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Evar Acute Results in Patients with Hostile Proximal Aneurysmal Neck

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Abstract: About 40% of patients with AAA, due to the anatomical characteristics of the aorta, cannot be candidates for EVAR. Anatomical features that are difficult or unacceptable for stent-graft placement include short or no proximal neck, angular, tapered neck, and vessel diameter that exceeds the existing capabilities of endoprostheses. In patients where traditional surgical correction is not an acceptable option, various technological methods and equipment are used. The observation included 18 consecutive patients with AAA, where EVAR was performed. When analyzing the anatomical characteristics of the aneurysmal sac, 9 (50%) patients were classified as patients with an unfavorable proximal neck of the aneurysm, the so-called “hostile neck”. 4 EVAR interventions were complex (2 patients with parallel grafts), which made it possible to achieve an increase in the proximal infrarenal zone implantation up to 16-20 mm, and supplemented or additional endovascular procedures - in our case, implantation of “Aptus Heli-FX” endoancors in 5 patients. The comparison group consisted of 9 patients with a standard aneurysm neck, where standard EVAR procedures were performed. The main anatomical difference in the groups was the length of the aneurysm neck - 9.8 mm and 36.1 mm in groups I and II, respectively (p - 0,0003). EVAR in the groups were carried out without significant complications and operation death; in the first group, the duration of the operation (p-0,01), the amount of contrast (p-0,03) and the fluoro time (p - 0,01) were significantly increased than in the patients of group II. The postoperative period did not differ between the groups. So the use of modern technological methods allows to significantly expand the indications for EVAR in patients with unfavorable anatomy.

Keywords: Abdominal Aortic Aneurism, Endovascular Repair, Hostile Aneurismal Neck, Chimney, Enndoanchors

1. Introduction

The endovascular abdominal aneurism repair (EVAR) technique has revolutionized the treatment of abdominal aortic aneurysms (AAA). At the same time, due to the anatomical characteristics of the aorta, some patients cannot be candidates for EVAR.

At the stage of planning and evaluating the possibility of EVAR the following details are analyzed first of all:

1) whether the intervention is indicated, namely, whether the pathology of the aorta, primarily the aneurysm, is "ripe" for surgical treatment. According to modern guidelines, an aneurysmal sac size of more than 55 mm in men and 50 mm in women, according to multispiral computed tomography (MSCT) data, is an indication for intervention.
2) whether the site of vascular access, especially femoral artery, its size, arterial quality, calcification, aneurysmal transformation, is sufficient. As a rule, the diameter of the artery in this area is 8 – 10 mm, which in most cases is enough to perform an operation.
3) how sufficient are the sites of proximal and distal positioning of the stent graft. The immediate effectiveness of endoprosthetics, as well as the long-term results of the operation, are largely determined by the correct selection of patients and the tightness of the sac insulation in the infrarenal segment and in the distal graft implantation area.

The anatomical indication for aortic endoprosthetics is the

length of the unaffected infrarenal neck of at least 10 mm. In addition to the actual length of the proximal aneurysmal neck, its shape is of no less importance.

The assessment of the proximal neck by length, diameter, calcification, thrombus and degree of angulation is often the first step in intervention planning. At the same time, in elderly patients, patients with significant commorbidity, traditional surgical correction is debatable.

One of the proposed options for stratification of aortic endoprosthetics operations according to the complexity of the procedure can be divided into three categories: standard, complex and supplemented [1].

A standard EVAR is defined as the implementation of a traditional endovascular intervention without additional interventions, which is usually performed in AAA patients with appropriate anatomy. A complex EVAR is defined as an EVAR for the uxtarenal AAA, which requires revascularization of the visceral arteries, the application of fenestrated EVAR and variants of parallel graphs [2, 3].

Supplemeted is defined as the standard EVAR, in combination with the optional endovascular intervention, such as embolization or revascularization iliaca interna, as well as the application of fixed zone of proximal implantation (in our case, the device "Aptus Heli-FX") [4-6].

The proximal neck is short if the distance between the lower renal artery and the beginning of the aneurysmal sac is less than 10 mm. The shape of the neck is conical if the difference between the proximal and distal diameters of the neck is greater than 4 mm [7].

In modern practice, various techniques of EVAR in patients with unfavorable proximal neck use fenestrated stent grafts, the various variants of the so–called "scallop" devices, but also the methodology of parallel grafts.

