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More on the Modern Approach to Diagnostics and Treatment of Spleen Trauma in Children

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ABSTRACT Today, the problem of spleen injury in children still appears relevant. The choice of diagnostics and treatment tactics at the present stage is far from being unified. The priority direction is the organ-preserving approach, which is possible and justified in children, which significantly reduces surgical aggression and prevents the likelihood of negative consequences of splenectomy. The choice of the optimal diagnostic method and determination of safe treatment tactics was the purpose of our study. Thirty-nine injured children were treated in 2007–2019. The predominant cause of spleen injury was fall from height (64.1%). Echography was the main diagnostic method, which was performed around the clock. Splenectomy was performed in 7 patients (17.9%), in 32 children (82.1%) the organ was preserved. One case (2.6%) was fatal. The analysis of our own results showed that the widespread use of echography, particularly by surgeons, is necessary in the emergency service and greatly simplifies the work. The developed local protocol for diagnosis and treatment is simple and accessible, since it is based on the interpretation of the main criteria, such as systemic hemodynamics and hemoperitoneum. Continued bleeding reasons diagnostic laparoscopy. With unstable hemodynamics, large hemoperitoneum, laparotomy is indicated.

Keywords: children, spleen injury, echography, organ-preserving tactics

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CBV - circulating blood volume
CT - computed tomography

INTRODUCTION

The spleen is the most vulnerable parenchymal organ of the abdominal cavity in children, which injury, when exposed to a traumatic factor, is a source of intra-abdominal bleeding. The most common causes of closed injuries of the spleen are road accidents and sports injuries, falls from a height, abdomen and chest trauma. Widespread motor vehicles, the growing passion for extreme sports, the availability of gyro scooters, mopeds and motorcycles increase injuries in children. In the structure of abdominal trauma, spleen injuries account for up to 58%, therefore, for many decades, the problem of spleen trauma in children has not lost its relevance [1]. At the present stage, there are various approaches to the methods of diagnosing and treating injuries of the spleen, however, the urgency of such situations requires a quick and extremely accurate choice of therapeutic tactics, since we are talking about an immediate threat to the health and life of the child.

Organ-preserving tactics for spleen injuries is a priority, and this approach was first widely used and developed in pediatric surgery. It should be noted that the spleen performs a number of important functions in hematopoiesis, but the spleen plays a primary role in the functioning of the immune system [2]. More than 60 years have passed since the first mention of "post-splenectomy sepsis" in the literature, and asplenism in childhood continues to be an urgent problem [3]. The number of so-called unnecessary splenectomies is decreasing, but the fear of continuing bleeding due to rupture of the spleen, which is actually passed down from generation to generation, remains with the majority of surgeons [4]. Often, doctors are stopped by the risk of possible delayed complications after conservative measures. These include: delayed rupture of the spleen, secondary or delayed bleeding, spleen abscess, subphrenic abscess, formation of pseudoaneurysms and spleen cysts [5, 6]. According to the literature, the risk of post-traumatic cysts is relatively high and varies from 2.4 to 7.7%, while the frequency of other above-mentioned complications is represented by isolated cases in the literature and does not exceed 0.7–1% [7].

The high frequency of damage to the spleen is explained by the fact that it is a parenchymal organ filled with blood, which undergoes a hydrodynamic shock under local action of force, while ruptures are most often transverse and cause intra-abdominal bleeding. Nevertheless, anatomical and morphological studies indicate that the spleen in children has a segmental nature of the structure and blood supply with a weak severity of intervascular anastomoses and a low degree of differentiation of the arterial bed, which creates conditions for non-operative treatment of spleen injuries [8]. In the available literature there are few information about the possibility of conservative treatment, nevertheless, organ-preserving tactics are indisputably in demand in our time.

