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Review

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Autosplenotransplantation After Splenectomy: Long-Forgotten Past or Promising Future?

***L.A. Otdelnov*[1, 2] ✉, *V.V. Dzhabadari*[1], *I.Z. Mamedov*[1, 2]**

B.A. Korolev Department of Hospital Surgery
[1] Privolzhsky Research Medical University
Minin and Pozharsky Sq. 1/10, Nizhny Novgorod, Russian Federation 603000
[2] City Clinical Hospital No. 13, Avtozavodsky District
Patriotov Str. 51, Nizhny Novgorod, Russian Federation 603018

✉ **Contacts:** Leonid A. Otdelnov, Candidate of Medical Sciences, Associate Professor, B.A. Korolev Department of Hospital Surgery, Privolzhsky Research Medical University.
Email: leonotdelnov@yandex.ru

AIM OF THE STUDY To investigate the clinical and functional outcomes of autosplenotransplantation in cases of spleen injuries, and to establish its effectiveness in clinical practice.

MATERIAL AND METHODS Using the databases "e-library" and "PubMed", a thorough review of national and international literature on autosplenotransplantation in patients with traumatic splenic injury was performed.

RESULTS This study analyzes literature sources to describe the technical aspects of autosplenotransplantation. The immediate outcomes of this operation show a low incidence of postoperative complications and good graft survival. In addition, this study presents the indications and contraindications of autosplenotransplantation. Comparing autosplenotransplantation to splenectomy, functional results indicate the best indices of humoral and cellular immunity and hemocoagulation. In the published literature, the functional activity indices of the transplant were comparable to those of healthy individuals with the functioning spleen. However, the studies yielding these results were conducted on small patient samples, limiting the reliability of the conclusions drawn.

CONCLUSION Autosplenotransplantation appears to be the only viable option for preserving the function of the lost spleen in patients with traumatic splenic injury who, for various reasons, cannot receive organ-preserving treatment. Large randomized studies are needed to assess functional results of the operation and, particularly, the immunological function of the transplant.

Keywords: splenectomy, autosplenotransplantation, spleen, abdominal trauma, spleen rupture

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Affiliations

Leonid A. Otdelnov	Candidate of Medical Sciences, Associate Professor, B.A. Korolev Department of Hospital Surgery, Privolzhsky Research Medical University; Surgeon, Surgical Department No. 1, City Clinical Hospital No. 13, Avtozavodsky District; https://orcid.org/0000-0003-4446-2082, leonotdelnov@yandex.ru; 65%, concept development, selection and analysis of literary sources, editing the text of the article
Vakhtang V. Dzhabadari	Student, Faculty of Medicine, Privolzhsky Research Medical University; https://orcid.org/0000-0002-3573-5598, vaho226771@gmail.com; 20%, selection and analysis of literary sources, editing the text of the article
Igbal Z. Mamedov	Assistant, B.A. Korolev Department of Hospital Surgery, Privolzhsky Research Medical University; Surgeon, Surgical Department No. 1, City Clinical Hospital No. 13, Avtozavodsky District; https://orcid.org/0009-0001-7123-7000, 9040623512@yandex.ru; 15%, selection and analysis of literary sources, editing the text of the article

INTRODUCTION

In case of closed abdominal trauma, the spleen is the most frequently damaged organ: it accounts for up to 23–40% of all abdominal injuries [1, 2]. Surgeries for splenic rupture are still accompanied by a high rate of postoperative complications, reaching 40%, and a mortality rate of 20–60% [3–5].

After Reinger performed the first splenectomy in 1892, this operation for splenic injury became a routine procedure that allowed surgeons to achieve reliable hemostasis and save the lives of victims [1]. Since the functions of this body organ were not clear in the first half of the 20th century, no one doubted this strategy. Over time, the functions of the spleen

were studied, and many years of experience with splenectomies showed a number of adverse consequences of this operation, called post-splenectomy syndrome. In the psycho-emotional sphere, it is manifested by increased fatigue, decreased intellectual abilities, and emotional lability, which is especially significant in children [2]. It has been shown that after splenectomy, the number of platelets and their functional activity, the activated partial thromboplastin time, and fibrinogen concentration increase, fibrinolysis is inhibited, and the rheological properties of the blood are disrupted due to an increase in viscosity, which ultimately raising the risks of thrombotic complications [2, 6].

