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Peculiarities of Immediate Postoperative Period in Abdominal Trauma With Splenic Injuries

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INTRODUCTION Splenic injuries in abdominal trauma is one of the most common injuries in abdominal surgery. The damage to this organ occurs in 22.3–30%. This is the second most common injury among damages to parenchymal organs.

Aim of study. To study the immediate results of treatment and to determine the factors that influence the choice of tactics for open injuries of the spleen.

MATERIALS AND METHODS The study included 75 patients with abdominal wound and damaged spleen. In 54 (72%) patients, stab and slash wounds were revealed, in 21 (28%) patients there were gunshot wounds (bullet or fragment). All patients were divided into two groups: Group A included 44 (58.6%) of patients, where the time gap between the time of injury and the surgery did not exceed 1 hour, and Group B, which included 31 (41.3 %) of cases, where the time gap between the moment of injury and surgical intervention exceeded 1 hour.

RESULTS As a result of the study, it was found that organ-preserving operations for open injuries of the spleen were possible in 33.3% of cases. The choice of surgical tactics for injuries of this organ depended on the type of damage to the organ: in case of gunshot wounds of the spleen, the organ-preserving operation was not possible at all, but this operation was performed for stab/slash wounds in 33.3% of cases. The development of complications and deaths directly depended on the journey time: in the case of that time gap up to one hour, complications developed in 27.3% of cases, and the mortality rate was 15.9%. If the time of journey exceeded 1 hour, the number of complications increased to 77.4%, and mortality rate grew up to 51.6%. According to our data, the number of complications and deaths depended more on the time of admission than on the type of operation performed. In addition, it is necessary to note one more factor that affected the lethal outcome and this was the type of the wound. Therefore, as a result of the study, it was found that mortality in the group with gunshot wounds amounted to 17 out of 21 (80.95%), and for stab/slash wounds it was 6 out of 54 (11.1%). It was found that the journey time and the type of operation performed operation affected the level of D-dimer in patients with splenic injuries. So, the level of D-dimer was 566±0.3 ng/ml in the group of the wounded, delivered within an hour after trauma, and 643±0.2 ng/ml in the group where the journey time exceeded an hour.

CONCLUSIONS 1. Performing organ-preserving operations with open injuries of the spleen is possible in 46.3% of cases and only for stab and slash wounds. Organ-preserving operations cannot be performed for gunshot wounds.

2. The number of complications and deaths is more dependent on the journey time to the hospital than on the type of operation performed. If a patient is admitted within an hour after trauma, the complication rate is 27.3%, and mortality rate is 15.9%. If the journey time exceeds one hour, the complication rate is 77.4% and the mortality rate is 51.6%.

3. In patients splenic injuries, the journey time and the type of the operation performed affect the level of the D-dimer, which may affect the course of the immediate postoperative period.

Keywords: open injuries of the spleen, the immediate postoperative period, types of operations

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AAST — American Association for the Surgery of Trauma
BFS-CA — battlefield surgery scale, condition upon admission
BFS-D — battlefield surgery scale, damage
CBV — circulating blood volume

INTRODUCTION

Spleen injuries associated with abdominal trauma occupy one of the leading places in abdominal surgery. Damage to this organ occurs in 22.3–30% of cases and is the second most common injury of parenchymal organs [1]. For a long time, it was believed that the removal of the spleen did not lead to serious consequences, therefore, splenectomy was the operation of choice. However, it has now been proven that the spleen has a number of important functions and its removal can lead to the development of severe complications, and the most dangerous one is postplenectomy sepsis [2, 3]. This made us reconsider tactics and give preference to organ-preserving surgeries or autolientransplantation [4] in cases where it is possible to fulfill the condition of the victim and technical capabilities [5]. It should be noted that the treatment of closed spleen injuries, the choice of tactics and the immediate results of treatment are well covered in the literature, while insufficient attention is paid to the surgical tactics and immediate results of the treatment of open injuries of the spleen.

The aim of the article is to study the immediate results of treatment and determine the factors influencing the choice of tactics for open injuries of the spleen.

