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Features of Diagnostics and Surgical Treatment of Closed Abdominal Injuries (Literature Review)

A. M. Khadjibaev, M. M. Pulatov, B. I. Shukurov, Z. B. Muzaffarov

Republican Research Centre of Emergency Medicine, Tashkent, Uzbekistan

Abstract The FAST protocol is a standard initial ultrasound screening of patients with abdominal and thoracic injuries, a means of rapid triage of patients, helps to determine the tactics of treatment. MSCT is the gold standard in the diagnosis of abdominal injuries, but the method also has a number of disadvantages, such as the high cost of the study, the impossibility of performing the study at the patient's bedside, and the presence of radiation exposure. Non-surgical treatment of patients with abdominal trauma under the condition of stable hemodynamics is becoming more widespread all over the world and shows high efficiency. However, there is a fairly wide list of unresolved issues in the use of surgical tactics that require study and consensus. Surgeons increasingly use laparoscopy for various urgent surgical diseases of the abdominal cavity, including abdominal injuries. Due to the lack of the necessary randomized controlled trials, the level of evidence for recommendations on the use of endovideosurgical techniques in patients with abdominal trauma is ranked as "weak" in the current clinical protocols.

Keywords Closed abdominal injury, Diagnostics, FAST, MSCT, Treatment, Non-surgical treatment, Laparoscopy

Closed abdominal injury (CAI) still retains a high medical and social significance. Injuries, according to research data of the World Health Organization (WHO), conducted jointly with the Harvard Center for Medical Research, is considered as the main death cause of people under the age of 40, ahead of the usual cardiovascular and oncological diseases [1-2]. In injury statistics, abdominal injuries range from 3.6 to 18.8% and represent one of the most severe categories among surgical patients [3].

Diagnosis of abdominal injuries should be quick and accurate, as the time factor can be crucial. Early diagnostics and treatment can reduce mortality up to 50% [4]. Errors or delayed diagnosis can lead to the death of the victim from bleeding or sepsis. At the same time, aggressive tactics aimed at surgical treatment leads to a large number of unnecessary laparotomies, the percentage of which varies from 1.7 to 38% in different clinics, leading to an increase in complications, lengthening of hospital stays and an increase in the cost of treatment [5]. Today, the methods of radiation diagnostics occupy one of the leading places in the diagnosis of abdominal injuries.

In many Western countries, the use of ultrasound has been an indispensable and routine practice in emergency medicine for a long time [6]. Point of Care Ultrasound (POCUS) is considered a basic practical skill for emergency physicians nowadays [7]. In the USA, such a curriculum is included among the mandatory, basic skills of doctors in the specialties of family medicine, internal medicine, military therapy, emergency medicine and intensive care [8].

Taking into account the diagnostic capabilities of ultrasound diagnostic methods, in 1996 Rozycki et al. introduced the term "Focused Assessment with Sonography in Trauma" (FAST) [9]. Today, Focused Assessment with Sonography in Trauma is a standard initial ultrasound screening study performed "at the patient's bedside" and is aimed at quickly searching for free fluid in the abdominal, pleural and pericardial cavities, as well as pneumothorax [10,11]. FAST-study is an important means of rapid triage of patients with unstable hemodynamics, it helps to determine the tactics of managing a patient with an injury at the same time.

Today, the FAST protocol is included in the ATLS (Advanced Trauma Life Support) clinical guidelines as a mandatory initial diagnostic study for patients with severe trauma. Numerous publications show that the use of the FAST protocol helps to reduce the time of preoperative diagnosis by 64-76%, allows obtaining objective data to substantiate indications for emergency surgical intervention without the need for computed tomography (CT), reducing the incidence of complications and reducing the duration of inpatient treatment [12].

The specificity of FAST-examination ranges from 98 to 100% [13], and the overall accuracy of the method is in the range from 98 to 99% in detecting free fluid in the pleural cavity and pericardium [14]. Since the FAST protocol is a non-invasive method, it does not involve the introduction of a contrast agent and irradiation of the patient and medical

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personnel, it is a safe method for repeated use even in children and pregnant women, significantly reduces the time for diagnosing signs of internal organs injury, allows examining severe patients directly at the bedside. The method has gained wide popularity in emergency surgery of internal injuries of the chest and abdomen.

