CHAPTER VI - Aneurysma of the aorta

6. 1. **Definition.** Aneurysm means a vessel permanently dilated of at least 1.5 times compared to its normal size, whose wall consists of all three parietal layers (intima, media and adventitia). Pseudoaneurysm, false aneurysm, is an accumulation of blood around the vessel resulted by tearing its wall and delimited by the surrounding structures. In their evolution aneurysma may dissect, by intima tearing, bearing the name of dissected aneurysma, as aneurysma can develop after an undiagnosed or untreated aortic dissection, thin vessel walls stretch and therefore the vessel dilates.

**History.** Starting from the statement of Sir William Osler, the great English physician: “there is not a disease that may lead to more clinical humiliation than aneurysma of the aorta”, it is understandable that vast efforts were made along four centuries after their description by Antoine of Sapori, Vesale until their surgical approach became successful, regardless of location, only in recent decades. Great physicians and surgeons have linked their name on the study and therapy of aneurysmsa during the long evolution of medicine. Starting with simple ligation of aneurysm introduced in 1535 by Ambroise Pare, continuing with the exceptional description made by Hunter brothers, 1757 “The History of Aneurysm of the Aorta with Some Remarks on Aneurysms generally”, with recommended endoaneurysmoraphy by Rudolf Matas, with the studies of that marked the modern vascular surgery era by Alexis Carrel, 1921, taken at its peak by famous names of cardiovascular surgery: Stanley Crawford, Denton Cooley, De Bakey, Bentall, DeBono, who standardized techniques which now have become routine.

**Classification.** Aneurysms are described according to: size, location, morphology and etiology.

Table I. Classification of aortic aneurysma after location in the aorta.

<table>
<thead>
<tr>
<th>Type of Aneurysm</th>
<th>Description</th>
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<tbody>
<tr>
<td>Aneurysma of ascending aorta</td>
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<tr>
<td>Aneurysma of aortic arch</td>
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<tr>
<td>Aneurysma of the descending aorta</td>
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<td>Thoracoabdominal aneurysma</td>
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<td>Aneurysma of the abdominal aorta</td>
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<tr>
<td>- Infrarenal</td>
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<tr>
<td>- Above the renal arteries</td>
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<tr>
<td>Associated aneurysms, ascending aortic + arch, complete thoracic aorta</td>
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Table II. Classification of aneurysma according to etiology

- Degenerative - atherosclerotic
- Congenital - Marfan syndrome, Ehler-Danlos syndrome, annuloaortic ectasia
- Inflammatory
- Infectious - specific (syphilis), nonspecific (Staphylococcus, Salmonella), mycotic
- Trauma - traffic accidents.
- Mechanical - poststenotic
- Anastomotic

Regarding the morphological form we meet aneurysms: fusiform and saccular

6.2. **Symptoms and signs of thoracic aneurysma**

Aneurysma remain asymptomatic for long time until the moment they are discovered by routine examinations. With their growth in size, also depending on their location they may become clinically manifest by compression of surrounding structures: airways, nerve structures, laringeal recurrent nerve and esophagus. Sometimes the diagnosis is made only when complications occur: rupture, dissection or distal embolism. Pain, the symptom that persuades the patient to address to a physician may occur late with the compression of the nerve structures or erosion of bone structures.

**Clinical examination**

Can detect systolic or diastolic heart murmurs, signs of valvular aortic stenosis or regurgitation. Systolic murmurs located on the main vascular axes and decrease or absence of distal pulses may be signs of a process of atherosclerosis with multiple sites of clinical expression. Palpation of the aneurysm is possible in abdominal or peripheral localizations. Pain intensification with signs of hemorrhagic shock may be the signs of
aneurysm rupture that can be fatal if it occurs in open cavities (pericardium, pleura, and peritoneal cavity) and it is not operated immediately.

6.3. Paraclinical diagnosis of aortic aneurysms

Thoracic aortic aneurysm may be suspected if a routine chest X-ray examination shows an enlargement of the mediastinal shadow (Fig. 2).

The most accessible paraclinical examinations are transthoracic and transesophageal echocardiography and peripheral vascular Doppler, which provide information on location, size of aneurysms on the ascending aorta, aortic arch, descending thoracic aorta. They also investigate heart functional status, valvular apparatus, detect valve stenosis or regurgitation, cardiac functional parameters (Fig. 3).

