INVAGINATIVE METHOD OF ANASTOMOSIS FORMATION UNDER REPLACEMENT OF THE ASCENDING AORTA IN PATIENTS WITH ACUTE AORTIC DISSECTION TYPE A

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INTRODUCTION The traditional “sandwich” technique of anastomosis between the dissected aortic wall and synthetic vascular prosthesis in the surgical treatment of acute aortic dissection type A does not fully meet the idea of an urgent surgical treatment of patients with this disease. We evaluated the experience of the new “invaginated” technique of anastomoses formation.

MATERIAL AND METHODS We compared the results of surgical treatment of patients with the “sandwich” and “invaginated” technique of anastomotic formation. The parameters of bleeding, cardiopulmonary bypass time, mortality, as well as the state of the false lumen in the early and late postoperative periods have been studied.

CONCLUSION Invaginative formation of anastomosis between the aorta and vascular prosthesis provides good immediate hemostatic effect and creates the best conditions for filling the false lumen in the treatment of acute aortic dissection type A.

Keywords: aortic dissection, aortic surgery, aortic anastomoses with vascular prosthesis.

INTRODUCTION

Acute aortic dissection of type *A* according to the Stanford University Classification (type I by *De Bakey)* remains one of the most serious diseases with mortality rates of about 50% within the first 48 hours [1]. The urgent surgical treatment of this desease is replacement of vulnerable to rupture ascending aorta (AA) and creation of conditions for obliteration of the false aortic lumen distally to the surgery area [2]. The residual functioning false lumen is a risk factor for complications shortly or long after the surgical treatment of acute aortic dissection [3]. Prevention of intraoperative bleeding is eqiually important.

The completeness of the dissected aortic wall recovery (exclusion of the false lumen from the anterograde flow) and anastomotic leakproofness are of first importance for prevention of these complications. Today, various methods strengthening the aortic wall exist: separate U-shaped stitching on pads, strengthening of the anastomosis with additional Teflon strip outside, "sandwich" technique, invagination technique, etc. The most widespread technique for the formation of anastomoses is a "sandwich" or "layered cake" which meets the above conditions. The disadvantages are technical complexity of its implementation, the presence of large quantities of synthetic material and adhesive at the anastomotic area, artificial fenestration at the distal anastomosis of high incidence [4]. Since 2013, "invaginated" technique suggested by *Floten H.S. et al.* have been performed in the N.V. Sklifosovsky Research Institute for Emergency Medicine [5].

There have been few reports on this technique in the foreign literature until now [3, 4, 7]. We have not found such reports in the home literature.

Aim of study: retrospective evaluation of initial results for replacement of the ascending aorta with "invaginated" formation of anastomoses in patients with aortic dissection of type A.

MATERIAL AND METHODS

From January 2013 to January 2016, we operated on 108 patients with acute aortic dissection of type A in the Department for Emergency Cardiac Surgery, Circulatory Support and Cardiac Transplantation of the N.V. Sklifosovsky Research

Institute for Emergency Medicine. Plastic surgery of the anastomosis was performed in 92 patients involved in the study. The average age of patients was 54.3±5.2 years, of whom 76.8% were male patients. In all cases, the cause of the disease was degenerative and dystrophic process in the aortic wall (macroscopic areas of atheromatosis and lipodystrophy visualized intraoperatively with signs of the aortic wall destruction, regarded by histological examination as manifestations of atherosclerosis).

Most patients underwent cannulation of common femoral artery and both caval veins, artificial circulation (AC) with mild hypothermia (32-34°C). Myocardial protection was cardioplegic "Consol" solution (800-1,400 ml, repeatedly administered every 25-30 minutes into the coronary sinus, or rarely into mouths of coronary arteries) or "Custodiol" (2,000-3,000 ml, single dosing into the coronary sinus). In recent years, coronary sinus cannulation has been usually performed "blindly", without right atriotomy. The aorta was clamped just proximally to the mouth of the brachiocephalic trunk. In the majority (92.4%) of patients, proximal fenestration was located in the AA, in the other patients it was located in the aortic arch.

All patients underwent AA replacement, combined with aortic valve replacement in 21 (19.4%) patients, and partial or total aortic arch replacement in 23 (21.3%) cases.

