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Aortic Root and Ascending Aortic Aneurysm Related to One Case. Reimplantation of the Right Coronary Artery by 8 mm Dacron Tube (Cabrol Hemi Mustache) and Review of the Literature

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Abstract

The aortic aneurysm is the 13th leading cause of death in Western countries. The incidence of thoracic aortic aneurysms is estimated at 4.5 cases per 100,000. The diagnosis is often made on a chest x-ray or other imaging tests, such as an echocardiogram done for other heart diseases. Echocardiography is the first test to assess the diameter of the ascending aorta and its progression over time. Most patients are first assessed and followed up with spiral thoracic computed tomography with injection of contrast medium, supplemented by 3-dimensional reconstruction of the aneurysm in order to improve the accuracy of measurements, identification of its proximal part and distal. When dilation of the ascending aorta reaches the critical diameter of 50 mm, there is a risk of aortic dissection or rupture. Supravalvular aneurysms are treated by replacing the ectatic portion with a Dacron® tube in the supracoronary position. Aortic root aneurysms, including coronary ostia, require tube replacement, reimplantation of coronary ostia, as well as surgery on the aortic valve. In this article, we report a case of aneurysm of the aortic root and the ascending aorta treated by aortic valve replacement and the ascending aorta associated with the Cabrol hemi-mustache technique and we review the literature.

Keywords

Aortic Root and Ascending Aortic Aneurysm, Aortic Valve Replacement and Ascending Aorta, Cabrol's Hemi Mustache

1. Introduction

The aortic aneurysm is the 13th leading cause of death in Western countries [1]. The incidence of thoracic aortic aneurysms is estimated at 4.5 cases per 100,000 [1] [2]. Supravalvular aortic aneurysms are less common than aortic root aneurysms and mainly affect males (3 males:1 female). The mean age at diagnosis ranges from 59 to 69 years [3]. For aortic root aneurysms, patients are younger (30 - 50 years), with a sex ratio of 1:1. Aortic aneurysms are degenerative aneurysms and are related to 3 phenomena: proteolysis (degradation) of the extracellular matrix, the gradual disappearance of smooth muscle cells in the media, replaced by areas of mucoid degeneration, rich in vacuoles and polysaccharides sulphated. Aortic root aneurysms (annulo-ectatic aortic diseases) can be idiopathic or associated with connective tissue diseases such as Marfan syndrome, Ehler-Danlos syndrome or valvular bicuspidia [1] [3]. Twenty percent of patients with Marfan syndrome are operated on for an aortic root aneurysm [4]. A frequent association has been well established between aortic valve bicuspid and aortic dissection (10 times more than the normal population) [5]. Chronic dissections of the ascending aorta usually develop with an associated aneurysm [1] [3]. Aneurysm formation following bacterial infection of the lining of the ascending aorta is rare. Syphilis, once the main cause of ascending aortic aneurysms, has become extremely rare today. Arteritis is even rarer; Takayashu's disease usually produces obstructive lesions, but can present with aortic aneurysms in 15% of cases [1]. Giant cell arteritis can also affect the ascending aorta. Rarer, ascending aortic pseudoaneurysms have been described after aortic trauma or infection or at the site of aortic cannulation. The incidence of dissection or rupture of the aneurysm increases with its size [6]. The critical size of the dilated ascending aorta from which the risk of rupture or dissection becomes greater than the risk of elective surgery is decisive for the management of this disease.

In this article, we report a case of aneurysm of the aortic root and the ascending aorta and we review the literature.

2. Clinical Observation

This was a 77-year-old patient referred to us for management of an aneurysm of the aortic root and ascending aorta with massive aortic insufficiency.

The patient was still active but had reduced his activities and complained of dysphonia.

His history included chronic bronchitis, hemi-thyroidectomy and removal of

melanoma in the leg.

Her cardiovascular risk factors were coronary inheritance because her father and sister died of a ruptured aortic aneurysm.

Transesophageal echocardiography revealed 69% left ventricular function, a globular left ventricle with a telesystolic diameter of 60 mm, a tricuspid aortic valve and a high-grade central leak with a regurgitating orifice area of 0.53 cm^2, dilation of the ascending aorta with 53 mm at the valsalva sinuses, a sino-tubular junction measured at 58 mm, and the ascending aorta at 57 mm.