At the same time, despite all the above advantages, the FAST protocol has some errors, such as the difficulty of differential diagnostics of hemoperitoneum from ascites, low information content in the visualization of retroperitoneal hematomas and damage to the parenchyma itself and the walls of internal organs, operator-dependence of the examination results, the presence of certain difficulties in examining patients with obesity, in the presence of severe subcutaneous emphysema and intestinal pneumatosis [15].

Engles S. et al., confirming the high specificity of sonography, note that in all patients who underwent emergency diagnostic laparotomy / laparoscopy only on the basis of a positive FAST result, always found a significant amount of blood and injuries of parenchymal organs in the abdominal cavity (true positive result) [16]. However, in cases where ultrasound did not reveal signs of hemoperitoneum, a false negative result was often stated. The authors themselves suggest that the main reason for the false negative results of FAST was the ultrasound after catheterization and emptying of the bladder, which reduces the visualization of the pelvic cavity, where free fluid is often accumulated. The same reason for the false negative sonography results is indicated by McGahan et al., who, when comparing FAST results with MSCT, noted a false negative ultrasound result in 14 cases, including 6 of them on MSCT free fluid was detected in the pelvis, which was not detected with FAST due to the absence of urine in the bladder. Therefore, some authors emphasize the need for FAST against the background of a filled bladder [17].

Some researchers have revealed the dependence of the informative value of ultrasound on the hemodynamic parameters of the patient. So, in the study of Engles S. et al. in patients with low blood pressure, the sensitivity, specificity, prognostic value of positive and negative results and the overall accuracy of the method were 64.2, 85, 85.7, 62.9 and 72.9%, respectively [18]. Approximately the same results were obtained by Lee B.C. et al., who had performed ultrasound for 4,029 victims with abdominal trauma for 6 years. 122 (3.0%) of them had a hypotensive condition at admission to the clinic and in whom abdominal ultrasound had sensitivity of 85%, specificity of 60% and overall accuracy of 77% [19].

In addition, ultrasound has a low sensitivity, not exceeding 41%, in detecting injuries of the abdominal cavity parenchymal organs, pancreas, retroperitoneum, diaphragm. The diagnostic capabilities of the method in detecting the rupture of hollow organs are extremely low [20].

According to various authors, multislice computed tomography (MSCT) is the most informative method to clarify the state of the organs and structures of the abdominal cavity and retroperitoneal space [21]. The use of MSCT is justified by a number of obvious advantages: the possibility of obtaining a clear layered image of an organ with almost complete anatomical correspondence; high resolution, which allows detecting sufficiently small contrast formations and minor differences in the physical, anatomical properties of tissues and organs; non-invasiveness. The diagnostic accuracy of the method increases with intravenous contrast of parenchymal organs, which allows to obtain significant information for therapeutic tactics in case of abdominal trauma on the topography and degree of organ rupture, to monitor post-traumatic intra- and para-organ changes, especially in conditions of conservative and endosurgical treatment tactics [22].

The detection of hemoperitoneum at a closed abdominal injury is of fundamental importance, as it is an indicator of the life-threatening consequences of injury. MSCT has high sensitivity and specificity in detecting free fluid. At a liquid volume of up to 500 ml, the sensitivity of MSCT is 76%, specificity is 72%, from 500 to 1000 ml – 89 and 86%, more than 1000 ml – 98 and 96%, respectively [23].

The spleen is injured in 28.5% of abdominal trauma cases [3]. Taking into account its role in the immune functions of the body, the high risk of infectious complications at asplenia, the "gold standard" is the rejection from splenectomy. Currently, the percentage of non-surgical treatment of patients in some clinics reaches 80-90%, so it is very important to accurately identify the spleen injury. The sensitivity of contrast-enhanced MSCT in diagnosing spleen injury reaches 98.5%, while non-contrast CT in intra-parenchymal hemorrhages has low sensitivity and specificity [24].

Liver injuries in abdominal trauma occurs in 31.6% of cases. As well as spleen injuries, most liver injuries are currently treated conservatively, and only 15% of victims with unstable hemodynamics or ineffective conservative treatment require surgery [25]. Timely and accurate diagnostics and characterization of liver injuries are very important for determining the tactics of patient management. The sensitivity of MSCT in detecting liver injury ranges from 91 to 97%, specificity and accuracy – from 96 to 98% [26]. MSCT provides clarification of the hematomas size and localization; in patients with focal changes the use of bolus contrast enhancement makes it possible to identify and clarify the nature of injuries (contusion, hematoma, biloma), the prevalence of the lesion and its volume [27]. The growing trend towards non-operative treatment is leading to an increase in delayed complications such as bile leakage, bile duct strictures, liver abscesses, delayed bleeding and other vascular complications [28]. Delayed bleeding may arise secondarily from formed pseudoaneurysms, which are inherently unstable and may rupture into the abdominal cavity or into the bile duct system leading to hemobilia. Injuries of the gallbladder are rare and in most cases are combined with injuries of the liver and duodenum. These include bruising of the bladder wall and its rupture. At a rare separation of the gallbladder, it can be in a free position in the abdominal cavity.