When choosing a therapeutic tactic, it is necessary to be guided by the principle of safety, both for the patient and for the doctor, since the surgeon is faced with a severe vital complication - intra-abdominal bleeding. The use of organ-preserving tactics is based on clear criteria characterizing intra-abdominal bleeding - the volume of hemoperitoneum and compensation (stability) of hemodynamics. Only a correct assessment and adequate interpretation of these criteria will make it possible to achieve the desired result. In addition, it is advisable to adhere to a unified classification of spleen injuries by the American Association of Trauma Surgeons (AAST), which describes the anatomical and morphological changes in the damaged organ in detail. Such unification is necessary for adequate analysis and generalization of experience in the treatment of spleen injury.

Thus, the aim of our study was to optimize the diagnosis and treatment of spleen injury in children.

To achieve this, the following tasks were consistently solved:

1. To establish the possibility of non-surgical treatment of spleen injuries in children.
2. To evaluate the role of echography in the conditions of urgent pediatric surgery.
3. To determine the clinical and echographic criteria characterizing the intra-abdominal bleeding of children with spleen injury to select the optimal treatment tactics.
4. To develop a local protocol for the management of children with spleen injury in a surgical hospital

MATERIAL AND METHODS

During the period from 2007 to 2019, 39 children with spleen injury were treated on the basis of the SBHI CRCH in Tver, whose age ranged from 3 to 17 years, of which 28 were male patients (71.8%) an 11 girls were female patients (28.2%). The average time of admission from the moment of injury to the hospital is 7 hours. In 25 children (64.1%), the cause of injury was catatrauma, 6 (15.3%) were involved in a road traffic accident, 4 patients (10.3%) hit the handlebars of a bicycle, 3 (7.8%) patients were injured in a fight and a block of ice fell on one child (2.5%). In 22 patients (56.4%), the condition was assessed as severe, and in 17 (43.6%) it was moderate. The study was carried out on a Mindray DC-8 ultrasound system. All patients were

admitted to the intensive care unit. The material was statistically processed using Microsoft Excel 2010 software and a statistical data analysis package.

DIAGNOSIS AND TREATMENT

To choose the correct treatment tactics — to operate on the patient or treat conservatively — it is necessary to evaluate in aggregate three key criteria that objectively characterize the patient's condition — hemodynamics, hemoperitoneum and the degree of spleen injury. The diagnostic stage depends on the state of hemodynamic parameters. So, three groups of patients can be distinguished: compensated (they carry out all the necessary complex of diagnostic measures), subcompensated (the hemodynamics of patients stabilized in the course of anti-shock measures and where it is possible to perform all diagnostic studies) and decompensated (minimal diagnostic studies with intensive anti-shock therapy and preparation for an emergency operation).

The main diagnostic method in our clinic was echography, which is available around the clock. In addition, most emergency surgeons have a certificate in ultrasound diagnostics, which allows the volume of hemoperitoneum to be timely established, as well as to identify damage to parenchymal organs and conduct monitoring for several hours. All children with closed trauma to the abdominal organs upon admission underwent ultrasound examination of the abdominal cavity in the FAST protocol format [9]. When hemoperitoneum was detected, its volume and location were measured, which made it possible to determine the degree of blood loss by ultrasound. Thus, the determination of free fluid within the small pelvis and the measurement of the volume, which is less than 15% of the circulating blood volume (CBV) (blood loss of the 1st degree), corresponded to a small hemoperitoneum (Fig.1). In moderate hemoperitoneum, free fluid was located in the small pelvis and lateral canals, which corresponds to 15–30% of the CBV and the 2nd degree of blood loss (Fig. 2). Visualization of free fluid in all parts of the abdominal cavity, under the anterior abdominal wall and in the interloop space is typical for grade 3 blood loss and more than 30% of the CBV (Fig. 3).

