плеврального и перикардиального выпота любого объема, вызванного травмой.

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