At the same time, the distal anastomosis was formed in all patients with a reconstructive technique which was selected intraoperatively according to pathological features of the disease in each individual case. Initially, the possibility of "invagination" technique was assessed in each case. In patients with an intact thin intima sufficient to perform duplication, we performed the "invagination" technique. If patients had thickened or insufficient intima, we perfomed a "sandwich" technique.

In 33 (35.9%) patients (group A), the ascending aorta replacement with "invaginated" formation of anastomoses was performed. In 59 (64.1%) patients (Group B), we performed a "sandwich" technique.

We devided operated patients into two equal subgroups according to the amount of surgery (supracoronary AA replacement with plastic reconstruction of both anastomotic areas) to assess the duration of artificial circulation and myocardial ischemia: A1 — 10 patients with "invagination" plastic reconstruction; B1 — 23 patients who had the "sandwich" surgery. The subgroups included all patients with a given intervention, randomization was not performed.

According to *Floten H.S. et al.* [5], an "invaginated" anastomosis is formed by adventitial duplication, with fixed intima between its leaflets which allows to isolate the false lumen with biological tissues without synthetic materials and adhesive. The "invaginated" anastomosis is formed as follows. The aorta is cut 2 cm above the sinotubular junction level. U-shaped stitches (prolene 6/0) fix dissected commissures of the aortic valve on pads. Then, the aortic wall is separated in the udissected area with by circular division of adventitia and intima to the level of sinotubular junction. Separated inner and outer layers of the aortic wall are cut circularly at different levels: the intima is cut 7-8 mm distally to the sinotubular junction, the adventitia is cut 1 cm distally to the edge of the cut intima. The adventitia is rolled inside the aorta, creating duplication over the edge of the intima. The resulting three-layer structure is circularly fixed with horizontal mattress suture (6/0 prolene). The continuous locking stich (4/0 prolene) is put on the anastomosis between a synthetic vascular graft and the aorta at

the level of plastics, and locking stiches are put above mattress stiches. Continuous locking stiches (prolene 5/0) followed by anastomosis formation with the distal edge of the vascular graft with the same continuous stich (4/0 prolene) is a distinctive aspect of adventitia fixation, invaginated into the aortic lumen (Figs. 1 and 2) .

Existing modifications of "invagination" techniques differ in fixing the adventitia. Among such techniques we may note continuous suturing at the proximal plastics [6] or strengthening of invagination area with a Teflon strip outside the aorta [7] (Fig. 3).

In our practice, we formed adventitial invagination using prolene suture 5/0 or 4/0. The anastomosis between the aorta and zero-porosity vascular graft soaked in gelatin *(Vascutek)* or collagen *(InterGard)*, was formed using prolene suture 4/0 or 3/0 [6].

Monitoring of the aorta was performed in all surviving patients approximately on day 10 after the surgery and 6 months after the surgery, including transthoracic echocardiography and multislice computed tomography of the aorta with bolus contrast enhancement (*Aqulion PRIME*, contrast agent *Omnipaque*). In lethal cases, the quality of anastomosis was assessed at autopsy.

The statistical analysis was performed using Student's t-test for statistical significance.

RESULTS

The average duration of artificial circulation in the A1 subgroup was 146.0±11.8 min, in B1 subgroup – 151.9±13.2 min; the average duration of myocardial ischemia – 107.8±12.1 and 107.9±10.3 min respectively.

In group A, cases of intra- and postoperative bleeding were not observed. In group B, uncontrolled intraoperative bleeding occurred in 7 patients (11.9%), and in all cases the cause was leakage from the rear semicircle of the proximal anastomosis.

The decision to use biological adhesive as an additional method of achieving tightness was made in 72.7% of patients of group A in the presence of areas with a thick, blood-soaked adventitia along the anastomotic line. In group B, the adhesive was applied in 100% of cases as a routine method in the area of "sandwich"-plastics.

The mortality rate was 28.3%. Of 26 dead, 5 patients were of group A and 21 patients were of group B. All patients in group A died of multiple organ dysfunction syndrome (MODS). In group B, 17 (80.9%) patients died of MODS, and 4 (19.1%) patients died of uncontrolled intraoperative bleeding.

