

DOI: <https://doi.org/10.34921/amj.2025.2.019>

KİÇİK ÇANAQ ORQANLARININ ODLU SİLAHLA ZƏDƏLƏNMƏLƏRİNİN ŞÜA DİAQNOSTİKASI

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Məqalədə döyüş əməliyyatları zamanı çanaq orqanlarının zədələnmələrinin şüa diaqnostikası metodları vasitəsilə tədqiqinin nəticələri təqdim edilib. Tədqiqata 37 xəstə cəlb edilmiş və ümumilikdə 68 zədələnmə (14 sidik kisəsi, 9 düz bağırsaq, 28 yumşaq toxuma və 17 çanaq sümükləri) – 8 küt və 60 qəlpə yarası qeydə alınmışdır. Göstərilmişdir ki, qəlpə yarasına küt yaraya nisbətən statistik etibarlı olaraq daha çox rast gəlinmişdir.

Hemoperitoneum daxilə nüfuz edən çanaq zədələrinin, xüsusən də sidik kisəsinin yırtılmasının ən çox yayılmış dolaylı əlaməti olmuşdur. Qəlpələri aşkar etməkdə rentgenoqrafiya ultrasəsdən (94,9%-ə qarşı 89,5% həssaslıq və 93,0%-ə qarşı 86,0%) daha yaxşı nəticə göstərmiş və hemoperitoneumun aşkar edilməsində ultrasəs müayinəsinin həssaslığı (97,1%) və dəqiqliyi (94,9%) daha yüksək olmuşdur.

Açar sözlər: şüa diaqnostikası, döyüş travması, çanaq orqanlarının zədələnməsi

Key words: radiological diagnosis, combat trauma, pelvic organs injuries

Ключевые слова: лучевая диагностика, боевая травма, повреждение органов таза

RADIOLOGICAL DIAGNOSTICS OF INJURIES TO THE PELVIC ORGANS DURING GUNSHOT WOUNDS

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The article presents the results of a study of pelvic injuries during combat operations using radiological diagnostic methods. 37 patients were included in the study and a total of 68 injuries (14 bladder, 9 rectum, 28 soft tissue and 17 pelvic bones) were recorded - 8 blunt and 60 shrapnel wounds. It was shown that shrapnel wounds were statistically more common than blunt wounds.

Hemoperitoneum was the most common indirect sign of penetrating pelvic injuries, especially bladder rupture. X-ray had better performance than ultrasound (94,9% vs 89,5% sensitivity and 93,0% vs 86,0%) in detecting metal fragments, and ultrasound showed high sensitivity (97,1%) and accuracy (94,9%) in detecting hemoperitoneum.

Pelvic trauma is associated with a high degree of morbidity and mortality, primarily due to vascular injury [1]. The following management algorithm is proposed for the

patient with penetrating pelvic trauma: 1) if the results of the focused assessment with sonography in trauma (FAST) are negative, then immediate extraperitoneal pelvic packing (EPP)

is recommended while the patient is in the resuscitation unit; 2) if FAST is positive, the patient should be promptly moved to the operating room for emergency laparotomy and hemostasis [2].

Bladder injuries occur in approximately 4% of abdominal gunshot wounds. When there is a concern for urinary bladder injury in penetrating trauma, the patient should be further evaluated with CT cystography [3]. Findings at single-contrast CT include a wound track coursing near or through the bladder (direct sign) and unexplained free fluid in the pelvis, hemorrhage in the rectobladder space, and gross or microscopic hematuria, which are indirect signs [4].

As in other segments of the gastrointestinal tract, a projectile path through or adjacent to the rectum is the most sensitive direct sign of bowel injury. A focal wall defect is a highly specific but uncommon sign of rectal injury, while mural hematoma is a highly accurate sign of injury. Indirect signs include perirectal fat stranding and hematoma. When evaluating anorectal injury, it is important to remember that the distal third and posterior portion of the upper two-thirds of the rectum are extraperitoneal, while the anterior portion is intraperitoneal [5, 6].

A plain radiograph of the pelvis allows visualization of metallic foreign bodies, such as bullets and shell fragments. Performance of intra-rectal contrast CT scan is currently the "gold standard" for assessing PPT. It can identify trauma of all pelvic structures. A 95% sensitivity and > 96% specificity for rectal trauma has been reported by some authors. If there is any doubt regarding possible associated urinary tract injury, a cystogram and pelvic ultrasound are performed [7].

At CT, bladder injuries are classified into five types. A type 1 injury is a bladder contusion that is characterized by the thickening of the urinary bladder (UB) wall. A type 2 injury is an intraperitoneal bladder rupture where extraluminal contrast material from the UB can be seen outlining loops of the bowel. A type 3 injury is an interstitial bladder injury characterized by bladder wall thickening with intraluminal contrast material dissecting into the bladder wall without extension into the extraperitoneal or intraperitoneal spaces. Type 4 injury is an extraperitoneal bladder rupture. A

type 5 injury is a combined intraperitoneal and extraperitoneal rupture [8].