![Fig. 2. Enlarging mediastinal shadow in a patient with aortic stenosis and poststenotic aneurysm of ascending aorta](image1)

![Fig. 3. Echo shows aortic regurgitation and ascending aorta aneurysm poststenotic in a patient with Marfan syndrome](image2)

**Computerized tomography (CT scan).**

It is a method with high accuracy, especially spiral CT angiography with threedimensional reconstruction that brings accurate data on aneurysm location, size, relationship with surrounding structures and allows monitoring the evolution in time.
Another modern method of investigation of aneurysms is magnetic radionuclide imaging (MRI), which investigates morphofunctional, three-dimensional and noninvasively the heart and the vascular structures without dye injection. It allows direct visualization of the aortic aneurysm, intraluminal thrombosis process, identifies dissection with false and true lumen, identifies of significant collateral vessels and delimitation from surrounding structures. Threedimensional images are of high accuracy and their rotation in $180^\circ$ clarifies the relationship with surrounding structures in all planes. Mapping of the flow identifies collateral vessels with diameter larger than 6 mm. Another advantage of MRI is the estimation of function of both ventricles and the myocardial wall thickness.

**Aortography and coronary angiography.**
Until recently the most important investigation in evaluating aortic aneurysm, it was replaced by noninvasive methods of greater accuracy as echocardiography, CT and MRI. However, angiography still keeps its value in assessing aneurysms regardless of location and provides additional information required by surgical indication. It specifies aneurysm location and assesses its inner size and also investigates the entire arterial vascular system: coronaries, aorta, upper aortic trunks, visceral and peripheral arteries, evaluating the patient completely. The most useful information is about the status of coronary system, knowing that coronary lesions are associated with coexisting aneurysma.

**6.4. Natural evolution.** Untreated aneurysma increase in size, regardless of location, until they become symptomatic, rupture or give other local and systemic complications. Natural evolution process does not comply strictly mathematical, but it is known that some forms, the infectious or postdissection, evolve quickly to rupture. Bickerstaff's retrospective studies have found a 58% survival rate at one year for thoracic aneurysms and 19% in five years. From the onset of symptoms until rupture, the average time
interval is 2 years. Intraaneurysmal thrombosis is another danger of complications because of the distal embolism: cerebral, visceral or peripheral. Surgical indication should balance the rate of operative mortality and complications with the rate of mortality by natural evolution.

**6. 5. Treatment of horacic aortic aneurysma**

Patients with aortic aneurysm should be considered and treated according to the complexity of its pathology. A correct sequence of surgical procedures should address different lesions: aneurysm, coronary artery disease, carotid artery disease or peripheral artery disease. Additionally, postoperatively the patient is framed in a comprehensive treatment system to control cardiovascular risk factors (smoking, hypertension, diabetes, hiperlipoproteinemia) and checked regularly.

**6. 4. 1. Indications for surgical treatment**

The optimal time of surgery remains to be customized for each case.

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- ascending aortic aneurysma of any etiology, symptomatic in size over 6 cm in diameter or twice the normal diameter of the aorta.
- aneurysma over 5 cm in Marfan syndromes.
- ascending aortic aneurysma associated with aortic regurgitation or aortic stenosis.
- immediate or late aneurysma occurring after acute aortic dissection processes
- Valsalva sinus aneurysma complicated with intracavitary fistulas
- Mycotic aneurysma
- Pseudoaneurysma complicating the Bentall operation

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**Preoperative preparation.** Full investigation is the most important element in the complex strategy of the team formed by surgeons, anesthetists, cardiologists and cardiotechnicians. On the quality of surgery and on the intra-and postoperative care depends the evolution of this category of patients.

**Surgical technique.** The goal of surgery is resection of the aneurysm and restoration of aortic continuity with a tubular prosthesis-graft or conduct, to prevent rupture and patient death.

Surgical approach depends on the location of the aneurysm: by median sternotomy if the aneurysm is located on the ascending aorta and/or on the aortic arch and by left thoracotomy in the descending thoracic aortic aneurysma. Cardiopulmonary by-pass CBP is used in surgery of the thoracic aortic aneurysma.