The control examination approximately on day 10 in the majority of survivors (92.9%) and autopsy in all the deseased revealed the lack of fenestration in the area of distal anastomosis and initiation of the false aortic lumen thrombosing. A similar scenario was observed only in 31 (52.5%) patients in group B. The other 28 (47.5%) patients had signs of fenestration at the level of the distal anastomosis with the lack of thrombotic signs in the false lumen.

In the late period, we examined 23 patients of group A and 27 patients of group B (the latter included 18 patients who had early postoperative fenestration at the level of distal anastomosis). Thrombosing of the false lumen of the aorta from the distal anastomosis to next fenestration was observed in all patients of group A and in 9 (33.3%) patients of group B without fenestration at the distal anastomosis. In 10

(37.0%) patients of group B with artificial fenestration at the level of the distal anastomosis, thrombosing of the false lumen was not observed. In the other 8 (29.7%) patients, thrombosing was partial.

DISCUSSION

Residual functioning of the false lumen is a risk factor for shirt-term and long-term complications of surgical treatment for acute aortic dissection [3]. The lack of conditions for its obliteration with the classic "sandwich" technoque is associated with creation of artificial fenestration at the level of the distal anastomosis. The reason for its occurrence is the need to use a more "rough" suture (polypropylene suture 3/0, needle 26 mm), as well as the higher physical effort when suturing to overcome the "sandwich" (2 strips of synthetic material + intima-media and media-adventitia + thrombotic mass between layers in some patients). [4] The "invagination" method of anastomosis formation is devoid of such shortcomings, and, as can be seen from the data presented, the aortic replacement gives the best results in obliteration of the aortic false lumen if performed according to this technique. In our study, the early postoperative thrombosing of the false lumen was observed in 93.9% of patients in group A and only in 52.5% of patients in group B. Similar results were obtained in the long-term period: thrombosing of the false lumen of the distal anastomosis in 100% of patients in group A (Figure 4) versus 33.3% of patients in group B (Fig. 5). Thus, the preference of "invagination" technique to "sandwich" is obvious.

It should be noted that the "invagination" technique is comfortable to be performed only in cases of thin morphologically unaltered intima sufficient for duplication. In our opinion, the presence of thickened, significantly changed intima of reduced mobility is the contraindication to this technique. Comparing groups of patients with various techniques performed and also basing on own experience, we emphasize that each technique has indications and limitations.

Analyzing the mortality, it should be noted that the vast majority of adverse outcomes are assocoated with MODS (22 patients out of 26). It is known, that predictors of MODS are the patient's age (as a defining indicator of "senility" factor), the severity of comorbidities, malperfusion, artificial circulation and myocardial ischemia [1]. In our study, the average age difference between the treatment groups was not statistically significant ($t_{EXP}<t_{CR}$ when $p\leq0.05$, Fig. 6). The severity of comorbidities was not possible to be evaluated due to the emergency of an underlying desease and urgent surgical treatment. The study included patients with no malperfusion syndrome.

The duration of AC and myocardial ischemia in our observation were not significantly different from those in the group of "sandwich" technique, ($t_{EXP}<t_{CR}$ when $p\leq0.05$), whereas others have reported a faster performance of "invagination" plastics than using "sandwich" [3-5]. The findings of our study do not indicate differences which is probably associated with the small volume of patient sampling and less experience in comparison with foreign colleagues.

The important factor determining the outcome of patients, is prevention of intra- and postoperative bleeding. We experienced 7 observations of uncontrolled intraoperative anastomotic bleeding in patients of group B. In group A, such complications were not observed. The advantage of "invagination" procedure in this

case is obvious, however, in view of the small number of patients in a representative sampling, this result is not statistically significant.

With years of experience in surgery of aortic dissection, it should be noted that bioadhesives improve the anastomotic tightness [2, 8]. However, it is known that its use is correlated with the frequency of false aneurysms formations in the postoperative period [8]. One of the advantages of "invagination" technique noted by its authors is the lack of bioadhesives (and more rare incidence of pseudoaneurysms as a consequence), evaluating "invaginated" anastomoses as mostly sealed [5]. In own practice of "invagination" technique adoption, we used bioadhesives to achieve reliable sealing of anastomoses in all cases for fear of intraoperative bleeding. In recent years, we have accumulated enough experience, and abandoned the routine use of bioadhesives for anastomotic sealing. We use it only when working with thicker, compacted, blood-soaked adventitia. This has led to the fact, that the usage of bioadhesives in the "invagination" technique is about 70% today versus 100% in the group of patients with a "sandwich" procedure. We had no cases of AA pseudoaneurysms formations in patients of both groups.