In a hemodynamically unstable patient, where a pelvic source of hemorrhage is clinically suspected it is reasonable to proceed directly to direct angiography. CT allows for comprehensive assessment of arterial and bony lesions. If this initial assessment reveals the presence of extra-intestinal pelvic arterial bleeding, first-line arteriography is required. In a hemodynamically stable patient three phase CT is a useful method for the detection of the site of hemorrhage. Arterial phase imaging is most likely to show a vascular blush or active hemorrhage and delayed phase imaging provides a second opportunity to demonstrate low flow hemorrhage or contrast pooling [9, 10].

The purpose of the study is a comparative assessment of the capabilities of radiological methods investigation in the diagnosis of injuries to the pelvic organs resulting from combat trauma.

Material and methods. The analysis of the results of ultrasonography and radiography in diagnosis of injury to the pelvic organs in 38 wounded during combat operations diagnosed by CT contrast was performed. The types of injury were established on the basis of CT-contrast, which is currently the main method of assessing injuries to the pelvic organs. The age of patients varied within 26-51 years (average 37 ± 6 years). Ultrasonography was performed on the RADMIR Ultima PA Expert ultrasound device using a convex sensor in the frequency mode of 2-5 MHz.

Statistical analysis was performed using the nonparametric Mann-Whitney method. If the p value <0.05, the difference between the compared groups was considered statistically significant. The sensitivity, specificity and accuracy of radiation research methods in the diagnosis of hemoperitenoum and shrapnels were determined.

Results. Among the 37 wounded, 68 injuries were recorded: of these, isolated damage to the urinary bladder – in 14 (20,6%), rectum – in 9 (13,3%), soft tissue – in 28 (41,2%), pelvic bones – 17 ($25,0 \pm 5,3\%$) cases. Bladder injuries were blunt in 2 ($2,9 \pm 2,0\%$) cases and penetrating in 12 ($17,7 \pm 4,6\%$) cases ($p < 0,01$); rectal injuries were blunt in 1 ($1,5 \pm 1,5\%$) case and penetrating in 8 ($11,8 \pm 3,9\%$) cases ($p < 0,05$); soft tissue injuries were blunt in 5 ($7,4 \pm 3,2\%$) cases and penetrating in 23 ($33,7 \pm 5,3\%$) cases ($p < 0,001$). Pelvic bone injuries were penetrating in all 17 ($25,0 \pm 5,3\%$) cases (Table 1).

Table 1. Distribution of cases of injury to the pelvic organs in blunt and penetrating combat trauma

Localization	Nature of injury (n = 68)		Total
	Blunt	Penetrating	
Urinary bladder	2 (2,9±2,0%)	12 (17,7±4,6%) P<0,01	14
Rectum	1 (1,5±1,5%)	8 (11,8±3,9%) P<0,05	9
Soft tissue	5 (7,4±3,2%)	23 (33,7±5,7%) P<0,001	28
Pelvic bones	-	17 (25,0±5,3%)	
Total	8 (11,8±3,9%)	60 (88,2±3,9%) P<0,001	68

Table 2 shows the frequency of detection of hemoperitoneum and shrapnels in injuries to various pelvic organs. As can be seen from the table, hemoperitoneum was recorded in 92.9±6.9% of cases with bladder injuries, 66.7±15.7% with rectum injuries, 32.1±8.8% with pelvic soft tissue injuries, and 64.7±11.6% with pelvic bone injuries. Fragments were detected in 85.7±9.4%, 55.6±16.7%, 89.3±5.8%, and 100.0% of cases, respectively. The table shows that hemoperitoneum was recorded statistically significantly more often in cases of bladder injury than in cases of soft tissue ($P_{1-3} < 0.001$) and pelvic bone injury ($P_{1-4} < 0.001$), and more often in cases of pelvic bone injury than in cases of pelvic soft tissue injury ($P_{4-3} < 0.05$). Bladder injuries were shrapnel-induced in 85.7±9.4% of cases, rectum

injuries in 55.6±16.7%, pelvic soft tissue injuries in 89.3±5.8%, and pelvic bone injuries in 100.0% of cases. Shrapnel was detected in 85.7±9.4%, 55.6±16.7%, 89.3±5.8%, and 100.0±5.9% of cases, respectively. A significant difference was found only between shrapnel wounds of the pelvic bones and rectum ($P_{4-2} < 0.05$). In soft tissue and bone injuries, shrapnels were recorded significantly more often than hemoperitoneum.

Hemoperitoneum was visualized as a hypoechoic heterogeneous mass on CT and ultrasound. When the bladder ruptures, local discontinuity of the wall image appears (Fig. 1). Metal shrapnel in all types of radiological diagnostics were defined as luminous inclusions with the dorsal track (Fig. 2).

