

POSSIBILITIES OF MINIMALLY INVASIVE METHODS OF DIAGNOSIS AND TREATMENT FOR CLOSED ABDOMINAL INJURIES

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Abstract

In this article, the study of the diagnostic effectiveness of ultrasound examination (ultrasound) in identifying signs of damage to the abdominal organs and a detailed description of the ultrasound semiotics of closed abdominal trauma (CAT).

Purpose. The study of the diagnostic effectiveness of sonography in identifying signs of damage to the abdominal cavity organs and a detailed description of the ultrasound semiotics of CAT.

Material and methods. Ultrasound was performed in 160 patients with blunt abdominal trauma as an initial method for diagnosing intra-abdominal injuries and was performed in the emergency department immediately upon admission to the clinic.

Conclusion. Among the diverse sonographic semiotics of intraperitoneal injuries in CAT, the presence of various volumes of free fluid in the abdominal cavity is the most constant ultrasound signs. The developed method of ultrasound assessment of the 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 zones, does not complicate or lengthen the FAST protocol procedure, allows to determine the critical volumes of hemoperitoneum, which are crucial in choosing the tactics of surgical treatment of CAT.

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Conflict of interest

The authors declare that they have
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Жабық абдоминальды жарақаттарды анықтау және емдеудің аз инвазивті әдістері

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Аңдатпа

Бұл мақалада біз құрсақ қуысы мүшелерінің зақымдану белгілерін анықтаудағы ультрадыбыстық зерттеудің (УДЗ) диагностикалық тиімділігін және іштің жабық жарақатының (ІЖЖ) ультрадыбыстық семиотикасының толық сипаттамасын зерттедік.

Мақсаты. Құрсақ қуысы мүшелерінің зақымдану белгілерін анықтауда сонографияның диагностикалық тиімділігін зерттеу және ІЖЖ ультрадыбыстық семиотикасының егжей-тегжейлі сипаттамасы.

Материал және әдістер. Құрсақішілік жарақаттарды диагностикалаудың бастапқы әдісі ретінде құрсақ қуысының доғалы жарақаты бар 160 науқасқа емханаға түскеннен кейін бірден жедел жәрдем бөлімінде ультрадыбыстық зерттеу жүргізілді.

Қорытынды. Құрсақ қуысындағы бос сұйықтықтың көлемін ультрадыбыстық бағалаудың әзірленген әдісі, сұйықтық қабатының қалыңдығына және оның құрсақ қуысы аймақтарында таралуына негізделген, FAST хаттамасының процедурасын қиындатпайды немесе ұзартпайды және мүмкіндік береді. Қуық асты безінің қатерлі ісігін хирургиялық емдеу тактикасын таңдауда шешуші маңызы бар гемоперитонеумның критикалық көлемін анықтау.

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Миниинвазивные методы диагностики и лечения при закрытых травмах живота

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Аннотация

В данной статье изучены диагностической эффективности ультразвукового исследования (УЗИ) в выявлении признаков повреждения органов брюшной полости и подробному описанию ультразвуковой семиотики закрытой травмы живота (ЗТЖ).

Цель. Изучение диагностической эффективности сонографии в выявлении признаков поражения органов брюшной полости и подробное описание ультразвуковой семиотики ЗТЖ.

Материал и методы. УЗИ выполнено 160 больным с ЗТЖ в качестве инициального метода диагностики внутрибрюшных повреждений и выполнялось в при поступлении пациента в клинику.

Заключение. Среди разнообразной сонографической семиотики внутрибрюшных повреждений при ЗТЖ наиболее постоянным УЗ-признаком является наличие различного объема свободной жидкости в брюшной полости. Разработанный метод ультразвуковой оценки объема свободной жидкости в брюшной полости, основанный на учете толщины слоя жидкости и ее распространенности в зонах брюшной полости, не усложняет и не удлинняет процедуру FAST-протокола, позволяет определить критические объемы гемоперитонеума, имеющие решающее значение в выборе тактики хирургического лечения ЗТЖ.