MATERIAL AND METHODS

The work included 75 patients with abdominal trauma and splenic injury, who were treated in the surgical departments of the hospital of emergency medical care (EMC) in Engels, V.N. Koshelev GKB No. 6 of Saratov and City Clinical Hospital in Grozny in the period from 1999 to 2017. The mean age of patients was 32 ± 5 years, most of them (78%) were men. The study included victims with isolated wounds of the spleen at the age from 20 to 45 years. Patients with concomitant and multiple wounds and in a terminal state were not included.

Upon admission, 54 patients (72%) had stab and slash wounds, and 21 (28%) had gunshot wounds, both bullet and shrapnel. Blood loss averaged 650 ± 50 ml upon admission. We used the method for determining the relative density offered by A.G. Barashkov (1956) to calculate blood loss. This method allows you to obtain approximate data on the amount of blood loss.

In a state of traumatic and / or hemorrhagic shock, 32 victims (42.6%) were delivered, of all those who were admitted, grade I shock was registered in 15 patients (20%), grade II — in 10 patients (13.3%) and grade III — in 7 patients (9.3%). The assessment of the severity of the injury was carried out using the scale BFS (battlefield surgery, D — damage), the assessment of the severity of the condition was performed using the scale "BFS-CA" (battle field surgery, C — condition, A — admission). It is known that a significant factor that plays a role in the choice of tactics in case of a spleen injury is the time gap between the moment of injury and the start of surgical treatment. In this regard, all patients were divided into two groups: group A included 44 patients (58.6%), whose delivery time from the moment of injury to the start of surgical treatment did not exceed one hour. Of the total number of victims, 9 out of 44 (20.5%) had gunshot wounds, and 35 out of 44 (79.5%) had stab wounds. Group B included 31 patients (41.3%). In this group, the time between the moment of injury and the beginning of the operation exceeded one hour; of these, 12 out of 31 (38.7%) had gunshot wounds, 19 out of 31 victims (61.3%) had stab wounds.

The severity of the spleen injury was assessed according to the AAST classification (American Association for the Surgery of Trauma) [6].

Surgical intervention was performed under endotracheal anesthesia, upper median laparotomy was the operative access. The following operations were performed: splenectomy according to the generally accepted technique with ligation of the vascular pedicle, splenectomy with transplantation of a piece of the spleen to the greater omentum, and organ-preserving operations using a CO_2 laser. The size of the autologous graft was 1.5 cm^3; it was preliminarily washed in saline sodium chloride solution, and separated from the rests of the capsule. The choice of the operative aid was carried out in each case individually by the surgical team.

Of the laboratory techniques, we used a study of the level of blood D-dimer, which is considered the most informative and stable marker of the activation of blood coagulation and lysis of a blood clot, at the same time it is also a marker of thrombosis. This indicator was determined using immunofluorescence analysis on a Triage® MeterPro device manufactured by BIOSITE, USA.

The study received a positive decision from the local ethics committee.

The results were mathematically processed using Statistica 6.0 and Excel (Microsoft, 2003).

RESULTS

In group A, the severity of injury according to "BFS-D" in 32 patients (72.7%) was 0.12 ± 3 points upon admission; the severity of the condition according to the "BFS-CA" scale was 9 ± 3 points, which refers to minor injuries. In the remaining 12 cases (27.3%), the severity of the injury was estimated 0.43 ± 2, and the severity of the condition was 17 ± 2 points, which refers to moderate severity. In group B, the severity of injury in 19 patients (61.3%) was 0.34 ± 2 points upon admission, and the severity of the condition was 17 ± 2 points, that is, these patients had moderate injuries. In the remaining 12 patients (38.7%) of this group,

the severity of the injury was 4 ± 2 points upon admission, the severity of the condition was 25 ± 2 points, that is, these patients had severe injuries. This implies that minor injuries prevailed in group A upon admission, and moderate injuries prevailed in group B ($p < 0.05$). It should be noted that in both groups, moderate and severe wounds were found in victims with gunshot wounds to the abdomen, even taking into account the absence of associated injuries.