Table 2. Types of radiological findings in bladder, rectum, pelvic soft tissue injury

Type injuries	Bladder wall n=14	Rectal wall n=9	Pelvic soft tissue n=28	Pelvic bones n=17
	1	2	3	4
Hemoperitoneum	13 (92,9±6,9%) $P_{1-3} < 0,001$ $P_{1-4} < 0,05$	6 (66,7±15,7%)	9 (32,1±8,8%)	11 (64,7±11,6%) $P_{4-3} < 0,05$
Shrapnels	12 (85,7±9,4%)	5 (55,6±16,7%)	25 (89,3±5,8%) $P^* < 0,001$	17 100,0% $P_{4-2} < 0,05$ $P^* < 0,01$

Note: P – difference between different pelvic organs in the frequency of hemoperitoneum and shrapnel; P* – difference between the frequency of hemoperitoneum and shrapnel in injuries to different pelvic organs.

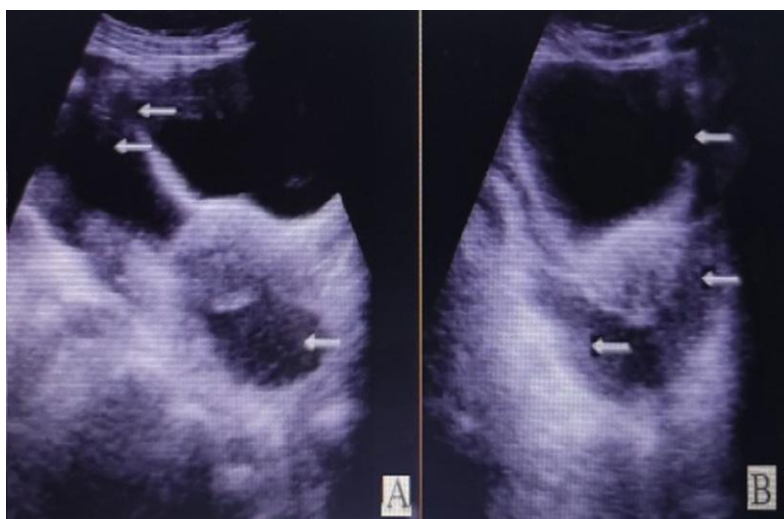


Fig. 1. **A.** Intraperitoneal rupture of the bladder (top arrow). Accumulation of blood in the abdominal cavity (middle arrow) and pelvis (lower arrow). **B.** Extraperitoneal rupture of the bladder (top arrow). Accumulation of blood in the pelvis (middle and lower arrows).

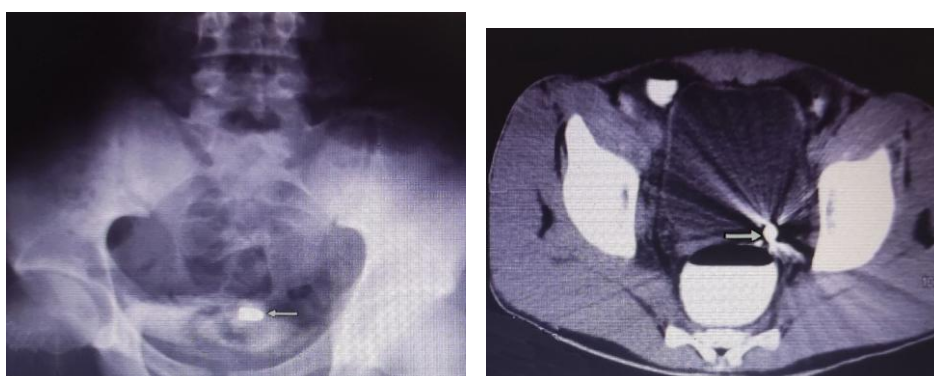


Fig. 2. Plain radiograph of the pelvis of a patient with a penetrating gunshot wound (arrow).

The path of the projectile through or near the rectum is the most sensitive direct sign of bowel injury. Indirect signs include disruption of the rectal contour and hematomas around it (Fig. 3).

Table 3 presents the results of X-ray and USG in the diagnosis of shrapnel, which was detected by CT. In 37 cases, the results of X-ray were true positive (TP), in 2 case false

negative (FN), in 3 cases true negative (TN), in 1 case false positive (FP). The sensitivity of radiography was 94,9%, the specificity was 75,0%, and the accuracy was 93,0%. In 34 cases, the results of USG were TP, in 4 cases FN, in 3 cases TN and in 2 cases FP. The sensitivity of USG was 89,5%, specificity – 60,0%, accuracy – 86.0%, respectively (Table 3).