Ключевые слова:
закрытая травма живота,
ультразвуковое исследование,
лапароскопия

Introduction

In choosing the tactics of surgical treatment of blunt abdominal trauma (BAT), the quantitative assessment of the volume of outflowing blood and ultrasound identification of the severity of injury to the internal organs of the abdominal cavity, mainly parenchymal organs, are of no small importance. Today, in emergency surgery of abdominal injuries, the initial methods 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 initiation. Given the importance of ultrasonography in diagnosing intra-abdominal complications of trauma and in performing a wide range of minimally invasive sonographically guided diagnostic and treatment procedures in a variety of emergencies, the American College of Surgeons has included in its expanded training protocol for emergency medicine physicians the use of the FAST protocol in providing care for patients with trauma (Advanced Trauma Life Support – ATLS) [1]. Moreover, the Agency for Healthcare Research and Quality (AHRQ) has included ultrasound-guided central venous catheterization in its clinical guidelines to increase the safety of the procedure [2]. Similarly, the American Society of Echocardiography (ASE), in collaboration with the American College of Emergency Physicians (ACEP), has developed a focused cardiac ultrasound (FOCUS) protocol for emergencies [3]. Protocols for the examination of organs that are traditionally considered poor-

ly amenable to sonographic imaging (lungs, pancreas) are being actively developed.

Purpose

The study of the diagnostic effectiveness of sonography in identifying signs of damage to the abdominal cavity organs and a detailed description of the ultrasound semiotics of BAT.

Material and methods

Ultrasound was performed in 160 patients with blunt abdominal trauma as an initial method for diagnosing intra-abdominal injuries and was performed in the emergency department immediately upon admission to the clinic. In 26 (16.3%) cases, ultrasound was performed in dynamics. The main inclusion criteria for patients in the study were age 18 and older, as well as stable hemodynamic parameters (BP \geq 90 mm Hg) at the time of the start of surgery.

Transabdominal ultrasound was performed using the Mindray DC-40 device (China) using a 3.5 MHz convex probe and 5 MHz and 7.5 MHz linear probes without prior patient preparation.

In order to assess the significance of various values of hemoperitoneum volume (<300 ml, 300-500 ml and >500 ml) in patients with BAT with stable hemodynamic parameters, the values of their relative risk (RR) were calculated in prediction of severe intra-abdominal complications of trauma. 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 were 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 BAT, the sensitivity (Se), specificity (Sp) and accuracy (Ac) of ultrasound in detecting one of the main signs of

injury - free fluid (hemoperitoneum) in the abdominal cavity - is, respectively, 88.3, 87.8 and 88.1% (Table 1), which by modern standards is not considered a sufficiently high figure.

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

Note: TP - 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 - negative predictive value.

However, sonographic signs of free fluid in the abdominal cavity in patients with BAT 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 positive predictive value (VPV) for this criterion is 94.2% (Table 1). At the same time, it should be borne in mind that the absence of pathological effusion in the abdominal cavity on ultrasound does not always exclude the presence of an injury to the abdominal organs and cannot serve as a contraindication to surgical intervention. Thus, our calculations of the negative predictive value (NPV) for the diagnostic sign "free fluid in the abdominal cavity"

show a low value (76.8%) of this criterion in a significant exclusion of abdominal trauma.

When studying the feasibility 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 BAT, it became necessary to develop a method for measuring the volume of hemoperitoneum. In order to solve this problem, 67 patients with BAT were selected, in whom the ratio of the volume of hemoperitoneum, assessed intraoperatively, and the width and extent of free fluid in the abdominal cavity, assessed by ultrasound was assessed (Table 2).

Free liquid layer width	1 region		2 region		>3 region	
	free liquid V	n	free liquid V	n	free liquid V	n
<1 cm	169,2±72,3	13	418,2±160,1	11	633,3±152,8	3
1-2 cm	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 cm	600	1	1233,3±152,8	3	2500	1
>4 cm	500	1	1600	1	-	0
Total	265,2±163,4	23	669,2±359,7	26	1144,4±608,0	18

Our calculations show that the presence of a thin (up to 1 cm) strip of free fluid within one anatomical region indicates a hemoperitoneum volume of up to 200 ml. With the accumulation of up to 300 ml of blood 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. For hemoperitoneum with a volume of 300-500 ml, visualization of a strip of free fluid up to 2 cm thick is typical, extending to 2 anatomical regions of the abdomen, or the presence of fluid within one area, but with a thickness exceeding 3 cm or more. Detection on ultrasound of free fluid in the abdominal cavity, extending to 3 or more areas

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

The above calculations comparing the prevalence and thickness of the sonographically detected free fluid with the volume of intraoperative blood removed from the abdominal cavity made it possible to develop the «Scale for ultrasound assessment of hemoperitoneum volume in patients with abdominal trauma» (Table 3).