When analyzing spleen injuries, it was found that in group A, according to the AAST scale, grade I injuries were detected in 24 of 44 victims (54.5%), grade II injuries were found in 12 cases (27.3%) and grade V injuries were revealed in 8 patients (18.2%). In group B, grade I injuries were found in 17 of 36 patients (54.8%), grade II injuries were found in 6 patients (19.4%) and grade V injuries were diagnosed in 8 cases (25.8%). At the same time, grade V injuries in both groups were associated with gunshot wounds. From this it follows that minor injuries to the spleen prevailed in patients of both groups, which could not but affect the determination of surgical tactics. The operations performed in two groups are presented in Table 1.

As can be seen from the data presented in Table 1, the distribution by type of operation in the two groups had its own differences. In group A, organ-preserving surgeries prevailed (40.9% of cases), in group B this type of surgery was performed only in 22.6% of cases ($p < 0.05$). At the same time, splenectomy prevailed in group B (48.4% of cases), while in group A this type of operation was performed only in 27.3% of cases ($p < 0.05$). The number of splenectomies with the addition of autolientransplantation in both compared groups was approximately the same, in group A – 31.9%, in group B – 29.0% ($p > 0.05$). The greater number of splenectomies in group B can be explained by the prevalence of patients admitted in a more serious condition, which was also associated with their later delivery. It should be noted that in both groups with gunshot wounds to the spleen, splenectomy was performed in 100% of cases, in accordance with the type of the organ damage. Taking into account the severity of the condition of patients, it was decided to abandon autolientransplantation, since this increases the time of surgery.

Table 1

Types of operations performed for splenic injuries

Type	Total operations (n = 75)	The number of operations in groups	
		Group A (n = 44)	Group B (n = 31)
Splenectomy	27 (36.0%)	12 (27.3%)	15 (48.4%)*
Splenectomy with autologous splenic transplantation	23 (30.7%)	14 (31.9%)*	9 (29.0%)
Organ-preserving operations	25 (33.3%)	18 (40.9%)*	7 (22.6%)
Total	75 (100%)	44 (100%)	31 (100%)

Note: * - sign of statistical significance ($p<0.05$)

In the immediate postoperative period, 36 complications (48%) were found in patients of both groups. In group A, there were 12 complications (27.3%), in group B – 24 (77.4%). The presented data show that the number of complications prevailed in group B ($p < 0.05$). The distribution of complications by types of operations performed in two groups is presented in Table 2.

Table 2

The number of complications in the immediate postoperative period for open splenic injuries, depending on the type of surgery

Type of operation	Total complications		The number of complications in groups			
			Group A		Group B	
	abs. number	%	abs. number	%	abs. number	%
Splenectomy	26 of 27	96.3*	8 of 12	66.7*	18 of 15**	120*
Splenectomy with autologous splenic transplantation	9 of 23	39.1	3 of 14	21.4	6 of 9	66.7*
Organ-preserving operations	1 of 25	4	1 of 18	5.5	0 of 7	0
Total	36 of 75	48	12 of 44	27.3	24 of 31	77.4*

Note: * - sign of statistical significance ($p<0.05$); ** - in this group several complications were observed in one patient

As can be seen from the data presented in Table 2, the greatest number of statistically significant complications in both group A and group B was detected in cases after splenectomy. Thus, in group A the number of complications was 8 (66.7%), in group B it was 18 (120%) ($p < 0.05$). The least number of complications was diagnosed after organ-preserving operations, where complications developed in one case (5.5%) in a wounded man in group A. After splenectomy with autolientransplantation, the total number of complications in both groups was 9 out of 23 (39.1%), in the group A – in 3 out of 14 (21.4%) and in group B – in 6 out of 9 (66.7%) ($p < 0.05$). The increase in the number of complications in group B can be explained by the fact that this group included the most severe wounded patients, the delivery time of which was more than one hour.

The type of revealed complications in the immediate postoperative period is presented in Table 3.