Today it is generally accepted that MSCT is the gold standard in the diagnostics of abdominal injuries. Nevertheless, the method has a number of disadvantages such as the high cost of the study, the inability to perform the study at the patient's bedside, the presence of radiation exposure, the nephrotoxicity of MSCT with contrast enhancement, the probability of artifacts due to patient movement, etc. [29].

In the historical aspect, the views on the management of patients with closed abdominal injury radically change from the tactics of mandatory laparotomy in the presence of clinical and ultrasound signs of intra-abdominal injuries to the tactics of conservative (non-surgical) treatment of certain types of patients. Today, non-surgical treatment of patients with abdominal trauma, subject to stable hemodynamics, is becoming more widespread throughout the world and shows high efficiency in the range of 80–90% [30]. Conservative management of victims selected according to strict indications helps to reduce the frequency of exploratory (in fact, futile) laparotomies and is considered the safest choice in large trauma centers, where surgeons on duty, operating units, intensive care units (ICU) and other support services work around the clock. However, conservative tactics are fraught with the risk of late diagnosis of intra-abdominal injuries, especially in cases of injury of hollow organs, the diaphragm and two-stage ruptures of parenchymal organs [31].

The main motivation for expanding the tactics of non-surgical management of patients with abdominal trauma are data on the frequency of exploratory laparotomies, especially in patients with penetrating wounds of the anterior abdominal wall, which, according to the established canons of surgery, are one of the main indications for laparotomy and revision of abdominal organs. According to various authors, the frequency of useless laparotomy in patients with wounds and blunt abdominal trauma reaches 25-40%. Moreover, this indicator is significantly higher (75-80%) at penetrating wounds of the lumbar region in compare with the anterior abdominal wall wounds (15–27%) [32].

In 1989, T.H. Cogbill et al. published the results of a multicenter study on the experience of conservative treatment of the spleen closed injury, where the efficiency of treatment in adults was 83%, and in children it made up 98% [33]. More recent data also indicate a high efficiency of conservative management of patients with the spleen rupture, reaching 95% [34].

The first report on the results of conservative treatment of liver ruptures was published in 1979 [35]. Subsequently, A.A. Meyer et al. pointed out the advantage of computed tomography in the selection of patients with closed liver injury subject to conservative management. In their opinion, patients without CT signs of the liver parenchyma deep injury, with a hemoperitoneum volume of not more than 250 ml or without a shock clinic, do not need laparotomy [36]. Currently, there are more and more supporters of conservative tactics for the treatment of closed liver injuries of any degree in patients with stable hemodynamics. The efficiency of this tactic reaches 90-95% [37].

A significant increase in the efficiency of non-surgical treatment of abdominal injuries was facilitated by the active introduction of interventional radiology methods, especially when performing endovascular hemostasis in patients with bleeding fractures of the pelvic bones, ruptures of the liver and / or spleen, injuries of the main vessels [38,39].

Taking into account the increasing interest of specialists in the non-surgical treatment of abdominal injuries, the International Consensus Conference in 2018 formulated this tactic as "the primary non-surgical strategy for the treatment of parenchymal organ injuries, which usually consists of observation, but may include the use of endovascular, percutaneous or endoscopic procedures" [40]. Important conditions for the surgical tactics of managing patients with abdominal trauma are the round-the-clock availability of emergency surgery and the possibility of continuous intensive monitoring. It is mandatory to conduct a CT scan with contrast enhancement to identify injured organs and evaluate the severity of the injury in patients selected for non-surgical treatment [41].

In addition to the points that limit the widespread use of surgical tactics, there is a fairly wide list of unresolved issues that require study and consensus: 1) how often and for how long is it necessary to conduct blood tests and repeated ultrasound / CT of the abdominal cavity? 2) When is the best time to resume oral fluid and food intake? 3) what is the duration of strict bed rest? 4) When is the best time to start medical prophylaxis of venous thromboembolism? 5) what is the optimal period of the patient's stay in the hospital?

