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Case Report Open Access

Replacement of ascending aorta and aortic arch and its main branches with reimplantation of coronary arteries in aneurysmatic aorta

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ABSTRACT

Aortic aneurysm is one of the vascular pathologies which may results in fatal complications such as rupture and dissection. Dilatation of the aortic vessels increases the pressure on the entire aortic wall, leading to more dilatation and risk of dissection or rupture. Surgical intervention should take place, when the aortic diameter reaches the level that may associate with such complications. Herein, we report a case with previous aortic valve replacement due to an ascending aorta, aortic arch, and proximal descending aortic aneurysm, extending to the aortic arch branches and right subclavian artery.

Keywords: Artery reimplantation, cardiopulmonary bypass, Dacron® graft, intensive care unit.

Aortic aneurysm is one of the vascular pathologies which may results in fatal complications such as rupture and dissection.[1] Dilatation of the aortic vessels increases the pressure on the entire aortic wall, leading to more dilatation and risk of dissection or rupture according to the Laplace's law.[2] According to the guidelines, surgical intervention should take place, when the aortic diameter reaches the level that may associate with such complications.[3]

In this report, we present a case with previous aortic valve replacement due to an ascending aorta, aortic arch, and proximal descending aortic aneurysm, extending to the aortic arch branches and right subclavian artery and discuss its surgical treatment in the light of literature.

CASE REPORT

A 57-year-old male patient was presented to our clinic with the chief complaint of recurrent episodes of chest pain, palpitation, and numbness in both lower limbs. He underwent aortic valve replacement surgery 32 years ago due to rheumatic heart disease. Five years ago, coronary angiography revealed no abnormal findings. Echocardiography showed a functional artificial aortic valve with an ejection fraction of about 60%. Contrast-enhanced computed tomography (CT) demonstrated an aortic root of 56 mm, an ascending aorta of 54 mm, an aortic arch of 46 mm, and a proximal descending aorta of 40 mm with a brachiocephalic artery of 28 mm and a right subclavian artery of 19 mm (Figure 1). The diameter of infrarenal abdominal aorta was 60 mm. Surgery was decided and a written informed consent was obtained from the patient. After all preoperative preparations were done, the patient was taken to the operating room.

Operative technique

After full intravenous heparinization, the artery was clamped by vascular clamps to allow anastomosis to an 8-mm polytetrafluoroethylene (PTFE) graft. This graft was, then, connected to the arterial line of cardiopulmonary bypass (CPB) machine. Median sternotomy was done in a regular fashion, as it is a case of resternotomy using the micro-oscillating saw. Substernal adhesions were resolved gently with caution. Two-stage venous cannulation was done via the auricula of the right atrium. The ascending aorta, aortic arch, and its branches were all dissected gently from the surrounding tissues (Figure 2). A vascular

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cross-clamp was applied at the distal ascending aorta and, then, antegrade isothermic blood-enriched cardioplegic cardiac arrest was achieved. On the other hand, a continuous retrograde cardioplegic solution was given via a retrograde cannula replaced into the coronary sinus through the right atrium. Excision of the aneurysmatic segment was done with caution to the aortic root in order to excise the coronary ostia as buttons. The previous artificial aortic valve was checked and found to be clean from any pannus formation and to be functional; therefore, it was kept in place. A 30-mm Dacron® graft was sewn to the mechanical valve using 3.0 polyester sutures in a continuous fashion and the left coronary ostium was, then, re-implanted into the graft using 6.0 polypropylene sutures (Figure 3a). At the beginning of the operation, a 28-mm Dacron® graft was prepared by implanting four pieces of 8-mm Dacron® grafts in an end-to-side fashion to a 28-mm polyester graft by the second assistant to obtain a special arch branch graft. The brachiocephalic artery was clamped and antegrade selective cerebral perfusion was done under 28°C. The left carotid artery was cannulated by a line taken from the arterial line and perfused during the antegrade cerebral perfusion. The left subclavian artery was snared. Meanwhile, all the branches of the arch were divided proximally from the aneurysmatic arch. The proximal descending aorta with a dilatation was resected as possible as we could. The 28-mm Dacron® graft was anastomosed to the descending aorta leaving about 3-cm free edge into the descending aorta as an elephant trunk. After the distal aortic anastomosis, the proximal 8-mm graft branch was cannulated by Y-line from the arterial line which was previously prepared (Figure 3b). Distal body perfusion was instituted and CPB was increased up to the normal level. The left subclavian artery and left carotid artery branches were anastomosed to the distal 8-mm graft branches. The 30-mm and 28-mm grafts were anastomosed to each other in an end-to-end fashion.

