DIAGNOSTIC METHODS FOR ABDOMINAL INJURIES

Elmuradov GolibjonKarshievich
PhD, assistant at the Department of Surgery, Endoscopy and Anesthesiology and Reanimatology, Faculty of Education and Science, Samarkand State Medical University, Republic of Uzbekistan.
Saidmurodov Khazratqul Xursandovich
Ultrasound diagnostic doctor of department of laboratory and diagnostics of the Samarkand branch of the Republican Research Center of Emergency Medicine, Republic of Uzbekistan.
Ruziyev Nizomiddin Uzakovich
Doctor surgeon at the emergency surgery department of the Samarkand branch of the Republican Research Center of Emergency Medicine, Uzbekistan
Xolmirzayev Orzumurod Murodulloyevich
Doctor surgeon at the emergency surgery department of the Samarkand branch of the Republican Research Center of Emergency Medicine, Uzbekistan

Annotation: *The literary review presents current trends in the use of ultrasound (ultrasound) and multislice computed tomography (MSCT) in the diagnosis of closed abdominal injuries. During discussing the issues of sonography, special emphasis is placed on publications devoted to assessing the informativeness of the so-called FAST-protocol ("Focused assessment with sonography in trauma"), which is included in the clinical recommendations of ATLS (Advanced Trauma Life Support), as a mandatory initial diagnostic study of patients with severe trauma. It is also shown that MSCT is currently considered the gold standard in the diagnosis of abdominal injuries.*

Key words: *abdominal injury, diagnosis, sonography, FAST protocol, MSCT.*

Relevance: Closed abdominal trauma still retains high medical and social significance. Injuries, according to the data of the World Health Organization (WHO) research conducted jointly with the Harvard Center for Medical Research, are considered as the main cause of death of people under the age of 40 by 2020, 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 diagnosis and treatment can reduce mortality by 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 futile laparotomies, the percentage of which in different clinics ranges from 1.7 to 38%, leading to an increase in complications, lengthening the duration of hospitalization and increasing the cost of treatment [5]. Today, methods of radiation diagnostics occupy one of the leading places in the diagnosis of abdominal injuries.

For the first time, T.Tiling and his colleague in 1990, in a study of 808 patients, reported a high sensitivity of ultrasound when detecting fluid in the abdominal cavity. They were the first to demonstrate the effect of training surgeons who, after a short period of training, could diagnose intra-abdominal fluid with high accuracy in just 2-3 minutes of examination [6].

In many Western countries, the use of ultrasound has long become an indispensable and routine practice in emergency medicine [7]. Today, ultrasound of critical conditions at the point of care (Point Of Care Ultrasound FOCUS) is considered a basic practical skill of emergency medical doctors [8]. 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 [9].

Taking into account the diagnostic capabilities of ultrasound diagnostic methods in 1996 Rozycki et al. the term "Focused assessment with sonography in trauma" (FAST) was introduced [10]. Today, focused assessment with sonography in trauma (Focused assessment with sonography in trauma – FAST) 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 [11,12]. FAST-examination is an important means of rapid sorting of patients with unstable hemodynamics, helps to determine the tactics of managing a patient with an injury at the same second.

Today, the FAST protocol is included in the ATLS (Advanced Trauma Life Support) clinical guidelines as a mandatory initial diagnostic study of patients with severe trauma. Numerous publications show that the use of the FAST protocol reduces the time of preoperative diagnosis by 64-76%, allows obtaining objective data to substantiate indications for emergency surgery without the need for computed tomography (CT), reducing the frequency of complications and reducing the duration of inpatient treatment [13].

In detecting free fluid in the pleural cavity and pericardium, the specificity of FAST-examination ranges from 98 to 100% [14], and the overall accuracy of the method is in the range from 98 to 99% [15]. Since the FAST protocol is a non-invasive method, does not involve the introduction of a contrast agent and irradiation of the patient and medical personnel, is a safe method for repeated use even in children and pregnant women, significantly reduces the time for diagnosing signs of internal organ damage, allows examining severe patients directly at the bedside, the method has gained wide popularity in emergency surgery of internal injuries organs of the chest and abdomen.