**6.4.2. Surgical techniques based on the location of the aneurysm.**
a) - Aneurysma located only on the ascending aorta without affecting the aortic valve. It represents the simplest form which is solved on CPB with resection of the dilated segment and replacement with a tubular vascular prosthesis.

![Fig.5 Aneurysm of the ascending aorta, aortic resection and reconstruction with a tubular prosthesis.](image)

b) - Aneurysma confined to the ascending aorta that are associated with aortic valve stenosis or regurgitation

In these cases it is resected the dilated segment of ascending aorta and the aortic valve is either repaired or replaced. The typical operation for this type of pathology was described by Bentall-DeBono in 1968 and uses a special composite prosthetic graft, the combination of a mechanical valve and a tubular prosthesis.

![Fig.6 Aneurysm of the ascending aorta with aortic regurgitation. Bentall operation is performed with resection of the aortic valve and ascending aorta and reconstruction with a composite graft with coronary reimplantation in the vascular prosthesis.](image)
c) - aortic arch aneurysms

Aortic arch aneurysms are usually associated with the ascending or descending aneurysma of the aorta and rarely are confined only to the aortic arch. In this case for resection of aortic arch and its replacement with a prosthesis a special technique is used, total circulatory arrest in deep hypothermia at 18° C for protecting brain function.

Fig.7 Aneurysm of the aortic arch: replacement with Dacron prosthesis in deep hypothermia and total circulatory arrest.

d) - Thoracic descending aorta aneurysma.

If they are isolated, they may be operated off pump, but if they are extended throughout the descending aorta, CPB may be used for medular protection during aortic cross-clamping and for heart decompression. The operation consists of segment resection and reconstruction of the aorta with a Dacron prosthesis sutured end-to-end

Fig.8 Aneurysm of the descending aorta, aortic resection and reconstruction with a tubular prosthesis.
Early complications are dominated by bleeding, infection, neurological injury (cerebral, medullary), acute renal failure, low cardiac output syndrome, multiorgan failure. **Surgical results.** Postoperative mortality in electively operated aneurysma decreased to less than 5%, being higher in case of complex reconstruction of the aortic arch aneurysma or in the emergency operations. Long-term results are good.

### 6. 4. 3. Aortic endovascular prostheses

It is a new, modern method in treating aneurysma and aortic dissections. It was introduced by E. Buffalo, and consists of placing an expandable prosthesis within the affected segment of the aorta that will constitute the new aortic lumen. It is indicated in:

- Descending aortic dissection, aortic arch dissection, acute and chronic.
- Descending aortic aneurysma limited to the first segment, just under subclavian artery emergence
- Type A aortic dissection with reentry on the descending aorta, when conventional surgical correction of the ascending aorta is performed and an expandable prosthesis is placed in the descending aorta.

The technique has evolved extremely rapidly, approaching both aneurysms and aortic dissection. Japanese authors, Hosokawa & Inoue presented at the Congress in Vienna, July 2000, a paper "stenting of the aortic arch", which describes and illustrates by video the technique of endoluminal prosthesis placement with one arm, two or three arms for dissected aortic arch.

![Endoluminal prostheses](image)

**Fig.10. Endoluminal prostheses**

**Postoperative care.**
The most important thing of intensive care after surgery is blood pressure control. These
measures include: drugs to reduce afterload, beta-blockers, paying attention to bleeding, correction of hypothermia and treatment of coagulopathy, administration of fresh plasma, platelets, fresh blood for the correction of coagulation disorders, neurological examination to detect any signs of cerebral or spinal ischemia.

6. 5. Results.
Results of surgical treatment have improved much in aortic dissection with low mortality up to 7% for type I and II, and 12% for type B (III). Predictive factors for postoperative death: ischemia, renal failure, hemorrhage, cardiac tamponade, pulmonary disease and visceral ischemia. Long-term results are also surprisingly good, with 82% survival at 5 years, 23% at 10 years. Reintervention is usually required for development of aneurysma, redissections, aortic regurgitation. Incidence and significance of late complications require careful follow-up of these patients for early detection and intensive treatment of recurrent aneurysma or dissections.