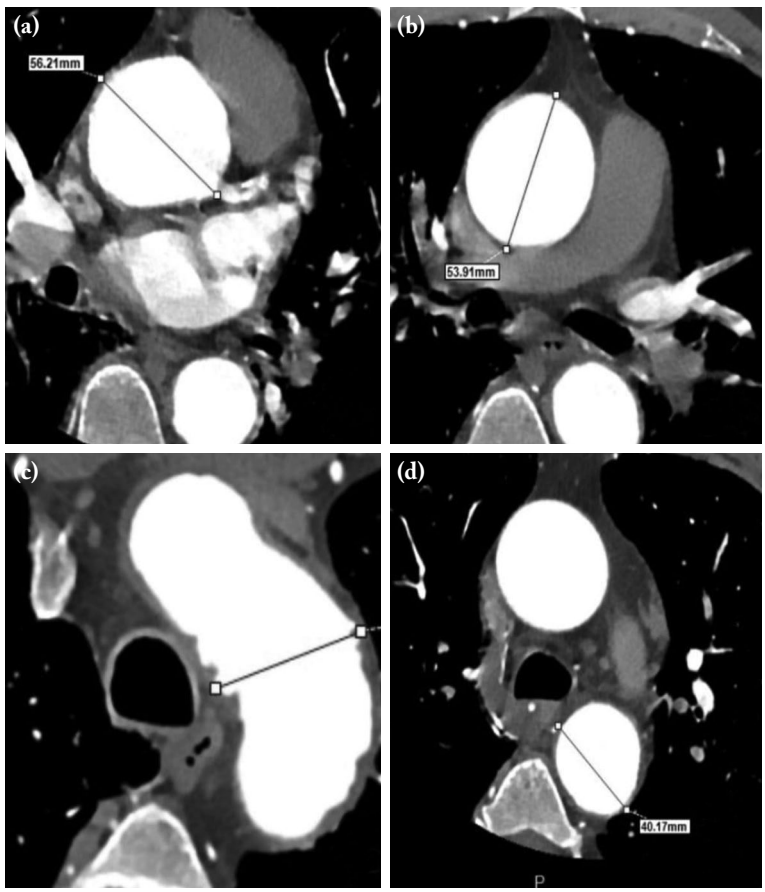

Figure 1. Contrast-enhanced computed tomography scans. **(a)** Aortic root. **(b)** Ascending aorta. **(c)** Aortic arch. **(d)** Descending aorta.