At the same time, despite all the above advantages, the FAST protocol has some errors, such as the complexity of the differential diagnosis of hemoperitoneum from ascites, low information content in the visualization of retroperitoneal hematomas and damage to the parenchyma proper and the walls of internal organs, operator-dependence of the results of the examination, the presence of certain difficulties in the examination of obese victims, in the presence of pronounced subcutaneous emphysema and intestinal pneumatosis [16].

Engles S. [11], confirming the high specificity of sonography, it is noted that in all patients who underwent emergency diagnostic laparotomy/laparoscopy only on the basis of a positive FAST result, a significant amount of blood and damage to parenchymal organs were always found in the abdominal cavity (a truly positive result). 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 often accumulates. 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].

The sensitivity of ultrasound in detecting free fluid in the abdominal cavity with closed abdominal injuries is 67-69.8%, specificity is 92.1–99% [11,18]. In a study by Natarajan B. Et al. [19] the specificity of FAST was 99%, the prognostic value of a positive result was 95%, a negative result was 94%, but the sensitivity of the method did not exceed 43%. Fleming S. et al. [20] also indicate approximately the same low sensitivity of FAST (46.2%). The same report indicates that with a sonography specificity of 94.7%, the prognostic value of positive and negative results differed significantly from each other, amounting to 96 and 39%, respectively.

Kumar et al. [21] in their study, significantly lower indicators of overall sensitivity (80.4%), specificity (75%) and accuracy (80%) of abdominal ultrasound in detecting free fluid were obtained. The same indicators in the study of McGahan J.P. and Richards J.R. were 60%, 98% and 80%, respectively [22]. According to the Cochrane systematic review, the sensitivity of ultrasound in detecting free fluid in the abdominal cavity during injuries is 85-95% [23].

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. [11] 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. Approximately the same results were obtained by Lee B.C. et al. [24], who performed ultrasound for 4029 victims with abdominal trauma for 6 years, of which 122 (3.0%) patients had a hypotensive condition at admission to the clinic and whose abdominal ultrasound had sensitivity of 85%, specificity of 60% and overall accuracy of 77%.

A comparative analysis of the informative value of sonography in patients with low and normal blood pressure revealed that the informative value of abdominal ultrasound in injuries was higher in the group of patients with normotension. According to other authors, against the background of normal blood pressure indicators, ultrasound sensitivity is 72-85%, specificity is 93.5-96%, the prognostic value of positive and negative results is 90 and 80.5%, respectively, the overall accuracy is 83.9-96% [11,22].

In addition, ultrasound has a low sensitivity in detecting damage to the parenchymal organs of the abdominal cavity, pancreas, retroperitoneum, and damage to the diaphragm, not exceeding 41%. The diagnostic capabilities of the method in detecting the rupture of hollow organs are extremely low [10,25].

According to various authors, the most informative method to clarify the state of the organs and structures of the abdominal cavity and retroperitoneal space is multisection computed tomography (MSCT) [26,27].

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 makes it possible to obtain information on the topography and degree of organ rupture that is significant for therapeutic tactics in abdominal trauma, to monitor post-traumatic intra- and para-organ changes, especially in conditions of conservative and endosurgical therapeutic tactics [28].

The detection of hemoperitoneum with a closed abdominal injury is of fundamental importance, since it is an indicator of the life-threatening consequences of damage. MSCT has high sensitivity and specificity in detecting free fluid. With 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 [29].

The spleen is damaged in 28.5% of cases with abdominal trauma [3]. Given its role in the immune functions of the body, the high risk of infectious complications in asplenia, the "gold standard" is the rejection of splenectomy. Currently, the percentage of non-surgical treatment of patients in some clinics reaches 80-90%, so it is very important to accurately identify damage to the spleen. The sensitivity of contrast-enhanced MSCT in the diagnosis of spleen injury reaches 98.5%, whereas contrast-free CT in intraparenchymatous hemorrhages has low sensitivity and specificity [27,30]. The severity of the damage is assessed on the AAST scale.

With high grades of damage (III and higher), surgical intervention is necessary. However, the management of the patient only on the basis of this scale is not always justified, especially with conservative tactics. It is necessary to take into account other factors, for example, the volume of the hemoperitoneum. Patients with a small hemoperitoneum are more likely to have a favorable outcome. About 25% of spleen injuries are not associated with free fluid.