Preparation of a fenestrated endoprosthesis usually takes a lot of time and is a rather expensive treatment option. The use of different variants of parallel graphs, as well as the scallop technique, is associated with an increased likelihood of endoleakage, and also raises doubts about the duration of such treatment [8].

The Pericles study analyzed 898 EVAR cases using the parallel Graft method, in this case the chimney method, in 517 patients who underwent interventions between 2008 and 2014, retrospectively. With an average follow-up period of 17.1 months, the primary patency was 94%, the secondary patency was 95.3%, and the overall survival rate of patients was 79%. Intraoperative endoleaks type IA were seen in 41 (7.9%), in 21 were at the time of EVAR. In other cases, the disappearance of endoleaks was recorded in all but 2 of these patients during control tomography in different observation periods. The results also show that endoleaks type Ia can be minimized, forming not less than 20 mm zone of the proximal neck. [9].

In addition, an important factor of success of the operation was the exceeding (oversizing) diameter endoprosthesis in terms of the diameter of the proximal neck of the aneurysm to 30%, which is slightly more than oversizing in standard cases (~ 20%).

According to the authors, the formation of so-called gutters, a problem that is specifically inherent in the technique of parallel graphs, represents a benign condition in most of the cases treated.

Recently, more and more applications are acquiring "endovascular" devices of mechanical fixation "Aptus Heli-FX" “Medtronic”, USA, which significantly expanded the possibilities of interventions in patients with an aneurysm of the abdominal aorta and the unfavorable proximal neck of the aneurysm [10].

The device consists of a feeding, controlled catheter, a proximal mechanical part and a cassette with metal fuses that look like screws. The process of loading the anchors and implantation occurs automatically by activating an electric motor mounted in the system. There are 8 anchors in the cassette. When implanting the device, the metal lock can be corrected.

The "metal holder" is loaded into the delivery catheter, the catheter is angulated and rests on the aortic wall at the site of the diligence of the graft. In the case of adequate positioning, the anchors is automatically removed from a catheter, screwed into the wall of the aorta by the graft material, providing a reliable and stable fixation of the endoprosthesis in the infrarenal position. As a rule, 6 to 8 devices are implanted along the graft circle [11].

The aim of our work was to collect and analyse the immediate results of the EVAR application in patients with unfavorable aneurysm neck anatomy (hostile neck).

2. Materials and Techniques

With increasing experience and the introduction of new technological approaches, we are expanding the range of interventions and indications for EVAR interventions. Thus, over the past year and a half, we have analyzed 18 consecutive AAA patients who have been operated on with use of EVAR techniques.

When analyzing the anatomical features of the aneurysmal sac, 8 (47.0%) of patients were assigned to patients with the so-called "hostile neck".

The complex of preoperative examination included general clinical methods (clinical and biochemical blood tests, ECG, ultrasound of the heart, ultrasound examination of the vessels of the lower extremities and the aorta). If necessary, the patients underwent coronarography before or at the time of the operation. The protocol of the clinical examination included various methods of imaging the aorta and its branches.

Planning of the operation in the preoperative period was based on highly informative spiral computed tomography - MSCT with contrast enhansment. In the immediate postoperative period (1-3 days) to control the presence and determine the type of endoleaks in aneurysmal sac, as well as the state of the visceral and pelvic arteries we preferred method of ultrasound duplex scanning and only in disputable cases returned to the methodology of MSCT. The spiral scans were performed in the "Helical" program at intervals of 1.5 to

2.0 mm, followed by a computer reconstruction of the native images into multiplanar projections. The final stage of the study was the three-dimensional modeling of the affected aortic area to determine its shape and extent.