The chest x-ray showed an enlargement of the ascending aorta which gave the upper mediastinum a convex outline (**Figure 1**: Chest x-ray showing an enlargement of the ascending aorta).

The preoperative coronary angiography showed a normal coronary network and dilation of the aortic root and ascending aorta (**Figure 2**). Doppler ultrasound of the supraortic trunks showed no hemodynamically significant lesion.

Respiratory function tests were normal.

The thoraco-abdominal-pelvic CT scan (**Figure 3**) showed aneurysmal dilation of the ascending aorta, with the valsalva sinus at 59 mm, the tubular aorta at 47 mm and the descending thoracic aorta at 28 mm.

The stomatological assessment was normal.

After multidisciplinary consultation, we operated on the patient.

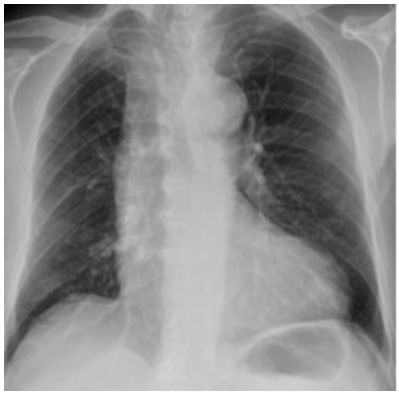


Figure 1. Chest x-ray showing an enlargement of the ascending aorta with a convex outline of the superior mediastinum.

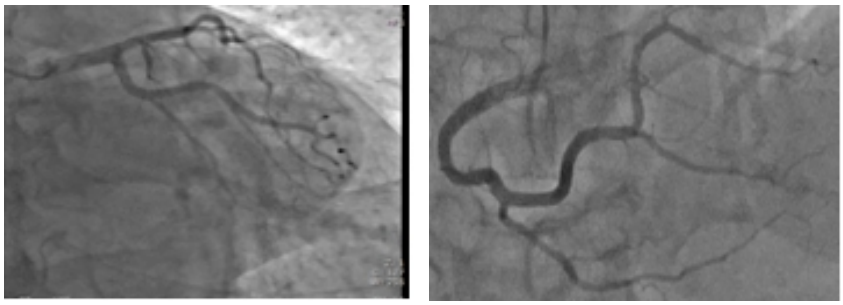
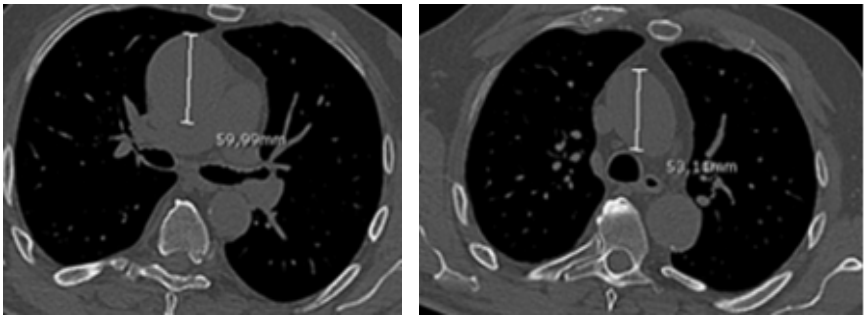


Figure 2. Showing the main incidences of coronary angiography on the left network (left) and on the right network (right). On the aortography, we can see the aneurysm of the aortic root and the ascending aorta.



(a) (b)

Figure 3. Thoracic mediastinal window CT showing the aneurysm of the aortic root (a) and the ascending aorta (b).

The operating protocol is as follows.

Median sternotomy, vertical opening of the pericardium, heparinization and normothermic CEC between an aortic cannula implanted in the arch in front of the left primary carotid and an atriocave cannula, left ventricular discharge transmitral through the upper right pulmonary vein. The ascending aorta returns to a sub-normal caliber about 2 cm upstream from the TABC.

