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## Comparison of treatment methods of abdominal aortic aneurysm (AAA) – review

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### Abstract

**Introduction:** An aneurysm of the abdominal aorta (AAA) is a local aortic dilatation, most often below the departure of renal arteries. It is becoming an increasingly common health issue amongst people over 65 years of age and poses a direct threat to life. However, early diagnosis, proper treatment and postoperative care significantly increase the chances for long-term survival. The currently available methods of treatment of an abdominal aortic aneurysm are surgical and include classical or endovascular approach. The classical method is an open operation consisting of the replacement of a changed section the aorta for a vascular prosthesis. Endovascular surgery protects the aneurysm from rupture by placing the peripheral vascular stent-graft access to the light of the aneurysm.

**Aim and method:** Comparison of two methods of treatment of abdominal aortic aneurysm: classical and endovascular in patients. We searched through the PubMed database and took into consideration all of the results available as of September 2020 and outlined the current evidence regarding AAA etiology, symptoms, clinical course, diagnosis and treatment.

**Results and conclusion:** Both classical and endovascular methods have similar long-term survival rates. More early complications can be observed in the classical method and late complications in the endovascular one. The choice which method the patient should be treated with should depend on the operators' experience with the method and their individual approach to the patient.

**Key words:** abdominal aortic aneurysm, classic method, endovascular method,

## **Introduction**

An aneurysm is a baggy widening of the artery due to congenital or acquired vascular wall pathology. The term "aneurysm" in Latin "aneurysma" is derived from the Greek word for "dilatation". For the abdominal aorta, the correct vessel size is assumed to be between 15 and 25 mm, depending on gender, age and weight. Aneurysms are the widening of the vessel by more than 50% of the correct width [1]. Abdominal aortic aneurysms commonly reach a size between 3 and 15 cm.

Abdominal aortic aneurysms can be divided into three categories: "true" aneurysm, delaminating aneurysm and pseudoaneurysm. The "true" aneurysm, on which we will focus on in this article, is the vast majority of abdominal aortic aneurysms. The wall of an aneurysm consists of all layers of the vessel wall. The most common location is the aortic segment between the renal arteries and the aortic division into the common iliac arteries. A delaminating aneurysm consists of the stratification of the inner membrane with subsequent bleeding to the middle layer. The pseudoaneurysm is formed by trauma or iatrogenic. The injury produces a hematoma. The organization of the wall thrombus leads to the formation of a membrane surrounding the aneurysm (pseudo-wall).

The most important risk factors for AAA include age over 50, male gender, nicotine use, hypertension, atherosclerosis, and the occurrence of AAA in the first degree relative.[2][3]

## **Epidemiology**

The number of abdominal aortic aneurysms has increased over the last 20 years. This is related to the aging of the population and the increase in their detectability due to the spread of different diagnostic methods. Based on autopsy studies, the frequency of abdominal aortic aneurysms ranges from 0.5% to 3%. The number of abdominal aortic arteries increases with age reaching its peak in the seventh and eighth decade of life. White men have the highest risk of developing abdominal aortic aneurysms, whereas they are uncommon in Asian, African American, and Hispanic individuals [4]. Based on an ultrasound screening of the Malmo population, the researchers found that 4.3% of men and 2.1% of women had an abdominal aortic aneurysm. [5]

### **Pathogenesis**

Most people with abdominal aortic aneurysm have atherosclerotic lesions in the vascular interior membrane. AAA is considered a late complication of atherosclerosis of the abdominal aorta. AAA may also be caused by chronic inflammation (Chlamydia Pneumoniae, Helicobacter, Brucella, Salmonella, Mycobacterium Tuberculosis, Treponema Pallidum, vasculitis) [6], genetic factors (Marfan's disease, Ehlers-Danos disease), or mechanical factors (tensile forces exerted by blood pressure).

AAA tends to occur when there is a structural abnormality of vascular wall proteins. The consequence of this is a gradual deterioration of the abdominal aorta wall. A reduced amount of proteins such as elastin or collagen has been observed in people with AAA. [7][8][9] The amount of collagen in the abdominal aorta walls is physiologically reduced below the renal arteries' departure, which results in the most common AAA site being below the renal arteries' departure and the division of the abdominal aorta into the common iliac arteries.