Table 1. *Characteristics of patients and interventions performed by the "hostile neck" group.*

Patient	Age	ØAAA (mm)	The shape and length of the neck of the aneurysm	Type of interventions
1.	71	65	8 mm short neck	*Supplemented* Implantation of Aptus Heli-FX devices (7 anchors)
2.	66	66	tapered neck	*Complex* EVAR and "chimney" implat on one renal artery
3.	59	66	Short neck 5 mm	*Supplemented* Implantation of Aptus Heli-FX (implantation of 6 anchors)
4.	65	59	Short neck 3-4 mm	*Complex* EVAR + bilateral "chimney"
5.	61	77	Short and tapered neck 10 mm	*Supplemented* Implantation of Aptus Heli-FX (implantation of 6 anchors)
6.	54	54	Short neck 13 mm	*Supplemented* Implantation of Aptus Heli-FX (implantation of 6 anchors)
7.	82	72	Short neck 10 mm	*Supplemented* Implantation of Aptus Heli-FX (implantation of 6 anchors)
8	68	66	Short neck 10 mm	*Complex* EVAR and "chimney" of the left renal artery (urgent)
9	72	65	Short neck 9 mm	*Complex* EVAR and "chimney" of the right renal artery

Such a study made it possible to determine the presence of indications and contraindications to the intervention, the possibility of EVAR, the possibility of complete endovascular treatment, as well as monitoring the course of the disease and the state of the aneurysmal sac in a follow-up period after the operation. All 18 patients, depending on the anatomical features of the abdominal aortic aneurysm, were divided into 2 groups. he first group of patients consisted of patients with unfavorable proximal neck aorta (hostile neck) – 9 patients (Table 1). The second group consisted of patients with a standard abdominal aorta aneurysm (9 patients).

The anatomical features of the aneurysm condition in the patient groups to be compared are presented in the table 2. The average age of patients was 63-65 years, all male patients, CAD were registered in 6 patients of group I and in 5 patients of group II.

The previous aorto-coronary bypass surgery was transferred from 2 patients (one from each group). Arterial hypertension was detected in 70% of the examined patients.

When analyzing the anatomical features of the abdominal aorta, it was found that the main difference in the groups was the length of the proximal aneurysm neck - 37.6 mm in the group of standard patients and only 9.8 mm in the group of patients with an unfavorable neck. In patients with an unfavorable neck, a slightly larger diameter of the aneurysm neck was noted (24.7 vs 22.7 mm), and also in patients in group I there was a tendency to initially larger aneurysmal sac sizes (64,9 vs. 59,1).

Table 2. *Anatomical features of the abdominal aorta of the examined patients.*

Parameter	Age (yy)	CHD.	Previous CABG & PCI	Proximal neck length (mm)	Proximal neck diameter (mm)	Aneurysm diameter (mm)
Group I (n-9)	63.1±9.91	6	1	9.8±5.6	24.7±2.1	64.9±7.4
Group II (n-9)	63.2±5.5	5	1	37.6±12.6	22.7±3.7	59.1±8.4
P	0.87	0.5	-	0.0003	0.53	0.11

The method of EVAR with proximal fixation devices in our cases had some steps: after the complete installation of the aortic stent with an operating catheter with a curvature size of 22-24 mm, 6-8 mechanical fixations were implanted in the infrarenal position in 2 rows. When implanting the anchoring devices, front and back and orthogonal projections are used. Control angiography testified to the complete exclusion of the aneurysmal sac from the bloodstream, the type IA endoleak was fixed in 1 case, immediately after the intervention, MSCT examination revealed absent at the time of discharge.

When carrying out the chimney technique, in our cases we used mono/bilateral, transbrachial, interventional access. For implantation, aortic stentgraft access was used traditionally, surgically, biphemorally. A completely endovascular approach, with exclusively endovascular approaches, can also be applied, which is determined by the condition of the femoral arteries at the site of access. In one case, in a patient with a short proximal neck, in an effort to preserve the zone of proximal graft implantation, the left renal artery was covered with a complete cessation of blood flow in the artery, which required emergency recanalization of the arteries and installation of an uncovered metal renal stent.

In group I, in 5 cases, the method of endoanchor implantation was used in parallel with the implantation of the endurant stent graft.

In 4 cases, the method of proximal neck extension with use of parallel grafts was performed, and in 3 cases with 1 renal

artery “chimney”, in one case with stenting of the two renal arteries with the application of 2 stent grafts "Advanta", which led to the increase of the proximal implantation zone to 16-20 mm.