Liquid layer width	1 region	2 region	>3 region
<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

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 BAT,

we decided to compare the volume of intraoperatively detected blood in the abdominal cavity (actual volume) with the nature and extent of the surgical intervention

Table 1. Informativeness of ultrasound in detecting signs of BAT, n=160

Table 2. The volume of intraoperatively determined blood in the abdominal cavity depending on the ultrasound data of the layer width and the prevalence of free fluid, n=67

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

performed (Table 4). Thus, in 44 (28.4%) patients with a free fluid volume in the abdominal cavity up to 300 ml, situations almost never occurred that required a mandatory wide laparotomy. 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 debridement and drainage of the abdominal cavity.

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

Intervention type	<300 мл, n=44		300-500 мл, n=34		>500 мл, 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
Sewing up the gap I st. according to Moore parenchymal organ	6	13,6	10	29,4	2	2,6
Suturing of desorized sections of the intestine, ruptures of the mesentery and b. omentum	6	13,6	2	5,9	-	0,0
Sewing up the gap ≥II st. according to Moore parenchymal organ	-	0,0	6	17,6	24	31,2
Resection and removal of the organ	-	0,0	7	20,6	44	57,1
Suturing the wall of a hollow organ	-	0,0	2	5,9	4	5,2

Note: the table does not include 5 (3.1%) patients out of 160 patients in whom damage to internal organs and hemoperitoneum were not detected intraoperatively.

Here we would like to point out as a discussion that today there are numerous experimental and clinical studies [4-10], proving the possibility of spontaneous resorption of a sufficiently large volume of blood from the abdominal cavity, there is a need for additional study of the feasibility of expanding and concretizing the indications to conservative treatment of BAT in patients with ultrasound or MSCT with signs of a small volume of hemoperitoneum without clinical signs of ongoing internal bleeding. Moreover, our observations on the management of patients with a volume of free fluid in the abdominal cavity less than 300 ml (n=44) show that with this volume of hydroperitoneum in patients with BAT, 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), more than half of the patients (19; 55.9%) underwent intraoperative surgical manipulations and procedures, such as debridement and drainage of the abdominal cavity, electrocoagulation of a bleeding vessel, suturing the gap I st. according to Moore of the parenchymal organ, suturing of the desorized sections of the intestine, ruptures of the mesentery and the greater omentum, without any special technical difficulties, can be performed using the laparoscopic technique using routinely used instru-

ments without the use of expensive consumables. And taking into account the above 44 patients in whom the volume of hemoperitoneum did not exceed 300 ml, the proportion of patients potentially subject to elimination of intra-abdominal complications of trauma by laparoscopic method without the use of a wide laparotomy increases to 80.8% (63 patients out of 78) (Table 4).

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

Our calculations show that the presence of up to 300 ml of blood in the abdominal cavity on ultrasound excludes with a high probability (RR=0.000) the presence of serious intra-abdominal injuries requiring a wide laparotomy. With a free fluid volume in the range of 300-500 ml, the "absolute risk of having significant damage to the abdominal organs" is 44.1% (EER = 0.441), and the relative risk (RR) is 0.472 units (doubtful sign). The highest relative risk (RR) was associated with a free fluid volume in the abdominal cavity of more than 500 ml, when the probability of having a serious intra-abdominal injury (EER) is 93.5%, and the relative risk seems to be absolute and is 4.862 units with 95% CI in the range from 3.074 to 7.692 units (Table 5).