The "invagination" technique was suggested by authors in 1995 [5]. We have not found any reports mentioning this technique in the home literature. Analyzing own experience and discussing this procedure with colleagues from other hospitals, it should be emphasized once again that the use of "invagination" technique is usually possible with a relatively intact intima, which is important for the acute phase of aortic dissection. Most cardiovascular centers of our country are working with patients in the chronic phase of this disease, which objectively restricts the performance of the technique. The material on the use of "invagination" method of anastomotic formation forming has been accumulated in the first aid and health care facility where patients with acute aortic dissection are exactly treated. Studying the foreign literature, we noted that the whole experience of using the analyzed methods had been also accumulated in clinics providing care for patients in the acute stage of the disease.

CONCLUSION

The invaginative method of anastomotic formation between the aorta and vascular graft provides good immediate hemostatic effect and creates better conditions for the false lumen thrombosing in the treatment of acute aortic dissection type A with maximum elimination of synthetic materials from the surgery area. This technique successfully meets all the principles of the urgent surgical treatment in patients with acute aortic dissection and it is a good alternative to the standard technique of "sandwich" with the use of Teflon strips and biological adhesive between the dissected aortic wall and synthetic vascular graft. Regarding the substantiation, it should be noted that this study has objective limitations due to retrospective analysis and differentiated approach to the use of techniques in patients with different morphological features of the disease. Nevertheless, the accumulated clinical experience confirms, that "invaginated" technique in certain clinical situations has not only the right to exist, but deserves wider application.

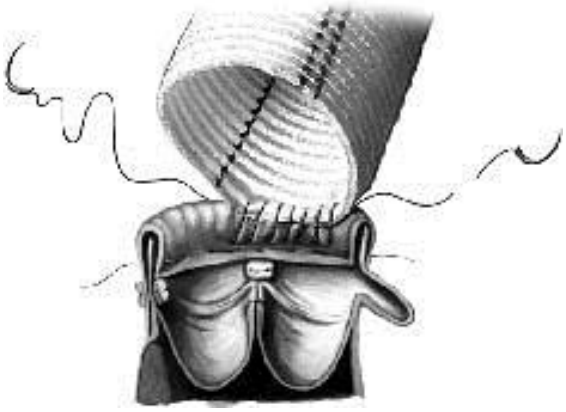

Fig. 1. Invaginative method of proximal anastomosis formation [5]

Fig. 2. Invaginative formation of distal anastomosis [5]

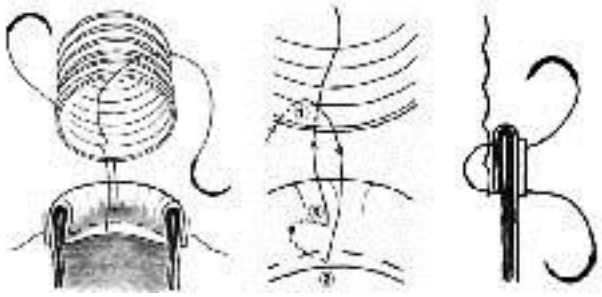

Fig. 3. Modification of invaginative technique by *Rylski B et al.* [7]

Fig. 4. Thrombosing and the absence of artificial fenestration of the aortic false lumen in a patient of group A, 6 months after the surgery

Fig. 5. Artificial fenestration and abscence of false lumen thrombosing in a patient of group B, 6 months after the surgery

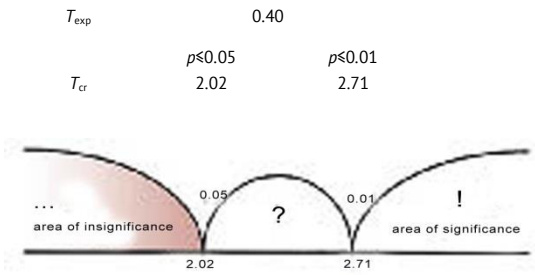

Fig. 6. Distribution of Student's *t*-test in group A and group B according to "age of patients"

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