Table 3

The type and number of complications in the immediate postoperative period

Complications	The number of complications in groups			
	Group A (n = 44)		Group B (n = 31)	
	abs. number	%	abs. number	%
Suppuration of a postoperative wound	7	15.9*	2	6.5
Abdominal abscess	2	4.5	9	29*
Pneumonia	-	-	9	29*
Abdominal bleeding	1	2.3	-	-
Early adhesive obstruction	2	4.5	3	9.7
Multiple organ failure	-	-	1	3.2
Total	12	27.3	24	77.4*

Note: * - sign of statistical significance ($p<0.05$)

As can be seen from the data presented in Table 3, the main complications were registered in the immediate postoperative period in the group A wounded were purulent-septic ones – in 9 of 44 (20.5%). These complications included postoperative wound suppuration in 7 cases (15.9%), as well as abdominal abscess in 2 patients (4.5%). We consider it necessary to note that these complications developed in the course of broad-spectrum antibacterial agents. Intra-abdominal bleeding developed in one case (2.3%) after performing organ-preserving surgery 5 hours after laparotomy. The diagnosis of this complication was based on the flow of fresh blood from the abdominal cavity through the drains. The patient underwent relaparotomy and splenectomy, the further postoperative period was uneventful. Early adhesive obstruction was noted in 2 cases (4.5%) on the 4^{th} and 6^{th} postoperative days. In both cases, relaparotomy and dissection of adhesions were performed.

In group B, purulent-septic complications developed in 20 cases out of 31 (64.5%) ($p<0.05$). Early adhesive obstruction was noted in 3 cases (9.7%) on the 5^{th} day and in two cases on the 7^{th} postoperative day. Relaparotomy was performed in all cases. In one observation (1.3%), multiple organ failure developed in a patient with a gunshot wound to the abdomen.

In the immediate postoperative period, 23 patients (30.6%) died, in group A – 7 out of 44 (15.9%), in group B – 16 out of 31 (51.6%), ($p <0, 05$). The distribution of lethal cases by types of operations performed in two groups is presented in Table 4.

Table 4

The number of fatal cases in the immediate postoperative period for open splenic injuries, depending on the operation performed

Operations	Overall mortality (n = 75)		The number of deaths in groups			
			Group A (n = 44)		Group B (n = 31)	
	abs. number	%	abs. number	%	abs. number	%
Splenectomy	21 of 27	77.7	7 of 12	58.3	14 of 15	93.3*
Splenectomy with autologous splenic transplantation	2 of 23	8.7	0 of 14	0	2 of 9	22.2
Organ-preserving operations	0 of 25	0	0 of 18	0	0 of 7	0
Total	23 of 75	30.6	7 of 44	15.9	16 of 31	51.6

Note: * - sign of statistical significance ($p<0.05$)

The data in Table 4 show that in group A, 7 of 44 patients (15.9%) died. All 7 deaths were registered in patients who underwent splenectomy. There were no lethal outcomes after splenectomy with autolientransplantation and organ-preserving surgeries.

The group B has the largest number of deaths – 16 out of 31 (51.6%). At the same time, 14 out of 15 (93.3%) ($p <0.05$) died after splenectomy, 2 out of 9 patients (2.6%) died after splenectomy with autolientransplantation. No deaths were recorded after performing organ-preserving surgeries. The greater number of deaths after splenectomy can be explained by the fact that this type of operation was performed in the most severely wounded patients, who were in a state of shock and had higher blood loss.

The main causes of death in the two compared groups are presented in Table 5.

Table 5

The type and number of deaths in the immediate postoperative period

Cause of death	The number of deaths in groups			
	Group A (n = 44)		Group B (n = 31)	
	abs. number	%	abs. number	%
Hemorrhagic shock	6 of 44	18.6	12 of 31	38.7*
Pulmonary embolism	1 of 44	2.3	1 of 31	3.2
Multiple organ failure	-	-	1 of 31	3.2
Pneumonia	-	-	2 of 31	6.5
Total	7 of 44	15.9	16 of 31	51.6*

Note: * - sign of statistical significance ($p<0.05$)

