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ULTRASOUND EXAMINATION RESULTS IN CLOSED ABDOMINAL INJURIES

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ҚОРИН БЎШЛИҒИНИНГ ЁПИҚ ЖАРОҲАТЛАРИДА УЛЬТРАТОВУШ ТЕКШИРУВИ НАТИЖАЛАРИ

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РЕЗУЛЬТАТЫ УЛЬТРАЗВУКОВОГО ИССЛЕДОВАНИЯ ПРИ ЗАКРЫТЫХ ТРАВМАХ ЖИВОТА

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Резюме. *Қорин бўшлиғи аъзоларининг шикастланиш белгиларини аниқлашда ультратовуш текширувининг диагностик самарадорлигини ўрганиш ва қорин бўшлиғи ёпиқ шикастланишининг ултратовуш семиотикасини батафсил тавсифлаш. Қорин бўшлиғи жароҳатларида беморни клиникага ётқизилгандан сўнг дарҳол шошилинч ёрдам бўлимида амалга оширилди. Беморларни тадқиқотга киритишнинг асосий мезонлари 18 ёш ва ундан катта ёшдагилар, шунингдек, операция бошланишига қадар барқарор гемодинамик кўрсаткичларга (АД сист. ≥ 90 мм сим.уст) эга бўлган. ҚЁШ энг кенг тарқалган ультратовуш белгилари қорин бўшлиғида турли ҳажмдаги эркин суюқлик мавжудлиги ҳисобланади. Қорин бўшлиғидаги эркин суюқликни аниқлашда ультратовушнинг сезгирлиги ,ўзига хослиги ва аниқлиги анча юқори ва мос равишда 88,3, 87,8 ва 88,1% ни ташкил қилади. Энг юқори нисбий хавф (РР) қорин бўшлиғидаги 500 мл дан ортиқ суюқлик ҳажми учун характерлидир, бунда қорин бўшлиғи жиддий шикастланиш эҳтимоли (ТВР) 93,5%, нисбий хавф қиймати 4,862 бирликдир. (95% СИ 3,074-7,692).Суюқлик қатламининг қалинлиги ва унинг қорин бошлиғида тарқалишини ҳисобга олишга асосланган қорин бўшлиғидаги эркин суюқлик ҳажмини ва ультратовушли баҳолашнинг ишлаб чиқилган усули беморларга ёрдам кўрсатишни мураккаблаштирмайди ва вақтни узайтирмайди. FAST протоколи жараёни ва жарроҳлик даволаш тактикасини танлашда ҳал қилувчи аҳамиятга эга бўлган критик гемоперитонеум ҳажмларини аниқлашга имкон беради.*

Калит сўзлар: *Қорин ёпиқ шикасти, ултратовуш, лапароскопия.*

Abstract. *To study the diagnostic effectiveness of ultrasound in detecting signs of damage to the abdominal organs and to provide a detailed description of ultrasound semiotics of closed abdominal trauma).Ultrasound was performed in 160 patients with a closed abdominal injury as an initial method for diagnosing intra-abdominal injuries and was performed in the emergency department immediately upon admission of the patient to the clinic. The main criteria for inclusion of patients in the study were age 18 years and older, as well as stable hemodynamic parameters (AD sist. ≥ 90 mm Hg) by the time the surgery begins.Among the diverse sonographic semiotics of intra-abdominal injuries in PTA, the most common ultrasound signs are the presence of different volumes of free fluid in the abdominal cavity. The sensitivity, specificity and accuracy of ultrasound in detecting free fluid in the abdominal cavity is quite high and amounts to 88.3, 87.8 and 88.1%, respectively. The highest relative risk (RR) was typical for the volume of free fluid in the abdominal cavity of more than 500 ml, when the probability of serious intra-abdominal damage (EER) is 93.5%, the relative risk value is 4,862 units.. (95%CI 3,074-7,692).The developed method of ultrasound assessment and volume of free fluid in the abdominal cavity, based on taking into account the thickness of the fluid layer and its prevalence in the abdominal cavity, does not complicate or lengthen the FAST protocol procedure, and allows us to determine critical hemoperitoneum volumes that are crucial in choosing the tactics of surgical treatment of CAI.*