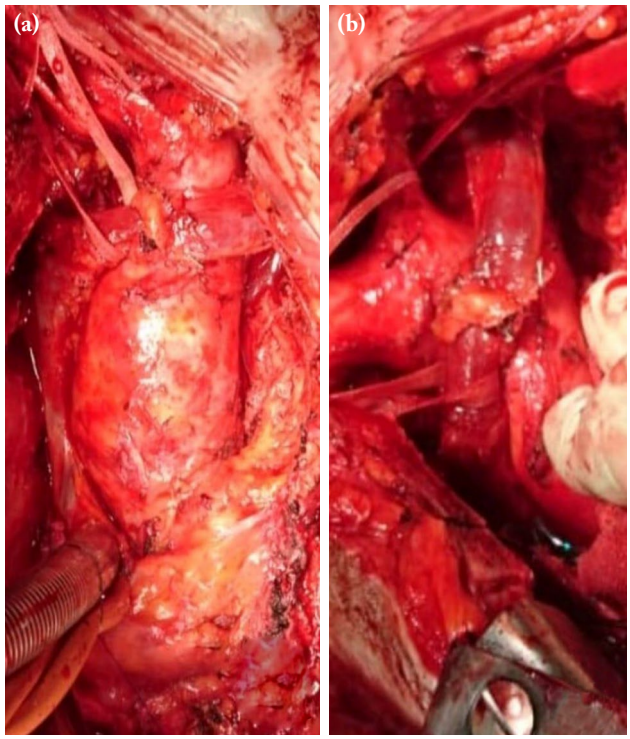

Figure 2. An intraoperative view. **(a)** Aneurysmatic ascending aorta. **(b)** Aneurysmatic brachiocephalic and right subclavian artery.

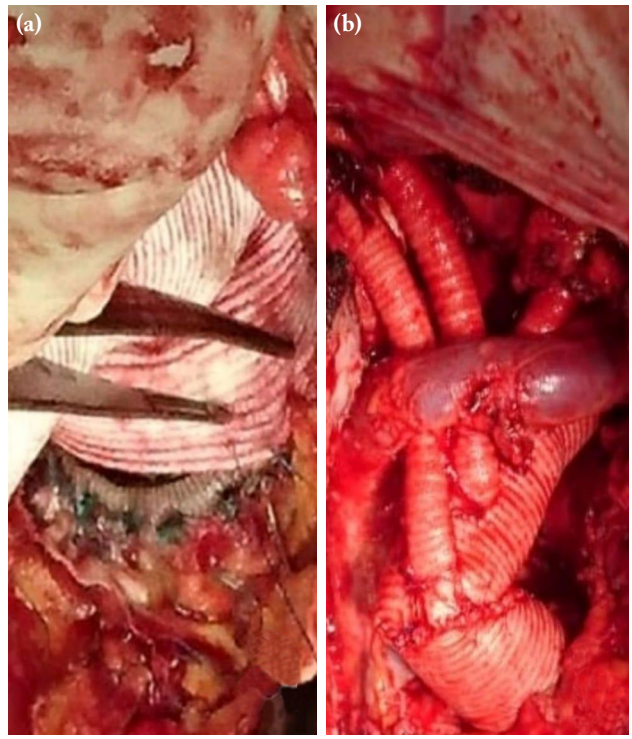

Figure 3. An intraoperative view. **(a)** Sewing 30-mm Dacron® graft to old artificial aortic valve. **(b)** Dacron® grafts after vascular clamps were released.

The right coronary artery button was anastomosed and cross-clamp was removed. The right carotid artery was anastomosed to the second 8-mm branch graft. After protamine administration the connection of the CPB was withdrawn. The proximal side branch was used for axillary artery bypass. The graft was passed through an anatomic tunnel to the right subclavian artery. The proximal and distal ends of the subclavian artery, the internal thoracic artery branch and its costocervical main thyrocervical branches were all ligated. The last anastomosis was done to the right subclavian artery using a right-sided 8-mm Dacron® graft. Embolectomy was done to the graft and distal axillary artery for a blood clot before tying the anastomosis suture due to protamine neutralization previously. Hemostasis was secured (Figure 3). At the end of the operation, two drains were placed into the mediastinum where one drain into the right and another one into the left thorax were placed. Sternum was closed in a standard manner and the patient was taken to the cardiovascular intensive care unit (ICU). The total CPB perfusion time was 204 min, while the total cross-clamp time was 119 min. Three units of erythrocyte suspension and two units of fresh frozen plasma were transfused.

For the first three days postoperatively, the patient was monitored in the ICU. The total drainage was about 450 mL. On Day 4, he was transferred to the ward. During ward stay, daily routine blood and imaging studies with daily dressing were done. On Day 10, the patient started doing well and was discharged on medication with scheduled follow-up visit one week later.

DISCUSSION

Aortic aneurysm is a vascular pathology with possible serious complications which can be prevented considerably by regular controls, proper medications, and appropriate and timely surgical interventions. The type of the operation and surgical technique used have also a key role for lifelong. In general, for all aortic aneurysms, surgical interventions have a high complication risk. On the other hand, the location of the aneurysm is critical in planning and achieving the operation. An isolated ascending aortic aneurysm operation surely has a lower risk than that one extending to the arch. Our case is a complicated case presenting with the ascending and

aortic arch aneurysm associated with an aneurysm of the brachiocephalic and right subclavian arteries which were all successfully treated. The cornerstone of a successful operation of all types of operations is the timing and planning of the operation steps.