Aortic clamping flush with the TABC, circular aortotomy above the sinotubular junction, iterative anterograde warm blood cardioplegia under the guise of monitoring the septal temperature by thermal probe. Note that above the right coronary ostium there is a calcified plaque, the end of which extends to the right coronary ostium (**Figure 4**). The aortic valve is tricuspid, there seems to be a slight prolapse of the right coronary sigmoid. Excision of this aortic valve, calibration of the ring using Hegar's candle n˚ 29. Selection of a Bio-Integral tube n˚ 29. During the preparation of this bio tube, dissection of the coronary arteries and removal of all aortic tissue up to the native ring. Coronary pimples are detached, taking care not to damage the coronary arteries. Note that at the level of the right ostium there is an early division of the right coronary artery giving an infundibular artery. The coronaries are also relatively ascended to the level of the valsalva sinuses. Positioning of the Bio tube (**Figure 5**) by three thirds of PROLENE 3/0 - 18 overlock tied next to each corner. The assembly is satisfactory. Reimplantation of the left coronary ostium using a PROLENE 5/0 - 13, reimplantation of the distal end of the biological tube using an overlock of PROLENE 4/0. It appears impossible to mobilize the right coronary ostium under suitable conditions to bring it into the usual position on the right neosinus valsalva biological tube. Under these conditions, it seems preferable to carry out an anastomosis using a Dacron tube 8 mm in diameter and approximately 4cm long, making a Cabrol half-mustache. The anastomosis of this tube on the right coronary ostium is carried out with PROLENE 5/0, as is the latero-aortic anastomosis also carried out with PROLENE 5/0 on the antero right face of the pericardial tube.

Careful purging of the cardiac chambers, aortic unclamping, spontaneous resumption of myocardial activity quickly becoming sinus and regular.

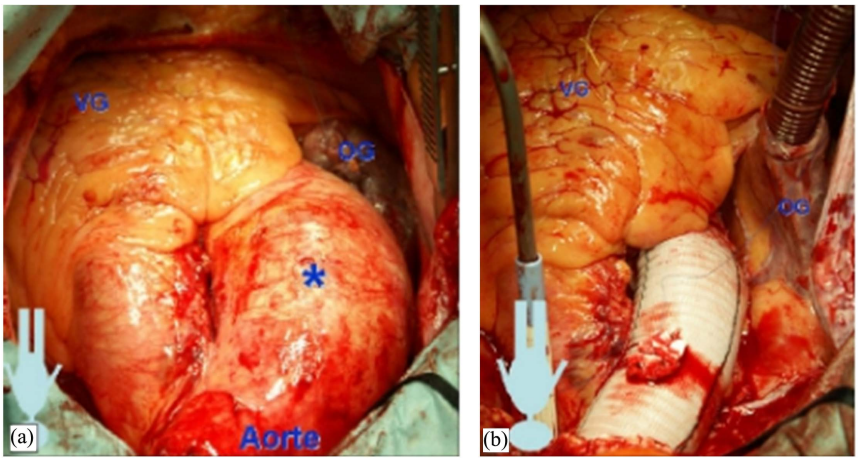


Figure 4. Operative view showing the aneurysm of the aortic root and the ascending aorta (a); Operative view showing the prosthetic tube replacing the aortic root and the ascending aorta (b). LV: left ventricle; AG: left atrium.

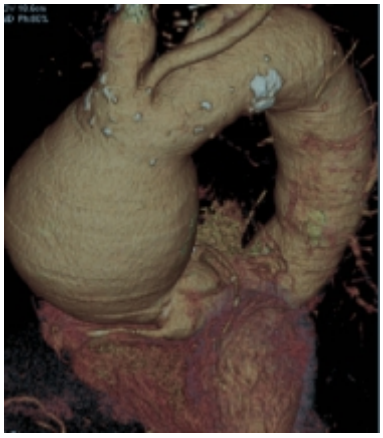


Figure 5. Cardiac CT angiography with 3D reconstruction showing an aortic root aneurysm.

Weaning of the CEC under optimal filling in good hemodynamic conditions. Decanulation, protamine, revision of hemostasis, usual closure on two mediastinal drains, one of which is positioned behind the aortic tube and a retrosternal drain. Two temporary epicardial ventricular electrodes, subtotal closure of the pericardium, sternal closure by seven steel wires, under the skin in three planes and intradermal overlock.

Clamping time: 104 min

CEC duration: 131 min

The consequences in Surgical Resuscitation were simple apart from an episode of spontaneously reduced AF.

The consequences in the cardiac surgery department were also simple. The patient left with good cardiac hemodynamics. The sternotomy scar was clean and the sternum was strong and stable.