Key words. *Cloused abdominal trauma, ultrasound, laparoscopy.*

Introduction. Quantitative assessment of the volume of blood spilled and ultrasound identification of the severity of trauma to the internal organs of the abdominal cavity, mainly parenchymal organs, is of no small importance in choosing the tactics of surgical treatment of closed abdominal trauma (CAT). Today, in emergency surgery of abdominal injuries, the initial method of instrumental examination of the abdominal organs is ultrasound, which is aimed at improving the quality of care for victims by early detection of injuries, especially when these conditions are potentially life-threatening, and the outcome of surgical treatment depends on the time of its start. Given the importance of ultrasound in the diagnosis of intra-abdominal trauma complications and in performing a wide range of sonographically guided minimally invasive diagnostic and treatment procedures in a variety of emergency situations, the American College of Surgeons has included the use of the FAST protocol in providing assistance to trauma victims (Advanced Trauma Life Support - ATLS) in its extended protocol of training courses for emergency department doctors [1]. Moreover, the Agency for Healthcare Research and Quality (AHRQ) has included ultrasound-guided central vein catheterization in its clinical guidelines to increase the safety of the procedure [2]. Similarly, the American Society of Echocardiography (ASE), together with the American College of Emergency Physicians (ACEP), developed a protocol focused for focused cardiac ultrasound (FOCUS) examination of the heart ultrasound in emergency situations [3]. Protocols for examining organs that are traditionally considered to be poorly amenable to sonographic imaging (lungs, pancreas) are being actively developed.

Goal: To study the diagnostic effectiveness of sonography in detecting signs of damage to the abdominal organs and to describe in detail the ultrasound semiotics of HRT.

Material and methods: Ultrasound was performed in 160 patients with a closed abdominal injury as an initial method for diagnosing intra-abdominal injuries and was performed in the emergency department immediately upon admission of the patient to the clinic. In 26 (16.3%) cases, ultrasound was performed in dynamics. The main criteria for inclusion of patients in the study were age 18 years and older, as well as stable hemodynamic parameters (AP sist. ≥ 90 mm Hg) by the time the surgery begins.

Transabdominal ultrasound was performed using a Mindray DC-40 device (China) using a 3.5 MHz convex sensor and 5 MHz and 7.5 MHz linear sensors without prior preparation of the patient. To assess the significance of various values of hemoperitoneum volume (<300 ml, 300-500 ml, and >500 ml) in patients with PTA with stable hemodynamic parameters, their relative risk values (RR or RR, from the English "relative risk") were calculated in predicting severe intra-abdominal trauma complications. At the same time, the degree of statistically significant association of these 3 ranges of hemoperitoneum volume with the probability of detecting severe intra-abdominal injuries was ranked as: doubtful (RR=0-1, 0); probable (RR=1.0-3.0); absolute (RR>3.0).

Results and discussion. Our observations show that in patients with HRT, the sensitivity (Se), specificity (Sp), and accuracy (Ac) of ultrasound in detecting one of the main signs of trauma – free fluid (hemoperitoneum) in the abdominal cavity-is 88.3, 87.8, and 88.1%, respectively (tab. 1), which is not considered high enough by modern standards.

However, sonographic signs of free fluid in the abdominal cavity in patients with PTA can serve as a relatively reliable criterion that allows predicting the presence of intra-abdominal complications of trauma with a high degree of confidence, since the predictive value of a positive result (VPV) according to this criterion is 94.2% (table 1). However, it should be taken into account that the absence of pathological effusion in the abdominal cavity on ultrasound does not always exclude the presence of trauma to the abdominal organs and can not serve as a contraindication to surgical intervention. Thus, our calculations of the predictive value of a negative result (NPV) for the diagnostic feature "free fluid in the abdominal cavity" show a low value (76.8%) of this criterion in reliably excluding abdominal trauma.

When studying the expediency and effectiveness of using the sonographic criterion "presence of free fluid in the abdominal cavity" in determining the tactics of surgical treatment of patients with PTA, it became necessary to develop a method for measuring the volume of the hemoperitoneum.

Table 1. Informative value of ultrasound in detecting signs of HRT, n=160

Ultrasound sign	TP	FP	TN	FN	Se	Sp	Ac	VPV	NPV
Free fluid	98	6	43	13	88,3%	87,8%	88,1%	94,2%	76,8%

Note: TR – true positive results, FP – false positive results, TN – true negative results, FN – false negative results, Se-sensitivity(sensitivity), Sp-specificity(specificity), Ac-accuracy (test accuracy), VPV – predictive value of a positive result (positive predictive value), NPV – predictive value of the negative result (negative predictive value).