Review of the literature reveals similar cases treated by similar surgical techniques. Many cases were managed by synthetically prepared branched grafts. In our case, we prepared the branched graft in the operating room by ourselves. Our patient had a diffuse aneurysm which involved all the aorta and brachiocephalic artery, extending to the right subclavian artery, as well. Most of the cases in the literature underwent dissection with a high mortality rate. In a study including 220 patients who underwent total arch replacement from 1990 to 1999, the mortality rate was about 12.7% and 3.3% of the patients had permanent neurological dysfunction postoperatively. However, no neurological problem was observed in our patient, which can be attributed to the fact that we perfused both of the carotid arteries during the operation. The only non-perfused period was during the left and right carotid artery anastomosis which were five and four min, respectively.

There are also several studies regarding the combined open surgical techniques and endovascular interventions. To the best of our knowledge, endovascular interventions have been increasingly used over the last two decades and widely adopted in the management of aortic aneurysms, mainly in thoracic and abdominal aneurysms. Unfortunately, ascending aorta and aortic arch aneurysms still have not the similar ability to be treated using such endovascular stents, due to their valuable branches and angularity.

For the aneurysmatic arch of the aorta, several endovascular techniques can be used including endoanchors, in situ laser fenestration, chimney grafts, and elephant trunk.[4] For all techniques, the main goal is to preserve the patency of the great vessels during treatment of the main pathology of the aorta. In a case report by Sonesson et al.,[5] a ruptured aortic arch was treated by in situ fenestrated endovascular stenting technique using a centrifugal pump to perfuse both carotid arteries from the right femoral artery. In another study, 41 patients underwent total thoracic aorta repair with the frozen elephant trunk stent graft due to acute type A aortic dissection.[6] The authors emphasized that, in such cases, treatment with the single-session frozen elephant trunk technique was safe with a high successful rate.

In some cases, patients can be operated before for other types of aortic pathologies such as dissection, followed by another dissection in the other site of the aorta. In a case report, a patient had secondary repair of the descending thoracic aorta with previous arcus aortic replacement and elephant trunk extension, and the authors concluded that endovascular elephant trunk could improve morbidity and mortality in high-risk patients.[7] In our center, we are unable to utilize such fenestrated stents and the health insurance of the does not cover that types of the stents. We did our operation as a case of resternotomy and left a graft extension of about 3 cm into the descending aorta to perform thoracic endovascular aortic repair (TEVAR) later. In addition, we attempted to decrease the total circulatory arrest time by perfusing the whole body immediately after we anastomosed the distal aortic anastomosis. The left subclavian, left carotid artery, and right carotid artery were anastomosed respectively under normal CPB circumstances during perfusion of the distal aorta and right axillary antegrade cerebral perfusion.

In the literature, Kreibich et al.[8] performed the first endovascular conduit stent graft for a case of dissected ascending aorta. However, those types of stent grafts have constricted indication and many limitations. In our case, we observed both ascending aorta and aortic arch aneurysms along with brachiocephalic and right subclavian artery aneurysms which was impossible to treat all of them by an endovascular intervention. Therefore, we left a 5-cm neck arch graft distal to the left subclavian artery branch and a 3-mm elephant trunk graft inside the descending aorta for a possible aneurysm formation in the descending aorta. In the future, we are expected to put an endovascular graft in such cases. Our patient was operated previously with aortic valve replacement. That was another cause to have more difficulties than a virgin case. We performed this operation very well and planned the steps before starting to shorten the time of CPB and cross-clamp and to reserve the full perfusion and normothermia, as soon as we could.

In conclusion, careful preoperative planning, perfusing as many aortic branches as possible, and a prompt surgery are the mainstays for surgical success in such extensive aneurysmal diseases.

Declaration of conflicting interests

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