Management of Concomitant Large Aortic Aneurysm and Severe Stenosis of Aortic Arc

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Primary large saccular aortic aneurysm with high grade stenosis of aortic arc is rare, and no standard therapy is available. We have encountered one case and successfully treated using a hybrid interventional approach. A 59-year-old woman with a 7-day history of headache, dizziness and chest pain, and a 5-year history of hypertension admitted and was diagnosed with transverse aortic aneurysm with severe aortic stenosis, the huge saccular aneurysm was located behind the transverse aortic arc. During surgery, a bypass with graft from ascending aorta to left external iliac artery was made initially in order to ensure the blood supply to the left leg, afterward, a 40 mm × 160 mm covered stent was implanted to cover the orifice of aneurysm and was used as a supporting anchorage in the descending aorta, a second covered stent (20 mm × 100 mm) was implanted to expand the stenosis of aortic arc. Follow-up at 1.5-year after surgery, the patient has been doing well without any surgical complication. A collateral pathway between internal mammary artery and inferior epigastric artery via the superior epigastric artery was found on 3-dimensional reconstruction before surgery. Interruption of the compensatory arterial collateral pathway in the patient with severe stenosis of aortic arc should be prevented if possible in order to ensure the satisfactory perfusion of the lower limbs of the body. In conclusion, a patient with transverse aortic aneurysm accompanied with severe aortic stenosis can be treated by hybrid surgery.

Keywords: aortic aneurysm, aortic stenosis, interventional therapy, collateral pathway

Introduction

Transverse aortic aneurysm with stenosis of aortic arc is uncommon, and has been treated with open surgery that is associated with high morbidity and mortality.1) Currently, no standard therapy for this disorder is available. We have successfully treated a patient with a large transverse aortic aneurysm concomitant with severe aortic stenosis using hybrid interventional approach with graft.

Case report

A 59-year-old woman presented with a 7-day history of headache, dizziness and chest pain, and a 5-year history of hypertension. In recent 3 years, she had been on antihypertensive medications irregularly. Her liver and renal functions were normal. On admission her blood pressure was 137/76 mmHg after antihypertensive medication. Ankle brachial index (ABI) on left side and right side was 1.24, 1.08, respectively. Chest computed tomography angiography (CTA) showed regional high grade aortic stenosis with atherosclerotic plaque, aortic aneurysm; CT showed old cerebral infarction and aortic
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Atherosclerosis. Angiography revealed local stenosis of aortic arc, and adjacent saccular aneurysm located at distal side of orifice of left subclavian artery (Fig. 1A, 1C, and 1D; Fig. 2D). The three-dimensional reconstruction showed that a collateral pathway between internal mammary artery and inferior epigastric artery via the superior epigastric artery (Fig. 2C and 2D). Given that the large saccular aneurysm was located just behind the aortic arc at the level of 2nd thoracic vertebrae, it was highly risk to resect the aneurysm and repair the stenosis even though it was possible to do so. After grand consultation and discussion with patient’s family members, the patient’s written consent was obtained to perform a hybrid operation, that is, implantation of covered stent in stenotic aorta and artificial graft bypass between ascending aorta and left external iliac artery. Under general anesthesia, a longitudinal incision was made above the left groin area to expose left external iliac artery, then a median sternotomy was performed to expose the ascending aorta, a bypass with artificial graft was made from ascending aorta to left external iliac artery. Distal end of graft was anastomosed with side of ascending aorta with 4/0 prolene continuously. Given the sharp curvature of aortic arc and a single stent might not be expanded satisfactorily to cover the orifice of aneurysm, a 40 mm × 160 mm covered stent was advanced via the descending aorta to cover the orifice of aneurysm and was used as a supporting anchorage in the descending aorta, in order to expand the part of aortic stenosis, a second covered stent (20 mm × 100 mm) was implanted by overlapping with first stent, internal leakage (Fig. 1B) was observed on aortography, thus balloon dilation was performed at the intersection of two stents, the internal leakage was subsequently improved and disappeared finally (Fig. 1C). Not surprisingly, the internal thoracic artery-inferior epigastric artery collateral, unfortunately, was not observed on postoperative angiogram. Luckily, her postoperative recovery was uneventful, the preoperative symptoms were improved, and her ankle brachial index after surgery in left side and right side was 1.18, 1.22, respectively. Thoracic CTA at 3 months after surgery revealed thrombosis in the saccular aneurysm (Fig. 1E), shrinkage and dent were observed on the three dimensional reconstruction of the aneurysm (Fig. 2A). On follow-up at 1-year