Table 2. Volume of intraoperatively determined blood in the abdominal cavity as a function of ultrasound data of layer width and free fluid prevalence, n=67

Free liquid layer width	1 region		2 regions		>3 regions	
	VSt.	liquid n	VSt.	liquid n	VSt.	liquid n
<1 cm	169,2±72,3	13	418,2±160,1	11	633,3±152,8	3
1-2 see	250,0±129,1	4	575,0±103,5	8	1233,3±111,8	9
2-3 cm	450.0±129.1	4	966,7±57,7	3	1740,0±207,4	5
3-4 see	600	1	1233,3±152,8	3	2500	1
>4 see	500	1	1600	1-0	-	0
Total	265,2±163,4	23	669,2±359,7	26	1144,4±608,0	18

Table 3. Scale of ultrasound assessment of hemoperitoneum volume in patients with abdominal trauma

Liquid layer width	1 area	2 areas	>3 areas
<1 cm	<200	300-500	500-1000
1-2 cm	200-300	300-500	1000-1500
2-3 cm	300-500	500-1000	1500-2000
3-4 cm	300-500	1000-1500	>2000
>4 cm	300-500	1500-2000	>2000

To solve this problem, we selected 67 patients with HRT, who evaluated the ratio of the hemoperitoneum volume assessed intraoperatively and the width and prevalence of free fluid in the abdominal cavity assessed by ultrasound (table 2).

Our calculations show that the presence of a thin (up to 1 cm) strip of free fluid within one anatomical area indicates the volume of the hemoperitoneum up to 200 ml. When up to 300 ml of blood accumulates in the abdominal cavity, the ultrasound picture is characterized by the presence of a layer of free fluid up to 2 cm wide within 1 anatomical region. A 300-500 ml hemoperitoneum is characterized by visualization of a strip of free fluid up to 2 cm thick, extending to 2 anatomical areas of the abdomen, or the presence of fluid within one area, but with a thickness exceeding 3 or more cm.

Ultrasound detection of free fluid in the abdominal cavity extending to 3 or more areas indicates the presence of a hemoperitoneum with a volume of more than 500 ml. The same blood volume is also indicated by the presence of free fluid with a layer thickness of more than 2 cm on ultrasound in 2 areas, or any accumulation of free fluid with a thickness of more than 3 cm (table 2).

The above calculations based on the comparison of the prevalence and thickness of sonographically detected free fluid with the volume of blood removed intraoperatively from the abdominal cavity made it possible to develop an "Ultrasound scale for assessing the volume of hemoperitoneum in patients with abdominal trauma" (table 3).

In order to assess the practical significance of preliminary measurement of the volume of free fluid in the abdominal cavity using ultrasound in patients with PTA, we decided to compare the volume of intraoperatively detected blood in the abdominal cavity (actual volume) with the nature and volume of surgical intervention performed (table 4). Thus, in 44 (28.4%) patients with the volume of free fluid in the abdominal cavity up to 300 ml, situations requiring mandatory wide laparotomy have almost never occurred. Moreover, with this amount of free fluid (<300 ml), in 20.5% of cases (n=9), surgeons deal with stopped intra-abdominal bleeding, and therefore the volume of surgical intervention is limited only to sanitation and drainage of the abdominal cavity.

Here we would like to point out as a discussion that today there are numerous experimental and clinical studies [4,5,6,5,6] that prove the possibility of spontaneous resorption of a sufficiently large volume of blood from the abdominal cavity, and there is a need for additional study of the feasibility of expanding and specifying indications for conservative treatment of PTA in patients with ultrasound or MSCT signs of a small volume of hemoperitoneum without clinical signs of ongoing internal bleeding.

Table 4. Comparison of the hemoperitoneum volume with the volume of surgical intervention performed, n=155

Type of intervention	<300 ml, n=44		300-500 ml, n=34		>500 ml, n=77	
	abs.	%	abs.	%	abs.	%
Sanitation and drainage of the abdominal cavity	9	20,5	1	2,9	-	0,0
Electrocoagulation of a bleeding vessel	23	52.3	6	17.6	3	3.9
Suturing of a rupture of the first stage according to Moore parenchymal organ	6	13.6	10	29.4	2	2.6
Suturing of deserotic sections of the intestine, ruptures of the mesentery and b. omentum	6	13,6	2	5,9	-	0,0
Suturing of rupture ≥II st. by Moore parenchymal organ	-	0,0	6	resection and removal -0.0 6 17.6	24	31.2
Organ resection and removal	-	0,0	7	20,6	44	57,1
Suturing the wall of the hollow organ	-	0,0	2	5,9	4	5,2

Note: the table does not include 5 (3.1%) patients out of 160 patients who did not have intraoperative damage to internal organs and hemoperitoneum.

Table 5. Relative risk value (RR) of severe intra-abdominal injuries at different volumes of free fluid in the abdominal cavity

Indicator	Hemoperitoneum volume, ml		
	<300	300-500	>500
Absolute risk in the presence of factor (EER)	0.000.000	0.441	0.935
Absolute risk in the absence of factor (CER)	0.935.935	0.935	0.192
Relative risk (RR)	0.000	0.472	4.862
Standard error of relative risk (S)	∞	0.195	0.234
Lower bound 95% CI	0.000	0.322	3.074
Upper bound 95% CI	NaN	0.692	7.692
Sensitivity (Se)	0.000	0.172	0.828
Specificity (Sp)	0.102	0.208	0.926

Moreover, our observations on the management of patients with the volume of free fluid in the abdominal cavity less than 300 ml (n=44) show that with this volume of hydroperitoneum in patients with PTA, there are practically no cases of damage to the hollow organs of the abdominal cavity.