The loss of immunological function is manifested by a higher incidence of infectious complications caused by opportunistic flora, but a particularly dangerous consequence of splenectomy is the development of fulminant post-splenectomy sepsis, known in the literature under the abbreviation OPSI (overwhelming post splenectomy infection) [7]. Its main pathogens are Streptococcus pneumoniae, Haemophilus influenzae and Neisseria meningitides [8]. The risk of developing this condition is more than 50 times higher in people who underwent splenectomy than in the general population, and the mortality rate exceeds 50% [1, 9]. Moreover, the risk of this complication is not limited only to the early postoperative period: half of the cases of post-splenectomy sepsis occur in the first 2 years after splenectomy; and cases of sepsis were described that occurred even 20 years after surgery. It was estimated that approximately 25% of people who underwent splenectomy have a lifetime risk of developing post-splenectomy sepsis [1, 10].

Thus, the detailed study of the spleen's functions contributed to a revision of the strategy for treating injuries to this organ in favor of expanding the indications for spleen-preserving, so-called NOM (non-operative management) technologies, which include conservative treatment, X-ray endovascular methods and splenography. NOM technologies have been actively introduced into surgical practice since 1977 and today are included in international guidelines for the treatment of splenic injuries, being recognized as the best means of preventing immunological complications and other manifestations of post-splenectomy syndrome [11–12].

The need to preserve the spleen today is beyond doubt; however, following the concept of non-operative management is associated with a number of clinical and organizational difficulties: 24-hour availability of IV contrast-enhanced computed tomography is required, as well as the presence of the interventional radiologist ready to carry out the necessary hemostatic interventions; and therefore this concept can only be implemented in specialized trauma centers [1, 11]. To date, NOM technologies cannot completely replace splenectomy which is still indicated for severe splenic injuries, in situations when conservative treatment is contraindicated or ineffective [11]. Thus, despite the introduction of non-operative management methods, splenectomy rates remain high, ranging 24–35% [9]. This operation is still the most effective hemostatic procedure in patients with splenic injuries [1].

A possible alternative to spleen-preserving technologies is the implantation of a fragment of the removed spleen—autosplenoplenotransplantation (AST), but to date there are no clear recommendations regarding its use in practice [7].

In 2017, the World Society of Emergency Surgery (WSES) published clinical recommendations for the treatment of patients with splenic injury, which do not include the use of AST in any clinical situations. Referring to a 1994 literature review [6], Coccolini F et al. argue that, despite the issue being studied, it was not shown how this procedure can reduce the incidence of postoperative complications and mortality rate [12]. Nevertheless, the interest in this issue on the part of surgeons does not wane, as evidenced by quite numerous publications of the last decade

MATERIAL AND METHODS

A review of domestic and foreign literature on the problem of autosplenosplenotransplantation in patients with traumatic injuries of the spleen was carried out using E-library and PubMed databases.

RESULTS AND DISCUSSION

The possibility of spleen transplantation has been known for more than a century. In 1883, Griffini and Tizzioni implanted the spleen in dogs, and already in 1896, this operation was performed for splenic injury by Albrecht, and in 1907 by Schilling. The survival of transplants was first proven in an experiment on dogs in 1912 by Stubenrauch. Since the 20s of the 20th century, experimental studies of this issue have begun. A detailed report of successful AST in a child with evidence of the functional activity of the graft according to scintigraphy was first published in the Journal of Surgery in 1989 by Gorovei [13].

AST issues were actively studied in experimental and clinical research in the 80s of the 20th century. According to PubMed data, the peak of publication activity on this problem occurred in the late 80s - early 90s. The first major publication summarizing this experience was a review by Pisters in 1994 [6]. It convincingly demonstrated the knowledge of the technical aspects of this operation, good graft survival and its functional activity in the postoperative period. Various graft preparation techniques and implantation methods were described. Both the preparation of homogenates from spleen tissue and the implantation of whole fragments of the organ, previously washed in saline and decapsulated, are used in practice. The second method, due to its simplicity, has found wider application [7]. Prepared fragments of the spleen can be implanted into the greater omentum, mesentery of the small intestine, into the free abdominal cavity, preperitoneal and retroperitoneal space, into muscle tissue; cases of successful implantation into subcutaneous tissue, liver and kidney tissue were described. With any method, the graft survives well, by the 16th week of the postoperative period it is functionally active, and the histological structure is indistinguishable from a normal spleen [14]. Nevertheless, a comparison of these techniques showed better regeneration and functional activity of the graft when implanted into the greater omentum [6–7]. It is assumed that this is due to its rich blood supply, the ability for neovasculogenesis and venous drainage into the portal venous system [14].

The question of the minimum required volume of the graft to fully replace the functions of the spleen was also studied in detail. In a group of laboratory animals, the ability to resist pneumococcal infection was significantly higher after AST compared with splenectomy without transplantation, even though the graft volume was more than 50% of the original spleen volume [14]. In his experiment conducted on rats, Marques (2012) examined the phagocytic activity of cells after AST. It was shown that the greater the volume of spleen implanted, the higher the ability for phagocytosis. Moreover, significant differences in the ability for phagocytosis compared to healthy animals disappeared when over 26% of the initial organ mass was implanted [15]. Another study conducted on rats showed that the critical volume of the preserved spleen associated with a reliable ability to resist infection is one third of the original weight of the organ [16]. In relation to humans, it is believed that the required volume of the implanted spleen should be at least 35–50 grams, which corresponds to a graft volume of about 1.5 cm^3 [13, 17].