Against the background of uncertainty in the issues of conservative treatment of patients with abdominal trauma, laparoscopy is becoming increasingly common in various urgent surgical diseases of the abdominal cavity, including abdominal injuries. The main generally recognized advantages of using laparoscopy are the possibility of reducing cases of "exploratory" laparotomy and the duration of inpatient treatment of patients with abdominal wounds, however, there are still disputes about the indications and therapeutic possibilities of laparoscopy [42]. If in the first publications there were concerns that laparoscopic diagnosis is fraught with a certain number of cases of missed intra-abdominal injuries [43], then in subsequent reports, as more clinical experience of using this technique is accumulated, researchers increasingly began to emphasize the accuracy of laparoscopy in the diagnosis of abdominal injuries at penetrating abdominal wounds [44]. There are separate reports on the use of therapeutic laparoscopy for the diaphragm, liver, spleen and hollow organs injuries [45,46].

Currently, laparoscopic surgery is widely used in almost all non-traumatic diseases of the abdominal cavity and retroperitoneal space and does not cause much controversy in terms of indications and efficiency. The success of laparoscopic surgery was facilitated by a significant improvement in video endosurgical techniques (the emergence of a high-resolution video camera, new staplers and energy devices that provide safer and more efficient

hemostasis and tissue resection) and the continuous improvement of the laparoscopic skills of surgeons. Against this background, there is a clear trend towards a decrease in the conversion rate of laparoscopic interventions for injuries. So, if early publications most often reflected the results of diagnostic laparoscopy [47,48], then recent reports demonstrate the high efficiency of therapeutic laparoscopy, which covers such procedures as hemostasis, suturing and resection of the intestine, restoration of the bladder, splenectomy, distal resection of the pancreas, suturing of a diaphragm defect, etc. [49,50,51].

But, at the same time, the possibilities and safety issues of laparoscopic surgery of injuries of retroperitoneal organs, especially the duodenum and pancreas, remain a subject of discussion. It is known that laparoscopic access to the organs of the retroperitoneal space requires more experience and skills of the surgeon than other approaches in intestinal surgery. A number of meta-analyses on laparoscopic pancreatic surgery have been published for recent years, but there are no indications of randomized controlled trials [52,53].

According to the results of a meta-analysis of 8 observational studies and 1 randomized clinical trial, laparoscopic interventions at abdominal injuries contribute to reducing the frequency of wound complications and pneumonia [54]. Besides, the duration of the operation and the terms of inpatient treatment with therapeutic laparoscopy are noticeably shorter compared to laparotomy interventions in both patients with wounds and patients with closed abdominal injuries [55,56,57].

Due to the lack of necessary randomized controlled trials, the level of evidence of recommendations for the use of endovideosurgical techniques in patients with abdominal trauma is ranked as "weak" in current clinical protocols [58]. Nevertheless, there is a steady trend towards a significant decrease in the use of laparoscopy in patients with abdominal trauma, which is due to the widespread use of radiation (including interventional) imaging methods, which allows specifying the indications for diagnostic laparoscopy. More accurate preoperative diagnosis of the volume and nature of intra-abdominal injuries, combined with the diagnostic capabilities of laparoscopy, contributed to a significant reduction in the frequency of unnecessary (diagnostic) laparotomies.

Conclusions

In patients with abdominal and thoracic injuries, the FAST protocol is the standard initial ultrasound screening, a mean of rapid triage of patients and helps to determine the treatment tactics.

MSCT is the gold standard in the diagnostics of abdominal injuries, but the method also has a number of disadvantages, such as the high cost of the study, the inability to perform the study at the patient's bedside, the presence of radiation exposure.

Non-surgical treatment of patients with abdominal trauma under the condition of stable hemodynamics is becoming more widespread all over the world and shows high efficiency. However, there is a fairly wide list of unresolved issues in the use of surgical tactics that require study and consensus. Surgeons increasingly use laparoscopy for various urgent surgical diseases of the abdominal cavity, including abdominal injuries. Due to the lack of necessary randomized controlled trials, the level of evidence of recommendations for the use of endovideosurgical techniques in patients with abdominal trauma is ranked as "weak" in current clinical protocols.

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More accurate preoperative diagnosis of the volume and nature of intra-abdominal injuries, combined with the diagnostic capabilities of laparoscopy, contributed to a significant reduction in the frequency of unnecessary (diagnostic) laparotomies.

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