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

Index	Hemoperitoneum volume, мл		
	<300	300-500	>500
Absolute risk in the presence of a factor (EER)	0.000	0,441	0.935
Absolute risk in the absence of a factor (CER)	0.935	0,935	0.192
Relative risk (RR)	0.000	0,472	4.862
Relative risk standard error (S)	∞	0,195	0.234
Lower limit 95% CI (CI)	0.000	0,322	3.074
Upper limit 95% CI (CI)	NaN	0,692	7.692
Sensitivity (Se)	0.000	0,172	0.828
Specificity (Sp)	0.102	0,208	0.926

Conclusion

Among the various sonographic semiotics of intra-abdominal lesions in BAT, the most constant ultrasound signs are the presence of various volumes of free fluid in the abdominal cavity. The sensitivity, specificity and accuracy of ultrasound in detecting free fluid in the abdominal cavity seems to be quite high and amount to 88.3, 87.8 and 88.1%, respectively. The

proposed approach to the ultrasound assessment of discrete volumes of free fluid in the abdominal cavity, based on the thickness of the fluid layer and its prevalence in the abdominal cavity, does not complicate or lengthen the FAST protocol procedure, and allows determining the critical volumes of hemoperitoneum, which are crucial in the choice of surgical tactics. treatment of BAT.

References

1. Abraham R., Vyas D., Narayan M., Vyas A. Strategically Leapfrogging Education in Prehospital Trauma Management: Four-Tiered Training Protocols. //Am J Robot Surg. – 2015. – T. 2. – № 1. – В C. 9-15. doi:10.1166/ajrs.2015.1022
2. Buchanan M.S., Backlund B., Liao M.M., Sun J., Cydulka R.K., Smith-Coggins R., Kendall J. Use of Ultrasound Guidance for Central Venous Catheter Placement: Survey From the American Board of Emergency Medicine Longitudinal Study of Emergency Physicians. //Academic Emergency Medicine. – 2014. – T. 21. – № 4. – С. 416–421.
3. Spencer K.T., Kimura B.J., Korcarz C.E., Pellikka P.A., Rahko P.S., Siegel R.J. Focused cardiac ultrasound: recommendations from the American Society of Echocardiography. //J Am Soc Echocardiogr. – 2013. – T. 26. – № 6. – С. 567–581.
4. Aleksandrov V.V., Maskin S.S., Ermolaeva N.K., Matyukhin V.V. Conservative management of patients with closed trauma of the parenchymal organs of the abdominal cavity and retroperitoneal space, with retroperitoneal hemorrhages - indications, methodology and expediency [Konservativnoe vedenie pacientov s zakrytoj travmoj parenhimatoznyh organov brjushnoj polosti i zabrjushinnogo prostranstva, s zabrjushinnymi krovoizlijanijami – pokazanija, metodika i celesoobraznost']// Russian Sklifosovsky Journal of "Emergency Medical Care". 2021;10(3):540–548. <https://doi.org/10.23934/2223-9022-2021-10-3-540-548>
5. Khadzhibaev F.A., Shukurov B.I., Elmuradov G.K. et al. Possibilities of ultrasound in assessing the nature and severity of closed abdominal trauma [Vozmozhnosti ul'trazvukovogo issledovanija v ocenke haraktera i tjazhesti zakrytoj travmy zhivota]// Bulletin of emergency medicine. - 2021. - T. 14. - No. 6. - S. 14-19.
6. Scarborough JE, Ingraham AM, Liepert AE, Jung HS, O'Rourke AP, Agarwal SK. Nonoperative management is as effective as immediate splenectomy for adult patients with high-grade blunt splenic injury. J Am Coll Surg 2016;223:249–58.
7. Goedecke M, Kühn F, Stratos I, Vasani R, Pertschy A, Klar E. No need for surgery? Patterns and outcomes of blunt abdominal trauma. Innv Surg Sci. 2019;4(3):100-107. doi:10.1515/iss-2018-0004.
8. Shojaei M., Faridaalaei G., Yuseffard M. New scoring system for intra-abdominal injury diagnosis after blunt trauma. Chin. J. of Traum. 2014;17(1):19–24.
9. Henneberry R.J., Hanson A., Healey A., Hebert G., Ip U., Mensour M., CAEP Ultrasound Position Statement Working Group. Use of point of care sonography by emergency physicians. Canadian Journal of Emergency Medicine. 2012;14(2):106-112.
10. Atkinson P., Bowra J., Lambert M., Lamprecht H., Noble V., Jarman B. International Federation for Emergency Medicine point of care ultrasound curriculum. Canadian Journal of Emergency Medicine. 2015;17(2):161-170.