A number of publications are devoted to the study of the functional outcomes of AST. In 1999, Leemans showed that patients vaccinated against pneumococcal disease 6 months after AST had a significant (more than 2-fold) increase in IgM and IgG titers compared with patients who underwent splenectomy without AST. However, the study group included only 10 patients [18].

A Toro's publication showed that patients after splenectomy without AST (n=5) had significantly higher postoperative levels of platelets and naive B lymphocytes, a higher percentage of micronucleated reticulocytes, and a deficit of memory B cells, whereas the corresponding indicators of patients who underwent AST (n=5) did not differ significantly from those of healthy people [10].

In 2010, a research of AST outcomes in pediatric surgery was published: in the compared groups, functions of the coagulation system, blood rheological properties were studied, and long-term surgical outcomes were assessed. It was shown that the long-term postoperative outcome was characterized as excellent in 89.4% of patients after AST (n = 39), and only in 12% of patients from

splenectomy group; the patients of the research group had indicators of coagulation hemostasis and blood viscosity indistinguishable from those of healthy children [17].

Comparing the clinical and functional outcomes of AST (n=30) and splenectomy (n=60), A.L. Charyshkin showed that on the 10th day after AST there was a decrease in the T-cell pool (CD3) to a lesser extent, postoperative inflammatory complications were recorded less frequently (6.7% after AST and 13.3% after splenectomy). By the 20th day, in patients after splenectomy CD3 deficiency persisted, while in AST patients this indicator did not differ from normal values. Moreover, in the research group a shorter duration of hospital treatment and lower mortality rates were noted. However, no indication of the reliability of the differences obtained was given in the work [19].

Researchers from the Zagazig University, comparing the outcomes of AST (n=6) and splenectomy (n=6), showed that patients after AST acquired immune and hemostatic functions of the spleen, close to those of healthy people [11].

In 2019, Surendran published a systematic review that included 18 studies examining AST outcomes in a total of 211 patients. In all the studies, scintigraphy showed the functional activity of the graft in 95.3% of cases. Research examining the cellular composition of the blood showed that it returned to its original level in 90.2% of cases. IgM levels returned to normal values in all the patients who underwent autosplenotransplantation. Most studies demonstrated that these values were significantly different from those in the group of patients after splenectomy. The average rate of postoperative complications after AST was 3.9%, and postoperative infections occurred in 1.3% of cases [7].

Thus, the addition of AST to splenectomy is not associated with an increased risk of postoperative complications; moreover, there is evidence to the contrary. Having assessed the immediate outcomes of surgical treatment for penetrating (including gunshot) injuries to the spleen, V.V. Maslyakov showed that in victims who underwent splenectomy with AST, there was a significantly lower incidence of postoperative complications (7.6% versus 18.7%), among which pneumonia was most often recorded [5]. Karip's data on the influence of the preserved spleen on the healing of intestinal anastomosis look interesting. In an experiment on animals which underwent colonic anastomosis in combination with splenectomy with and without AST, it was shown that the bursting pressure of the anastomosis in the AST group was significantly higher than in the splenectomy group without transplantation [20].

The conditions for performing AST are as follows: the absence of other severe intra-abdominal injuries, acidosis, coagulopathy and hypothermia, and hemodynamic stability [1].

Contraindications usually include concomitant intestinal lumen injury, patient age over 70 years, cases of damage control strategy, total damage to the spleen pulp by purulent-destructive process, the presence of an accessory spleen or foci of splenosis [5, 13]. However, the issue of contraindications is debatable. Thus, concomitant intestinal damage is not always considered a strict contraindication to AST. According to Moore, among 43 patients who underwent AST, 23 had concomitant hollow organ injuries and only one of them developed an intra-abdominal abscess in the postoperative period [21]. The patient's serious condition, caused by combined trauma and shock, can also be considered as a relative contraindication to AST performance [5].

CONCLUSION

Thus, autosplenotransplantation is a safe, technically uncomplicated procedure with a low incidence of intra- and postoperative complications.

In situations when, for one or another reason, it is impossible to avoid splenectomy; performing autosplenectomy is the only option that allows to a certain extent preserving the functions of the lost organ.

The functional outcomes of autospplenotransplantation, and above all, the immunological function have not been sufficiently studied to date; the available data come from studies with a small number of observations. Nevertheless, their results look encouraging, and therefore this issue requires further research in large randomized trials.

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