The data in Table 5 data show that the main cause of mortality in both groups was hemorrhagic shock, which led to death in 18 of 23 cases (78.3%) of deaths. The severity of the condition naturally led to greater mortality in group B, where hemorrhagic shock caused death in 12 of 31 cases (38.7%). At the same time, in group A mortality from hemorrhagic shock was 6 out of 44 people (18.6%) ($p <0.05$). In most cases, the patients, admitted in a state of hemorrhagic shock, died either on the operating table or in the first hours after the operation. Studies show that in group A, out of 7 deaths (15.9%), 5 (11.4%) had gunshot wounds, and 2 (4.5%) had stab wounds. In group B, out of 16 patients (51.6%), 12 (38.7%) had gunshot wounds, and 4 patients (12.9%) had stab wounds. In addition to shock, one death was reported in both groups as a result of pulmonary embolism. In group B, one patient (3.2%) died from multiple organ failure, another 2 patients died (6.5%) from pneumonia.

Thus, the presented results show that organ-preserving operations in open injuries of the spleen are possible to be performed for stab wounds, which took place in 25 out of 54 cases (46.3%). The number of complications and deaths depends more on the time of admission of the injured person than on the type of operation performed. In addition, it is necessary to note another factor that influences the lethal outcome – the type of the injury. Thus, as a result of the study, it was found that mortality in the group with gunshot wounds was 17 out of 21 (80.9%), and with stab wounds – 6 out of 54 (11%) cases ($p <0.05$). The presented data

show that in the group of patients with gunshot wounds the number of deaths was statistically significantly higher than in the group with stab wounds.

Considering the fact that most of the complications in patients with open injuries of the spleen were registered on the 3-5th postoperative day, a study of the level of D-dimer of blood was performed. For comparison, the indicators of the level of D-dimer of blood in 15 healthy people were studied, which was 212 ± 0.3 ng / ml and was taken as the norm (comparison group). The results obtained in groups A and B, depending on the operation performed, are presented in Table 6.

Table 6

D-dimer in the immediate postoperative period for open splenic injuries depending on the operation performed (M±m)

Operation	D-dimer in groups (ng/ml)	
	group A (n = 24)	group B (n = 24)
Splenectomy	566 ± 0.3 *	643 ± 0.2 *
Splenectomy with autologous splenic transplantation	562 ± 0.3 *	632 ± 0.1 *
Organ-preserving operations	426 ± 0.1 *	532 ± 0.3 *

Note: * - sign of statistical reliability compared to data on healthy people ($p<0.05$)

As can be seen from the data presented in Table 6, in the patients of both groups, regardless of the operation performed, a statistically significant increase in the blood D-dimer index was recorded in comparison with the data obtained in the comparison group. At the same time, there is a clear correlation between the increase in this indicator and the delivery time of patients, as well as dependence on the type of operation. Thus, in group A, the maximum increase in the level of D-dimer in the blood was observed among patients who underwent splenectomy. When performing splenectomy with autolientransplantation, the level of D-dimer did not differ significantly from the data obtained after splenectomy. The lowest level of D-dimer in group A was noted among patients who underwent organ-preserving surgery. However, in this case, too, it was statistically significantly increased in comparison with the data of healthy people. In group B, a significant increase in the D-dimer index was found in comparison with both the data of healthy people and with the results obtained in group A. At the same time, as in group A, there is a correlation between the increase in the level of D-dimer and the type of operation performed. Thus, the maximum increase in the level of blood D-dimer was noted among patients who underwent splenectomy. The result in patients, who underwent splenectomy with autolientransplantation, did not differ significantly from the data obtained in patients after splenectomy. The level of D-dimer of blood in patients after organ-preserving surgeries was the lowest in group B, but it was significantly increased in comparison with the same indicator in group A and with data from healthy people.

Hence, it follows that in patients with injured spleen, the admission time and the type of the operation performed affect the level of D-dimer in the blood, which may affect the course of the immediate postoperative period.