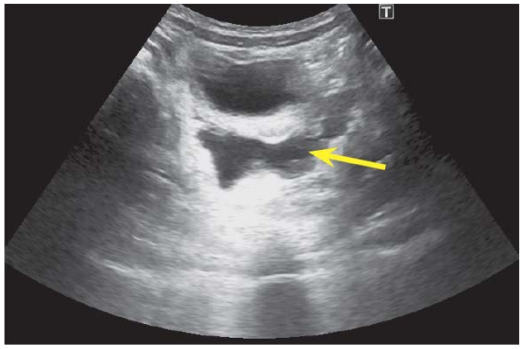

Fig. 1. Free fluid in the small pool — small hemoperitoneum

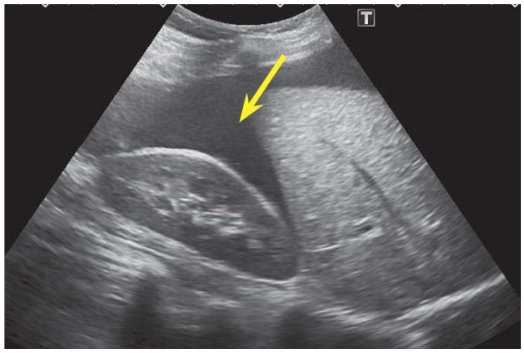

Fig. 2. Accumulation of fluid in the hepatorenal recess — moderate hemoperitoneum (indicated by the arrow)

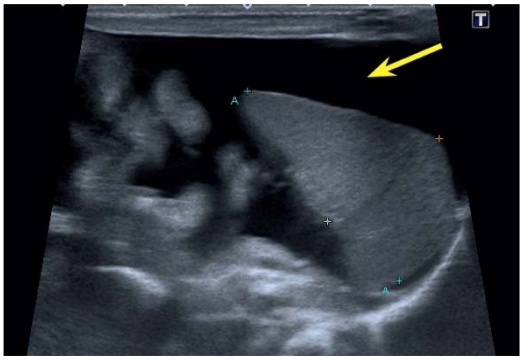

Fig. 3. Accumulation of fluid in the interloop space and under the anterior abdominal wall — large hemoperitoneum (indicated by the arrow)

With dynamic observation using echography, which was performed 1, 3 and 6 hours after admission, the increase in free fluid in the abdominal cavity was assessed. It is the ongoing bleeding, that is, the increase in the volume of hemoperitoneum over time, that is the indication for diagnostic laparoscopy.

It is known that the ultrasound method has low sensitivity (41%) for determining the degree of damage to the spleen, but the analysis of our diagnostic protocols indicates the identification of echographic signs of damage to the spleen in 38 children (97.4%) [10]. Nevertheless, only in 15 (38.5%) cases, linear ruptures of the spleen parenchyma were identified echographically, which corresponded to the 2nd-3rd degree of damage (Fig. 4), and in other cases, the damage area was assessed as an echo-heterogeneous area (characteristic of 1 degree of damage). Subcapsular hematomas were visualized in 10 patients (25.6%) - of these, in 9 children, these echographic findings corresponded to the 1st or 2nd degree of damage, and in 1 child - to the 3rd degree, since the hematoma occupied more than 50% of the spleen surface (fig. 5). In 3 cases (7.6%) there were no signs of hemoperitoneum.

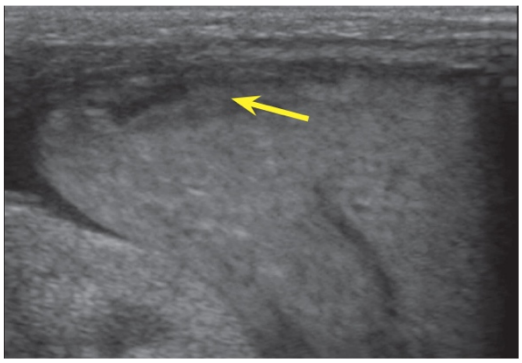

Fig. 4. Damage to the spleen in the lower pole

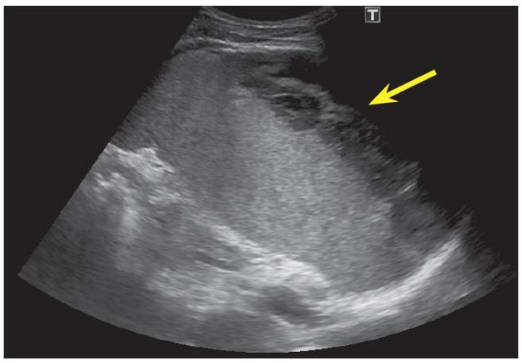

Fig. 5. Subcapsular hematoma of the spleen of large sizes

Undoubtedly, computed tomography (CT) provides comprehensive information about the degree of damage to the spleen and the identification of ongoing bleeding in the form of extravasation of contrast agent. We believe that it is impractical to determine the indications for surgery on the basis of only the conclusion of CT, since tomography does not give an idea of the dynamics of the increase in blood loss.