### **Diagnosis**

The vast majority of abdominal aortic aneurysms are detected accidentally during examinations in another direction. The diagnosis is usually based on the results of an ultrasound. In some cases, a CT scan is needed to determine the exact location and size of the aneurysm.[10] Ultrasound is used for screening but is less accurate in detecting abdominal aortic aneurysms above the renal arteries because of the overlying air-containing lung and viscera. During the examination, the common iliac arteries must always be checked. Their

dilatation may indicate an abdominal aortic aneurysm which may have been previously overlooked. CTA and magnetic resonance angiograms can also be used to determine the exact anatomy of the aneurysm.

### **Symptoms and clinical course**

We can distinguish 3 types of clinical course of abdominal aortic aneurysm. The vast majority of abdominal aortic aneurysms are asymptomatic.[11] Unspecific symptoms such as: feeling of fullness after meals, unspecific pain in the abdominal cavity, feeling of pulsation in the abdominal cavity or symptoms related to ischemia of the limbs, heart, kidneys or central nervous system. Most such aneurysms are detected accidentally during the examination. Symptomatic aneurysms are those that give symptoms such as compression symptoms, imitation sciatica, radiation of pain to the perineum or testicles, swelling of the lower extremities, pulsating tumor in the abdominal cavity, weight loss, and microspin. The last type of aneurysm is a ruptured aneurysm, which requires immediate surgical treatment. A ruptured abdominal aortic aneurysm gives symptoms such as: sudden, severe pain in the lumbar region radiating to the lower abdomen and perineum, hypovolemic shock, pulsating tumor, machine murmur in the mid-abdomen, gastrointestinal bleeding.

### **Treatment**

The only method of treating an aneurysm is surgery. Emergency mode is for a ruptured aneurysm. Only an immediate treatment can save the patient's life. All diagnostics should be kept to a minimum. For the diagnosis of this condition, a physical examination, supported by basic tests (image and hemorrhagic shock exponents) should be sufficient. All actions should be aimed at stopping the bleeding as soon as possible. Urgent procedure is for symptomatic aneurysm. It is an indication for hospitalization and urgent diagnostics. If it confirms or does not exclude rupture, immediate surgery should be performed. If vascularization is excluded, surgery can be postponed for several days (urgent procedure). Usually this allows the patient to be brought to an optimal state (wider diagnostics, necessary consultations, treatment of aggravating diseases), which makes the procedure conditions and prognosis significantly improve. Absolute contradictions for surgery include circulatory failure, respiratory failure, kidney failure and critical narrowing of the carotid arteries. Contraindication for endovascular surgery is an aneurysm neck shorter than 15 mm. It prevents the stent-graft from being

anchored in a way that saves renal arteries. For endovascular surgery, the "implantation criteria" must be observed. This term means the ratio of an aneurysm to adjacent aortic segments. They are determined by CT angiography and subtraction angiography. The transverse dimensions are best suited for the determination of the transverse dimensions and for the longitudinal angiography with a calibrated catheter. The diameter of both ends of the stent-graft, its length and possibly the number of modules needed to supply the entire aneurysm with curvature lumen are then determined.[12]

### **Classic method**

The operation is performed under general anesthesia from the central access.

The first step is to expose the retroperitoneal space and locate the neck of the aneurysm, on which a vascular clamp is placed. Then the front wall of the aneurysm is cut open and thrombotic material is removed.

The key stage of the operation is to sew in a vascular prosthesis: straight or forked, depending on the extent of the aneurysm. The ends of the denture are cut to create a tongue increasing the length of the aneurysm. The anastomosis is performed with a continuous monofilament suture not absorbed, starting from the back wall of the denture. The proximal anastomosis is performed first. It is the "end to end" anastomosis. If the aneurysm includes the renal arteries, they should be attached to the denture or performed outside the anatomical bay with the aortic segment located higher. Then the circulation in the abdominal section of the aorta and lower limbs is restored. The denture is covered with the excess of the left wall of the aneurysm creating a "muff" that seals and makes it easier to insert the denture. The procedure ends with leaving the retroperitoneal space drainage and closing the layers.

### **Endovascular method**

The endovascular procedure starts with the preparation of the femoral arteries, inside which vascular sluices are placed. During the procedure they are replaced with appropriate systems, which contain stent-graft. The borders of the incision on the iliac artery are sewn together. The upper part of the denture is then anchored and developed below the renal arteries. On the opposite side, the stent-graft is attached. The stent-graft arms are most safely developed in the common iliac arteries, which are located below the internal iliac arteries. When the aneurysm passes from the aorta to the common or internal iliac arteries, the endings of the stent-graft

arms should be located in the healthy arteries. The next stage of the procedure requires pressing certain parts of the prosthesis using a special balloon catheter. This mainly concerns the module connections and proximal stent-graft elements. At the end of the procedure a control arteriography is performed. The location of the stent-graft, the flow through the arterial vessels (renal, hip joint, internal) is also evaluated. If no abnormalities are found after the examination, the introducers are removed from the femoral arteries. The inflow and outflow in the arteries are then checked. The procedure ends with the suturing of vessels with single vascular stitches, paying particular attention to hemostasis. The clinical indications do not differ from those proposed for classical surgical technique. Due to limited knowledge of the results of distant surgeries, it is considered that this method should be reserved for patients who are at highest risk or who do not qualify for classical surgery at all because of the comorbidities.