In cases where the volume of intra-abdominal blood loss is 300-500 ml (n=34) in more than half of the patients (19; 55.9%), intraoperatively performed surgical manipulations and procedures, such as sanitation and drainage of the abdominal cavity, electrocoagulation of a bleeding vessel, suturing of a rupture of the first stage according to Moore parenchymal organ, suturing of desortized intestinal areas, ruptures of the mesentery and greater omentum, can be performed without any special technical difficulties with the help of laparoscopic techniques using routinely used instruments without the use of expensive consumables. And taking into account the above 44 patients, in whom the hemoperitoneum volume did not exceed 300 ml, the proportion of patients potentially subject to correction of intra-abdominal trauma complications by laparoscopic method without the use of wide laparotomy increases to 80.8% (63 patients out of 78) (table 5).

In the presence of more than 500 ml of blood in the abdominal cavity (n=77), the possibilities for using laparoscopic techniques were extremely limited and occurred only in 5 (6.5%) patients (table 4).

Our calculations show that the presence of ultrasound blood volume in the abdominal cavity up to 300 ml is highly likely to exclude (RR=0.000) the presence of serious intra-abdominal injuries requiring extensive laparotomy. When the volume of free fluid is in the range of 300-500 ml, the indicator "absolute risk of significant damage to the abdominal cavity" is 44.1% (EER=0.441), and the relative risk (RR) is 0.472 units (doubtful sign). The highest relative risk score (RR) was found for the volume of free fluid in the abdominal cavity greater than 500 ml, when the probability of serious intra-abdominal damage (EER) is 93.5,%, and the relative risk value is absolute and is 4,862 units with a 95% CI ranging from 3,074 to 7,692 units.

Conclusion. Among the diverse sonographic semiotics of intra-abdominal injuries in PTA, the most common ultrasound signs are the presence of different volumes of free fluid in the abdominal cavity. The sensitivity, specificity and accuracy of ultrasound in detecting free fluid in the abdominal cavity is quite high and amounts to 88.3, 87.8 and 88.1%, respectively. The proposed approach to ultrasound assessment of discrete volumes of free fluid in the abdominal cavity, based on taking into account the thickness of the fluid layer and its prevalence in the abdominal cavity, does not complicate or lengthen the FAST protocol procedure, and allows us to determine critical hemoperitoneum volumes that are crucial in choosing the tactics of surgical treatment of PTA.

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РЕЗУЛЬТАТЫ УЛЬТРАЗВУКОВОГО ИССЛЕДОВАНИЯ ПРИ ЗАКРЫТЫХ ТРАВМАХ ЖИВОТА

Элмурадов Г.К., Хурсанов Ё.Э., Шукуров Б.И., Пулатов М.М.

Резюме. *Цель: изучить диагностическую эффективность УЗИ в выявлении признаков повреждения органов брюшной полости и дать развернутую характеристику ультразвуковой семиотики закрытой травмы живота). Ультразвуковое исследование выполнено у 160 пострадавших с закрытой травмой живота как начальный метод диагностики. внутрибрюшных ранений и выполнялась в приемном покое сразу при поступлении больного в клинику. Основными критериями включения пациентов в исследование были возраст 18 лет и старше, а также стабильные показатели гемодинамики (АД сист. ≥ 90 мм рт. ст.) к моменту начала операции. Среди разнообразной эхографической семиотики внутрибрюшных повреждений в ЗТЖ наиболее частыми ультразвуковыми признаками являются наличие разного объема свободной жидкости в брюшной полости. Чувствительность, специфичность и точность УЗИ при выявлении свободной жидкости в брюшной полости достаточно высоки и составляют 88,3, 87,8 и 88,1% соответственно. Наибольший относительный риск (ОР) был характерен для объема свободной жидкости в брюшной полости более 500 мл, когда вероятность серьезного внутрибрюшного повреждения (ТВР) составляет 93,5%, величина относительного риска составляет 4,862 ед. (95%ДИ 3,074-7,692). Разработанный метод ультразвуковой оценки и объема свободной жидкости в брюшной полости, основанный на учете толщины слоя жидкости и ее распространенности в брюшной полости, не усложняет и не удлиняет протокол FAST, и позволяет определить критические объемы гемоперитонеума, что имеет решающее значение при выборе тактики хирургического лечения ЗТЖ.*

Ключевые слова: *закрытая травма живота, УЗИ, лапароскопия.*