Fig. 1 Angiography reveals the stenosis of aortic arch and the saccular aneurysm at the distal side of left subclavian artery (A), after implanting 2 covered stents, there is minor endoleak (B), which is disappeared after further balloon expansion at the overlapping of two stents (C). CT scans show preoperative aortic saccular aneurysm (D) and thrombosis formed inside of the aneurysm (E) 3 months after hybrid surgery.
cardiac surgery with cardiopulmonary bypass is the gold standard to treat ascending aortic aneurysms, yet, it is not easy to perform open surgery to excise the aneurysm because of the location of the aneurysm and limited operative field to expose the lesion. And the conventional open surgery for aortic arc aneurysm is associated with a high morbidity and mortality.1,2) Fortunately, endovascular repair for complex thoracic aortic stenosis has emerged over the past decade as an alternative to open surgical repair, it is technically feasible, safe and effective, endovascular interventions lower operation related morbidity and mortality.3) And endovascular repair of ruptured descending thoracic aortic aneurysm is associated with a lower risk of a composite of death, stroke, and paraplegia in comparison with traditional open surgery.4) Our case was too complicated to be suitable for conventional open surgery, because the large aneurysm was located just behind aortic arc and adjacent to origin of left subclavian artery distally, and the huge saccular aneurysm had been constantly compressing the aortic arc, and thus, caused the severe stenosis of the aortic arc; clinically, the patient had felt chest pain, headache and dizziness. Given the large aneurysm sitting at back of transverse aortic arc, it was rather difficult to excise the aneurysm directly; therefore, an endovascular treatment of the ascending aorta was considered the best choice to seal the orifice of the aneurysm. Given the chance of failure of interventional therapy, a bypass with graft from ascending aorta to left external iliac artery was performed at the beginning of surgery in order to ensure the blood supply to the left lower extremity and reduce the blood pressure within the large aneurysm, thereby decreasing the risk of rupture of aneurysm. Subsequently, the interventional therapy was performed successfully with great confidence. Given the acute curvature of aortic arc and location of the aneurysm and aortic stenosis, we used a covered stent to cover the orifice of the aneurysm, and then used a second stent to expand the stenotic section of the aortic arc. There was a mild endoleak after implanting the second stent; the leak was disappeared following further balloon dilation. This case revealed that the concomitant aortic aneurysm and aortic stenosis could be managed with interventional approach, which simplifies the conventional surgery in a single-stage approach with optimal results. However, stent graft exclusion of more advanced and complex ascending aortic stenosis should be performed cautiously in institutions equipped with good hybrid surgical facility by the staff with related expertise.5) After surgery, the patient had no headache and chest pain, blood tests results were normal, her vital signs including blood pressure and liver, renal function were normal. Duplex ultrasonography showed that the bypass graft between the ascending aorta and left external iliac artery remained open with no obstruction of blood flow. The endoleak of the stent graft was eventually closed at one-year follow-up, thoracic CTA in local hospital demonstrated the sealed saccular aneurysm became closed with no blood flow and the covered stent grafting in the aortic arc was patent as well. The patient has been doing well without any surgical complication on follow-up via telephone at 1.5-year following surgery.

Discussion

Primary aortic arch aneurysm adjacent to left subclavian artery concomitant with severe aortic stenosis is rare. The risk of rupture is high if it is left untreated. Open
In patients with aortoiliac occlusion, the internal thoracic artery-inferior epigastric artery (ITA-IEA) collateral is one of the collaterals providing lower-extremity perfusion, and the interruption of this collateral may cause severe leg ischemia.\textsuperscript{5,6} Incidentally, preoperational three-dimensional reconstruction showed that the patient had a collateral pathway between internal mammary artery and inferior epigastric artery via the superior epigastric artery (Fig. 2C and 2D), this usually occurs in patients with aortoiliac occlusion and has a significant role in perfusion to the lower body of patients with aortoiliac occlusion,\textsuperscript{5,6} yet it is rarely reported in a patient with aortic stenosis like our case. If it were interrupted during the thoracic surgery, it would jeopardize the sufficient blood supply to the lower part of the body. Monitoring of the blood supply in the ITA-IEA route to lower limbs may provide beneficial diagnostic information necessary for the pretreatment work-up of patients with aortoiliac occlusion.\textsuperscript{7} Ideally, the surgeon should be cautious to try to avoid interrupting this compensatory arterial collateral pathway in order to ensure the satisfactory perfusion of the lower part of the body. In our case, the ITA-IEA was unavoidably destroyed during surgery and could not be seen on the postoperative angiogram. As this case had processed chronically, fortunately, our patient did not have any ischemic symptom of left leg, and the ankle brachial index had been normal before and after surgery.

In conclusion, a transverse aortic aneurysm accompanied with severe aortic stenosis is rare and can be treated with hybrid surgery. A collateral pathway between internal mammary artery and inferior epigastric artery via the superior epigastric artery can occur in the patient with aortic aneurysm associated with severe stenosis of aortic arc. Interruption of the compensatory arterial collateral pathway should be prevented if possible in order to ensure the sufficient blood supply to the lower limbs of the body.

**Disclosure statement**

The authors have declared that no competing interests exist. Dr. Ren is the guarantor for this article.

**References**