His heartbeat was sinus and regular with left ventricular electrical hypertrophy, a slight disturbance of inferior repolarization.

Exit transthoracic echocardiography showed a good left ventricle without para-prosthetic aortic leakage with a mean trans-aortic gradient of 5.65 mmHg.

3. Discussion

Most ascending aortic aneurysms remain asymptomatic for a long time. The diagnosis is often made on a chest x-ray or other imaging tests, such as an echocardiogram done for another heart disease, or performed routinely in a family setting such as Marfan's disease. The onset of acute symptoms in the form of tearing pain strongly suggests impending rupture, or dissection, and is present in 75% of these patients. They can be precordial or also be located in the back. Chronic pain can result from compression of the breastbone and is the first symptom in 25% - 75% of patients. Symptoms are due to pressure of the aorta against adjacent structures such as cough and hemoptysis by compression or erosion of the trachea or bronchus; compression dysphagia of the esophagus, compression dysphonia of the left inferior laryngeal nerve, superior vena cava syndrome and less commonly, fistulas with the right atrium or superior vena cava [1]. Our patient was active but had reduced his activities and complained of dysphonia which was indeed due to the compression of the left inferior laryngeal nerve since it completely disappeared postoperatively.

The clinical examination does little to contribute. An aortic root aneurysm is often associated with aortic failure with a diastolic murmur, or symptoms of heart failure. A thorough vascular examination should be performed to look for concomitant peripheral vascular disease, carotid disease, or sequelae of peripheral embolization [1].

Cardiac auscultation of our patient found a 3/6 diastolic murmur at the aortic focus but there were no signs of right or left heart failure. Lung auscultation was normal and peripheral pulses were noticeable and bilateral.

The clinical signs in the patient with an aortic root aneurysm vary depending on the cause. Patients with Marfan syndrome have skeletal features including: large stature, arachnodactyly, thoracic deformities, and scoliosis [4]. It is essential in patients with thoracic aortic aneurysm to evaluate other family members. Indeed, Marfan syndrome, aortic bicuspidia, familial aortic aneurysms, and familial aortic dissections are often diagnosed for the first time during an "asymptomatic" screening of another family member [4] [5].

Our patient did not have any physical signs of Marfan syndrome and had no significant family history.

Echocardiography is the first test to assess the diameter of the ascending aorta and its progression over time [7]. Most patients are first assessed and followed up with spiral thoracic computed tomography with injection of contrast medium, supplemented by 3-dimensional reconstruction of the aneurysm in order to improve the accuracy of measurements, identification of its proximal part. And distal, the distinction between dissection, penetrating ulcer or intramural hematoma (**Figure 5**).

The diagnosis of our patient was made by trans thoracic echocardiography and confirmed by chest computed tomography.

Magnetic resonance imaging (MRI) helps prevent injection of iodinated contrast medium and x-ray exposure. In addition to cardiac anatomy, MRI can provide an assessment of cardiac perfusion and myocardial function. However, MRI is still more expensive and less accessible than chest computed tomography.

We did not perform an MRI in our patient because the diagnosis was evident from the results of the echocardiogram and chest CT.

Traditional angiography is performed to assess the relationship of the aneurysm to the supraortic trunks, along with coronary angiography as a preoperative workup. In practice, it is recommended to perform 2 echocardiograms and a thoracic CT to assess and confirm the size of the aneurysm. Aortic and coronary angiography is mainly indicated before surgery.

We performed in our patient, coronary angiography and doppler ultrasound of the supra aortic trunks which returned to normal (**Figure 2**).

In asymptomatic patients, medical treatment with β-blockers and follow-up with echocardiography once or twice a year are recommended [8]. More recently, angiotensin II receptor antagonists [notably losartan (Cozaar®) and irbesartan (Aprovel®)] have shown a curbing effect on the dilation of the aortic root in a pediatric population with Marfan syndrome [9]. Cardiovascular risk factors must be controlled as well as healthy lifestyle.

Our patient's cardiologist prescribed a β-blocker before the surgery.

When the aorta reaches 6 cm in diameter, the annual rates of rupture, dissection, and death are 3.6%, 3.7%, and 10.8%, respectively. The cumulative risk of these events is 14.1% [6]. It is on the maximum diameter that the surgical indication decisions are made.