DISCUSSION

As a result of the study, it was found that organ-preserving operations with open injuries of the spleen are possible in 33.3% of cases. The choice of surgical tactics for injuries of this organ depends on the type of the damage: in case of gunshot wounds, it was not possible to perform an organ-preserving operation in any case, while in case of stab wounds, this operation was possible in 33.3% of cases. It should be noted that the determination of surgical tactics, especially the choice of organ-preserving surgery, is influenced by several factors, among which the following can be distinguished: the general condition, the time of delivery to the hospital, the type of the injury. So, in case of admission of a patient in a state of shock of II – III degree, severe blood loss, crush injury and separation of the organ from the vascular pedicle, it is necessary to perform splenectomy. The special case is a mine-explosive wound of the spleen, where the priority should be given to splenectomy even if the general condition and the type of the damage to the spleen allow performing organ-preserving surgery.

The data obtained are confirmed by previous studies [7]. The development of complications and deaths directly depends on the time of admission: in the case of delivery up to one hour from the moment of injury, complications develop in 27.3% of cases, and mortality is 15.9%. In the case of admission within more than one hour, the number of complications increases to 77.4%, and the mortality rate to 51.6%. It should be noted that performing organ-preserving surgery on the spleen in some cases leads to repeated bleeding: according to the literature [5], such a complication occurs in 2.1% of cases, in our observations such a complication was noted in one of 25 cases (4%). At the same time, other complications described in the literature (pancreatitis, spleen infarction) were not observed in our observations. If it is impossible to perform organ-preserving operations on the spleen, autologous transplantation should be used. There is evidence that at least 1/3 of the organ must be transplanted for the normal functioning of the autologous graft. At the same time, it has been proven that transplanting a piece of 1.5 cm^3 is able to prevent the development of postplenectomy syndrome [8]. According to our data, the number of complications and deaths depended more on the time of admission than on the type of operation performed. In addition, it is necessary to note another factor that influences the lethal outcome – the type of the injury. So, as a result of the study, it was found that mortality in the group with gunshot wounds was 17 out of 21 (80.95%), and in the group with stab wounds it was 6 out of 54 (11.1%). The data presented show that in the group with gunshot wounds, the number of deaths was statistically significantly higher than in the group with stab wounds. Undoubtedly, one of the factors influencing the development of complications and deaths is the volume of blood loss. With its increase, mortality

and the number of complications increase. In our observations, the replacement of blood loss was carried out taking into account the deficit of the circulating blood volume (CBV). With a CBV deficit of up to 15%, the volume of the infusion medium was 800–1000 ml (crystalloids 80% + colloids 20%), 100% in relation to the deficit. In the case of blood loss of 15–25% CBV, the volume of transfusion was 150% of the deficit,1500–2300 ml, the ratio of crystalloids, colloids and plasma was 4:4:2. With blood loss of 25–35% CBV, the volume of replacement was 180–220%, 2700–4000 ml (crystalloids 30% + colloids 20%, plasma 30%, erythrocyte mass 20%). With a BCC deficit of more than 35%, the volume of transfusion was 220% - 4000–6000 ml (crystalloids 20% + colloids 30%, plasma 25%, erythrocyte mass - 25%). It is known that injuries cause imbalance in the hemostatic system, cause hypercoagulation and pathological thrombus formation, which can affect the development of complications and death [9]. In this regard, a study of the level of D-dimer in the blood was carried out. As a result of the study, it was found that in patients with injured spleen, the delivery time and the type of the operation performed affect the level of blood D-dimer, which may affect the course of the immediate postoperative period.

CONCLUSION

1. Performing organ-preserving operations for open injuries of the spleen is possible in 46.3% of cases and only with stab wounds. With gunshot wounds to the spleen, it is impossible to perform organ-preserving operations.

2. The number of complications and deaths depends more on the time of admission of a patient than on the type of operation performed. When victims are admitted within an hour, the frequency of complications is 27.3%, and mortality is 15.9%, while when admitted within an hour, the figures are 77.4% and 51.6%, respectively.

3. In patients with injuries of the spleen, the delivery time and the type of the operation performed affect the level of D-dimer in the blood, which may affect the course of the immediate postoperative period.

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