Focusing on the technique of parallel grafts, it should be noted that in our planned cases, puncture transbrachial bilateral or unilateral access was used using the “COOK” 7F shuttle introducer, 80 cm long in the form of MP or straight. To cannulate the renal arteries, a JR 5F or 6F coronary catheter was used, which was placed in a shuttle and a polymer-coated guidewire "Stiff angled" 0.035". After cannulation of the artery with a diagnostic catheter, for a stable position, the wire can be changed to a standard diagnostic guidewire of 0.035" or 0.038" with a length of 260 cm without a polymer coating with a soft J-shaped tip, but with sufficient rigidity for good coaxial support (like "Rosen" from Cook Company). After the wire and the diagnostic catheter, both shuttle introducers are passed into the renal arteries, but not to the ostium of the artery, as with standard renal stenting and slightly deeper at 1-1.5 cm. In this position, the diagnostic catheter can be removed from the shuttle.

After this stage of the operation by femoral access, aortic endoprosthesis is implanted and performed in accordance with the standard rules, but in our case not already in the infrarenal position and up to the ostium of the superior mesenteric artery to cover the introducers, positioned inside the real artery/ies. After the correct positioning of the endoprosthesis, peripheral stent grafts of appropriate size and length are directed into the renal arteries and the shuttles are removed. In our case, it is an "Advanta" stent-graft with a diameter of 6 mm and a length of 32-38 mm, which is positioned proximally to the upper edge of the aortic graft or slightly higher. I It is worth speaking about the choice of the size of the renal stent graft. If the diameter does not cause problems and correspond with the diameter of the stented renal artery, then the length is a calculated indicator. According to modern ideas, the depth of stent positioning in the renal artery should be about 15-20 mm in order to reliably fix the renal graft. In addition, it is necessary to add the distance from the renal artery to the ostium of mesenteric artery in case of double “chimney”, or to the ostium of upper real artery in case of single “chimney” where the coated proximal end of the aortic stent-graft is located. Such calculations are suitable for the application of the technique with stenting only of the renal arteries. The control angiography testifies to the validity of the created design. Our experience with this technique indicates the effectiveness of the approach.

Analyzing the features of EVAR in the compared groups, it is worth paying attention to certain differences, which are fixed in groups I and II. (Table 3).

Table 3. *Features of the operations.*

Parametr	EVAR duration (min)	Amount of contrast agent used (ml)	Radiation time (min)	Duration of stay in the hospital after EVAR (days)
Gr I (n-9)	221,4±48,0	360,14±64,7	44,0±17	6,14±1,35
Gr II (n-9)	155,6±52,5	255,6±88,2	26,3±8,5	5±1,22
P	0,01	0,031	0,01	0,1

It can be expected that the operation in patients of group I was characterized by greater technical complexity and lasted correspondingly longer (221 against 155 minutes), accompanied by a significantly higher radiation exposure – the radiation time was 44.0 and 26.3 minutes, respectively, in groups I and II, as well as a larger amount of the contrast medium used. By analyzing the complications and the length of stay of patients in the clinic in the postoperative period, which indirectly reflects the presence of complications, no significant differences were found. Thus, no operational deaths were recorded, as well as no significant cardiovascular events. For one case, in each group, immediately after the operation, an endoleak of type I A was fixed with control angiography, which disappeared at the time of control ultrasound or CT (4-7 days).

3. Conclusion

The use of additional techniques in case of unfavorable proximal neck (hostile neck) in patients with aneurysm of the abdominal aorta significantly expands the possibilities of endovascular treatment, especially in patients with disabilities of traditional surgical correction.

The differentiated approach to the selection of the method of treatment, as well as adjuvant technical techniques and technologies, is based on a careful analysis of the original MSCT. With unfavorable anatomical features of abdominal aortic aneurysm, the traditional surgical approach is preferred. If the possibilities of surgery are limited due to concomitant diseases, advanced age or preferences of the patient, we used the following algorithm in our observation:

1) with a conical proximal aneurysm, but of sufficient length, we used Aptus Heli-FX proximal fixation devices, specifically if the patient's life expectancy is more than 10 years, with the hope that this additional option will raise the durability of the EVAR result.
2) an isolated short neck of an aneurysm or in combination with its conical shape is not a favorable anatomy for standard aortic endoprosthetics. In such cases, the method of parallel grafts was used (in our case, "chimney"). With a sufficient length (18 to 20 mm) of the new infrarenal implantation area, no additional mechanical fixing devices were used by us.

It is worth noting that performing the above operations requires a certain experience, the operations take longer, and also require the use of more contrast medium and radiation time.

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