Surgery is indicated as an emergency in cases of acute dissection of the ascending aorta or rupture of the pericardium (acute tamponade). Elective ascending aortic surgery is associated with a significantly lower mortality rate (5%) than emergency intervention. A key factor in the decision to operate is the scalability of the maximum diameter of the ectasia, requiring several imaging checks to demonstrate, within a specified time frame, a substantial increase in this diameter. Only really large or complicating aneurysms lead to surgery without delay. Taking into account the natural history of ascending aortic aneurysms, surgery seems appropriate when the maximum diameter reaches 5 - 5.5 cm, depending on the etiology [10]. Symptoms due to aortic valve insufficiency or stenosis may be the first indication for intervention. During valve surgery, a decision must be made regarding moderate dilation of the aorta. About 25% of patients operated on for aortic insufficiency, with an aortic diameter > 4 cm, subsequently undergo aortic replacement surgery [1].

For patients with Marfan syndrome and bicuspid valves, the size criterion is a little lower. In these patients, most authors believe that prophylactic repair is indicated when the aortic diameter is 4.5 - 5 cm [10]. Dissections or ruptures have

been reported with diameters < 5 cm in several cases, and a rate of increase in aneurysmal dilation > 5% per year increases the risk of complications by 4.1 times. In Marfan syndrome, there are other risk factors for aortic dissection: a family history of dissection, a ratio of observed diameter to predicted diameter greater than 1.3. In addition, these patients are often young and healthy, and therefore prophylactic intervention can provide them with substantial benefits.

Our patient's indication for surgery was based on chest CT data (**Figure 3**). Indeed, Valsalva's sinuses were 59 mm and the tubular aorta was 47 mm. Our patient's indication for surgery complies with the recommendations of the European Society of Cardiology [11] and the American college of cardiology [12].

Interventions on the ascending thoracic aorta are performed by extracorporeal circulation (CPB) sternotomy allowing cardiac arrest. Lung function examination is indicated pre-operatively in patients undergoing thoracotomy or with severe lung disease. Renal function should also be examined [13].

Our patient's respiratory function tests were normal and consistent with a sternotomy. His kidney function was also normal. Surgery for an isolated aneurysm of the ascending aorta involves implanting prosthesis in the supracoronary position.

In the presence of an aortic root aneurysm with dilation of the valve ring and of the sinus portion, dilation of the sinotubular line with separation of the aortic valve commissures causes central aortic insufficiency due to the impossibility of coaptation of the valves [13].

The presence of a valve disease generally requires the replacement of the aortic root with the valve by a valve prosthesis, the valve being mechanical or biological (Bentall procedure); or by homografting. In young patients, Ross's operation (which involves transferring the pulmonary valve to the aortic position with reconstruction of the outlet of the right ventricle through a biological duct with valve) may be offered. However, whatever the technique, the coronary ostia must be reimplanted [13].

If the aortic valve is normal, it is possible to replace the aortic root while keeping the native aortic valve and replacing only the dilated sinuses and the ascending aorta. If the aortic valve is intact, it is possible to consider Yacoub's or David's operation, saving the valve with reimplantation of the coronary ostia. The main benefit of root replacement (keeping the valve or transferring the pulmonary valve) is the lack of lifelong anticoagulation [13].

Our patient was operated on by midline sternotomy and underwent replacement of the aortic valve, aortic root and ascending aorta with a Bio-Integral tube no.29, reimplantation of the left coronary ostium using a PROLENE 5/0 - 13, an anastomosis of the right coronary ostium using a Dacron tube 8 mm in diameter and about 4 cm long making a Cabrol hemi mustache, this to avoid too much traction on the right coronary artery and to preserve the infundibular branch which was born early from it. The distal end of the biological tube was anastomosed using a PROLENE 4/0 suture.

The post-operative consequences of our patient were simple.

4. Conclusion

When dilation of the ascending aorta reaches the critical diameter of 50 mm, there is a risk of aortic dissection or rupture. Supravalvular aneurysms are treated by replacing the ectatic portion with a Dacron® tube in the supracoronary position. Aortic root aneurysms including coronary ostia, require tube replacement, reimplantation of coronary ostia, as well as a gesture on the aortic valve, which must be preserved or replaced.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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