There are indications in the literature that even with significant organ damage, treatment tactics can be conservative [11]. That is, the fundamental factor for choosing the optimal treatment tactics is the correct characterization of the presence or absence of ongoing bleeding using the combined assessment of the above criteria - hemodynamics, hemoperitoneum and the degree of spleen injury.

Laparotomy, splenectomy was performed in 7 children (17.9%), the abdominal cavity was drained according to Generalov. In these children, the state of hemodynamics was assessed as sub- and decompensated (unstable), the volume of blood loss according to echographic calculations was more than 25% of the CBV. In cases where it was not possible to reliably exclude ongoing bleeding, the diagnostic laparoscopy was performed (in 9 patients (23.1%)). During laparoscopy, the abdominal cavity was sanitated and the spleen was visualized, which in 8 cases was wrapped in an omentum, and there were no signs of ongoing bleeding. A detailed examination of the damaged area was not performed due to the risk of intra-abdominal bleeding; surgical treatment ended with the installation of a safety drainage into the small pelvis. In one (2.6%) child, during a survey laparoscopy after debridement of the hemoperitoneum, a flow of scarlet blood was noted, which was regarded as ongoing bleeding, and access conversion and splenectomy were performed. In 23 patients (58.9%) with compensated hemodynamics, small and moderate hemoperitoneum, non-operative treatment tactics were chosen, conservative measures were successful and no surgical intervention was required. Conservative treatment included compulsory hospitalization in the intensive care unit for anti-shock measures, hemostatic therapy, hourly ultrasound monitoring and control of laboratory signs of post-hemorrhagic anemia.

RESULTS AND DISCUSSION

Analysis of treatment results showed that spontaneous hemostasis in spleen trauma was effective in 32 patients (82.1%). In the group of unoperated children with echographic control, the volume of hemoperitoneum was assessed as "small" - up to 7.5 ml / kg of body weight (less than 15% of the BCC) and "moderate" - up to 25 ml / kg (from 15 to 30% of the CBV). Diagnostic laparoscopy was performed in doubtful cases to assess the ongoing bleeding and debride the hemoperitoneum, which volume almost completely corresponded to the echographic calculations. According to the results of our study, only one child with diagnostic laparoscopy had ongoing bleeding, and surgical treatment ended with splenectomy. Potentially, the remaining 8 patients could be cured conservatively, and this was due to the imperfection of the ultrasound service in our clinic. Thanks to the training of emergency surgeons in ultrasound imaging, it has become possible to perform repeated measurements of hemoperitoneum volume to determine ongoing bleeding. In all children with performed splenectomy, the organ had single or multiple ruptures of the parenchyma through the vascular pedicle, which corresponded to the 3rd and 4th degrees of damage. One child (2.6%) died from hemorrhagic shock caused by complete detachment of the spleen from the vascular pedicle (5th degree of damage).

DISCUSSION

Based on the analysis of the literature and our own observations, we came to the conclusion that it is necessary to develop a local protocol for the management of patients with spleen injury, adapted for use by emergency surgeons. We consider it expedient to simplify it as much as possible in order to use it in the conditions of urgent pediatric surgery to select the optimal treatment tactics (Fig. 6).