Also important is the activity of bleeding, the presence of vascular damage in the form of pseudoaneurysms or arteriovenous fistulas, the presence of which increases the risk of unsuccessful conservative treatment. To detect pseudoaneurysms, the arterial phase of CT is the most sensitive [31]. Active bleeding can be identified if there is a local hyperdensive zone in the parenchyma or the output of a contrast agent outside the organ. In contrast to stopped bleeding, in which the initially determined contrast is washed out in subsequent phases, hyperdensity with active bleeding not only persists, but also becomes greater in the delayed phase. Thus, the delayed phase is used to characterize vascular damage to the spleen as stopped or active bleeding. The sensitivity of the arterial phase in the detection of pseudoaneurysms and active bleeding is 70%, parenchymal lesions – 76%, periarticular hematomas – 95%. The sensitivity of the venous phase in the determination of pseudoaneurysms is only 17%, active bleeding – 93%, parenchymal lesions – 93%, periplastic hematomas – 98%. The specificity of both phases for the detection of all listed lesions is 95-100% [31].

Liver damage in abdominal trauma occurs in 31.6% of cases [3]. Like spleen injuries, most liver injuries are currently treated conservatively, and only 15% of patients with unstable hemodynamics or ineffective conservative treatment need surgery [32,33]. Timely and accurate diagnosis and characterization of liver injuries are very important for determining patient management tactics. The sensitivity of MSCT in detecting liver damage ranges from 91 to 97%, specificity and accuracy – from 96 to 98% [27,34]. When assessing the severity of liver damage, the AAST scale can also be used. MSCT provides clarification of the size and localization of hematomas, in patients with focal changes, the use of bolus contrast enhancement makes it possible to identify and clarify the nature of injuries (bruise, hematoma, biloma), the prevalence of the lesion and its volume [35]. The growing trend towards non-surgical treatment leads to an increase in such delayed complications as bile leakage, bile duct strictures, liver abscesses, delayed bleeding and other vascular complications [36]. Delayed bleeding can occur a second time from formed pseudoaneurysms, which are inherently unstable and can break into the abdominal cavity or into the bile duct system, leading to hemobilia. Damage to the gallbladder is rare and in most cases combined with injuries to the liver and duodenum. These include bruises of the bladder wall and its rupture. With a rare separation of the gallbladder, it can be in a free position in the abdominal cavity.

CT signs of damage to the gallbladder include blurring of the contours of the wall, a collapsed gallbladder in patients on an empty stomach, soft tissue formation in the duodenum, bleeding into the lumen of the bladder, especially in the presence of fluid in the perivesical space.

In recent years, the interest of researchers in adrenal trauma has increased, as a result, it was found that this pathology occurs in 2% of cases and is well diagnosed with MSCT. In approximately 75% of cases, the right adrenal gland is damaged, in 15% – the left, in 10% – both adrenal glands. Most of the adrenal gland injuries are not isolated [37]. CT signs of adrenal hematoma are described. They consist in the fact that a three-dimensional oval-shaped formation with clear contours appears in its projection, with a size not exceeding 60 × 30 mm. The densitometric parameters of the hematoma depend on the timing from the moment of injury. On the 1st-3rd day, the hematoma has a homogeneous structure, its density is increased, then its density decreases. In dynamics, the hematoma gradually decreases in size. Many authors consider the problem of differential diagnosis between hematoma and the formation of the adrenal gland to be important, since accidental findings of the latter occur in 5% of patients, 75% of them are adrenal adenomas. The use of contrast in this case is necessary — in adenomas, contrast is usually washed out within 15 minutes, while hematomas do not change their density [37].

Conclusion

The FAST-protocol of examination of the abdomen in case of injuries has a sufficiently high specificity in identifying an indirect sign of intra–abdominal damage - free fluid in the abdominal cavity. But nevertheless, given its relatively low overall sensitivity, a negative ultrasound result should not be interpreted as the absence of damage to the abdominal organs.

Today it is generally accepted that in the diagnosis of abdominal injuries, MSCT is the gold standard. Nevertheless, 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, the nephrotoxicity of MSCT with contrast enhancement, the likelihood of artifacts due to the patient's movement, etc.

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