## **Complications**

One of the factors influencing the number of complications is the size and location of the aneurysm. There is a correlation between the size of the aneurysm and the percentage of complications. A particularly high number of complications occurs in cases of aneurysms reaching above the renal arteries. In such patients, postoperative renal failure is more common as a result of temporary ischemia.

### *Classic method*

The occurring complications can be grouped into three main groups: intraoperative, early (up to 30 days after surgery) and late (over 30 days after surgery). Among the intraoperative complications, the most common are hemorrhages during the insertion of a vascular prosthesis. They may also be caused by the damage to the inferior vena cava, iliac vein or left renal vein. Therefore, it is sometimes necessary to ligate and cut the left renal vein. This is a procedure which in most cases does not cause more serious complications but may be one of the causes of temporary or permanent left renal insufficiency or even rupture. Sometimes it is necessary to ligate the inferior mesenteric artery. In the vast majority of cases after ligation, at the point of departure from the aorta, the circulatory system is preserved and only in a few cases is colorectal ischemia occurring. The second group are early complications occurring up to 30 days after the procedure. Early complications can be divided into local and general.

Local complications include hemorrhages at the site of vascular anastomoses, denture thrombosis and peripheral artery blockages. Sometimes temporary symptoms of ischemia of the left half of the colon may occur, requiring thorough endoscopic control. Lymphatics and infections may also occur. Early postoperative general complications include respiratory failure, circulatory failure, acute renal failure, gastrointestinal bleeding, nervous system complications and coagulopathies (e.g. DIC). Late complications are primarily the obstruction of the vascular prosthesis. The occurring prosthesis thrombosis may be caused by a technical error during surgery or by progression of atherosclerotic changes. A thrombectomy is then performed and the causes of the obstruction are removed. Another complication is the occurrence of aneurysms at the anastomosis sites, usually with coexisting prosthesis infections. Very dangerous complications are fistulas between the aorta (at the point of its anastomosis with the vascular prosthesis) and the vena cava or duodenal lumen. They require emergency surgical intervention.

#### *Endovascular method*

The most common complication of the endovascular method are endoleaks. They lead to migration of the stent-graft (change of its position by more than 5 mm from the original position) or destruction of the stent-graft structure, therefore regular inspections are necessary. This leads to more frequent surgical reinterventions in the group of patients treated by endovascular method. Other possible complications are thrombosis and infection of the endovascular prosthesis.

### **Comparison of treatments**

The main finding after 4-15 years of observation of this randomized studies was that there is no significant difference in overall survival between open and endovascular procedures in patients with abdominal renal aortic aneurysms, despite the steadily increasing number of secondary procedures after endovascular procedures. After the known initial benefit of survival after endovascular repair in the first 6 months and the subsequent disappearance of this advantage in the mid-year period between 6 months and 6 years of age, further parallel survival curves over 6 years are observed. Despite the fact that no increased aneurysm-related mortality was observed, the occurrence of death from an aneurysm rupture after 6 years of observation in patients after endovascular repair illustrates the lack of persistence and underlines the need for continuous close endographs supervision. This problem is amplified

by the number of secondary interventions associated with the use of an endovascular repair stent more than 6 years after randomization.

During the long-term observations, there was no difference in survival between patients undergoing classic or endovascular repair of an abdominal aortic aneurysm, despite a steadily increasing number of re-interventions in the endovascular group. Endograft durability and the need for continuous endograft surveillance remain key issues.[13][14][15][16]

## Conclusion

Abdominal aortic aneurysm is a serious threat to the patient's life. Currently, we have two methods of surgical removal of abdominal aortic aneurysm: classical method and endovascular method. Studies have shown that the survival of patients after a long time in both methods is very similar. The choice which method the patient should be treated with should depend on: the operators' experience with the method and their individual approach to the patient. (The higher the comorbidities, the more endovascular method is preferred).

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