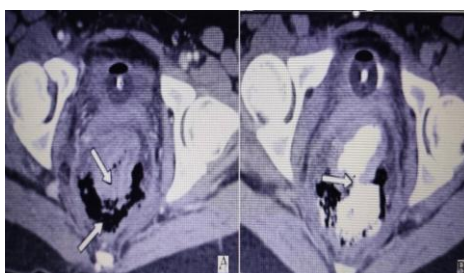


Fig. 3. Axial CT images with contrast enhancement of a patient with shrapnel wounds of the rectum. **A.** The upper arrow shows the area of the traumatic defect of the rectum, the lower arrow shows a local accumulation of free air. **B.** The arrow shows contrast leakage through the defect.

Table 3. Results of X-ray and USG in identifying of shrapnels

Shrapnels on the pelvic wall identifying by contrast-enhanced CT (n=43)							
X-ray				USG			
Yes		No		Yes		No	
39		4		38		5	
TP	FN	TN	FP	TP	FN	TN	FP
37	2	3	1	34	4	3	2
Sensitivity		94,9%		Sensitivity		89,5%	
Specificity		75,0%		Specificity		60,0%	
Accuracy		93,0%		Accuracy		86,0%	

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

Table 4 presents the results of USG in the diagnosis of hemoperitoneum, which was detected by CT. In 34 cases, the results of USG was true positive (TP), in 1 case false negative (FN), in 1 case true negative (TN) and in 1 case false positive (FP). The sensitivity of USG was 97,1%, the specificity was 75,0% and the accuracy was 94,9% (Table 4).

Table 4. Results of USG in identifying of hemoperitoneum

Hemoperitoneum identifying by contrast-enhanced CT (n=39)			
Yes		No	
35		4	
TP	FN	TN	FP
34	1	3	1
Sensitivity		97,1%	
Specificity		75,0%	
Accuracy		94,9%	

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

Discussion. Pelvic trauma is a injuries which may be incurred through many different etiologies, including low and high velocity penetrating trauma, and blunt injury. It is accepted that pelvic trauma is associated with a high degree of morbidity and mortality, primarily due to vascular injury [11]. Pelvic arterial injury may result from penetrating injuries such as gunshot wounds. Penetrating trauma is typically associated with mural laceration, complete or incomplete transection and arteriovenous fistula formation [12].

Among gunshot wounds of abdominal organs, in particular pelvic organs, the leading place is occupied by shrapnel. Radiological methods of examination are the main methods of diagnosing damage to various structures. Previous studies show that in identifying metal fragments, plain radiography has an

advantage over ultrasound [13]. According to our data, in detecting metal fragments, the sensitivity of radiography was 94.9%, specificity – 75.0%, accuracy – 93.0%, and ultrasound – 89.5%, 60.0%, accuracy – 86.0%, respectively.

It is known that detection of free fluid - blood in the abdominal cavity is an indirect sign of damage to internal organs, in particular the pelvic organs. In recent years, the FAST protocol has been actively used, which is carried out using ultrasound [2. Hornez E. 2016]. Hemoperitoneum is observed in all cases of rupture of the bladder wall, and is also often present in shrapnel wounds of the pelvic bones [14]. In our studies, the sensitivity of ultrasound in the diagnosis of hemoperitoneum was 97.1%, specificity 75.0% and accuracy 94.9%, which indicates

the high efficiency of the method.

Conclusion

1. Hemoperitoneum is one of the indirect signs of penetrating wounds of the pelvic organs and is most often recorded with a ruptured bladder.

2. Traditional radiography has an advantage over ultrasound in detecting metal fragments in gunshot wounds of the pelvic organs.

3. Ultrasound has high sensitivity and accuracy in detecting hemoperitoneum in gunshot wounds of the pelvic organs.

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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ЛУЧЕВАЯ ДИАГНОСТИКА ПОВРЕЖДЕНИЙ ОРГАНОВ МАЛОГО ТАЗА ПРИ ОГНЕСТРЕЛЬНЫХ РАНЕНИЯХ

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Резюме. В статье представлены результаты исследования повреждений таза в ходе боевых действий с использованием лучевых методов диагностики. В исследование было включено 37 пациентов, у которых в общей сложности зафиксировано 68 - 8 тупых и 60 осколочных ранений (14

мочевого пузыря, 9 прямой кишки, 28 мягких тканей и 17 костей таза). Показано, что осколочные ранения встречались статистически чаще ($p < 0,001$), чем тупые ранения.

Гемоперитонеум был наиболее частым косвенным признаком проникающих ранений органов малого таза, особенно разрыва мочевого пузыря. Традиционная рентгенография имела лучшие показатели перед ультразвуком в выявлении металлических осколков, а ультразвук показал высокую чувствительность и точность в выявлении гемоперитонеума.

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Təqdim edilmişdir: 07.02.2025

Qəbul edilmişdir: 02.06.2025