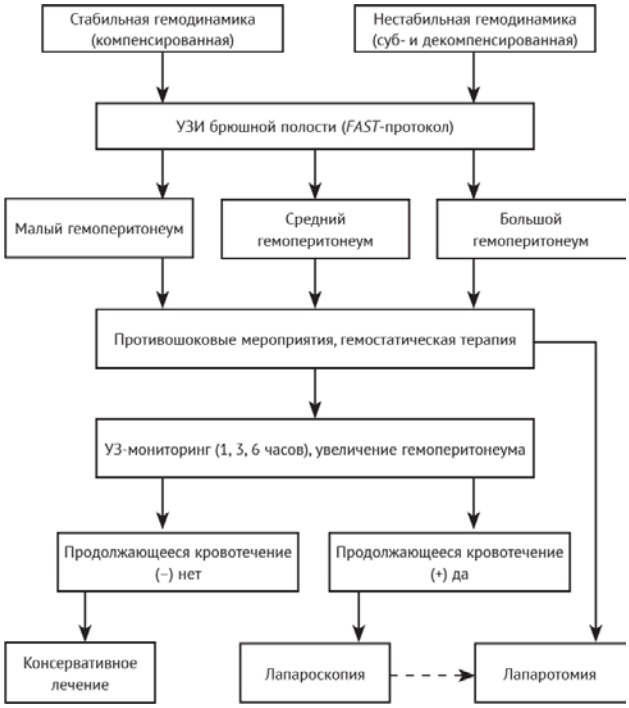

Fig. 6. Local protocol for the management of patients with spleen injury (scheme)

All children with suspected spleen injury undergo ultrasound, if signs of hemoperitoneum and damage to the spleen parenchyma are detected, patients are hospitalized in the intensive care unit. With stable hemodynamics, small hemoperitoneum, hemostatic therapy and ultrasound monitoring are performed. Accordingly, the absence of signs of ongoing bleeding is the basis for the transfer of the child on the first day after the injury to the surgical department, where they provide a protective mode, laboratory and echographic control, continue hemostatic and symptomatic therapy.

Unstable hemodynamics with "small" and "moderate" hemoperitoneum implies intensive anti-shock and hemostatic therapy. Compensation of hemodynamics allows ultrasound monitoring, and an increase in the volume of hemoperitoneum over time to "medium" or "large" indicates ongoing bleeding, which is the basis for diagnostic laparoscopy. In the presence of a "large" hemoperitoneum and unstable hemodynamics revealed upon admission, the child should be transferred to the operating room to perform a laparotomy.

We also want to note an important fact - performing laparoscopy for sanitation purposes is unacceptable and is considered unjustified surgical aggression, since blood is not a source of peritonitis and adhesions in the abdominal cavity. According to our observations, regardless of the volume of hemoperitoneum, by the 10–12th day after the injury on the control echography, free fluid is either completely absent, or is determined in an insignificant amount.

CONCLUSION

Thanks to the study of the available literature and the analysis of our own treatment results, we can offer a local protocol for the choice of diagnostic and therapeutic tactics for spleen injury in children. The presented algorithm allows to choose an adequate and safe tactics of patient management in urgent conditions. The advantage of our protocol is that the surgeon who provides emergency care to children with spleen injury gets a clear idea of whether to operate on a patient or treat conservatively. Such an organ-preserving approach is widespread and clearly justified in pediatric surgery, which makes it possible to exclude unnecessary surgical aggression and reduce the number of “unnecessary” diagnostic laparotomies. The compliance with the developed local protocol reduced the operative activity, and the percentage of conservatively cured children with spleen injury reached 82.1%.

FINDINGS

1. The morphofunctional features of the structure of the spleen parenchyma in case of its damage contribute to spontaneous hemostasis, as evidenced by the analysis of the literature and our own results on the possibility and reasonability of non-surgical treatment of spleen injury in children.

2. Echography is the most optimal, mobile and fast method of diagnosis and determination of treatment tactics for spleen injury in children.

3. Determination of the hemodynamic status, echographic assessment of the degree of damage and the volume of hemoperitoneum in dynamics serve as objective criteria for the choice of therapeutic tactics.

4. The use of the developed local protocol simplifies the surgeon's work in emergency conditions and implies, in case of stable hemodynamics, the absence of ongoing bleeding, small and moderate hemoperitoneum, the choice of conservative treatment tactics. Unstable hemodynamics, large hemoperitoneum, and ongoing bleeding are indications for emergency laparotomy.

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