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Case Report

Modified Total Arch Debranching TEVAR with Aberrant Left Vertebral Artery

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Total arch debranching and thoracic endovascular repair of an aortic arch aneurysm with a left aberrant vertebral artery are rare procedures. A small artery is difficult to reconstruct and anastomose in a narrow thoracic space with a large aneurysm. We describe an 85-year-old man with a fusiform aortic arch aneurysm and left aberrant vertebral artery who underwent a hybrid procedure with reconstruction of the left aberrant vertebral artery at a surgical site in the neck. Postoperative computed tomography images confirmed exclusion of the aneurysm and patency of all arch vessels, including the left vertebral artery.

Keywords: thoracic aortic aneurysm, hybrid procedure, aberrant left vertebral artery

Introduction

The left vertebral artery typically branches from the left subclavian artery and travels from between the anterior scalene and longus colli muscles to the sixth foramen transversarium of the cervical vertebra. An aberrant origin of the vertebral artery is rare. Few reports have described supra-aortic arch debranching and thoracic endovascular repair (TEVAR) for thoracic aortic aneurysm with an aberrant left vertebral artery, and all of them describe reconstruction in a narrow anastomotic space in the thoracic cavity. Herein, we describe a modified supra-aortic arch debranching bypass that permitted relatively easy reconstruction of an aberrant left vertebral artery at a surgical site in the left neck.

Case Report

An 85-year-old man was diagnosed with a fusiform aneurysm involving the aortic arch. His history included hypertension, dyslipidemia, and chronic kidney disease (eGFR 36.7 mL/min/1.73 cm^2). He was referred to our institution for surgery. Computed tomography (CT) revealed an aneurysm with a diameter of 67 mm and a left aberrant vertebral artery (VA) originating directly from the aortic arch between the left common carotid artery (LCCA) and left subclavian artery (LSA). The aberrant left VA coursed along the dorsal side of the LCCA at the neck, from between the anterior scalene and long colli muscles to the sixth foramen transversarium of the cervical vertebra. The ascending aorta was dilated to 41 mm, and an abdominal aortic aneurysm was evident. Magnetic resonance imaging revealed that the right VA was not hypoplastic, and that the circle of Willis network was incomplete (**Fig. 1**).

We planned a hybrid procedure comprising supra-aortic arch debranching with banding of the ascending aorta with a proximal landing zone of at least 2 cm because conventional total arch replacement was too invasive considering the patient's age, a 4.6% operative mortality risk on the Japan Adult Cardiovascular Surgery Database, and a clinical frailty scale of 5.

Bilateral radial arterial pressures and regional cerebral oxygen saturation were monitored under general anesthesia. The left axillary artery was exposed first, followed by the exposure of the LCCA and left VA at the neck. A standard median full sternotomy was performed and the aorta was exposed in the standard manner. The great vessels, innominate artery, and LCCA were dissected free. Following full heparinization, a side-biting clamp was placed with a Lambert–Kay aorta clamp on the ascending aorta, and a trifurcated graft, constructed by combining 12, 8, and 8 mm woven MAQUET Dacron tubes (HEMASHIELD GOLD, Getinge, Gothenburg, Sweden), was anastomosed in end-to-side fashion with a 4-0 monofilament running

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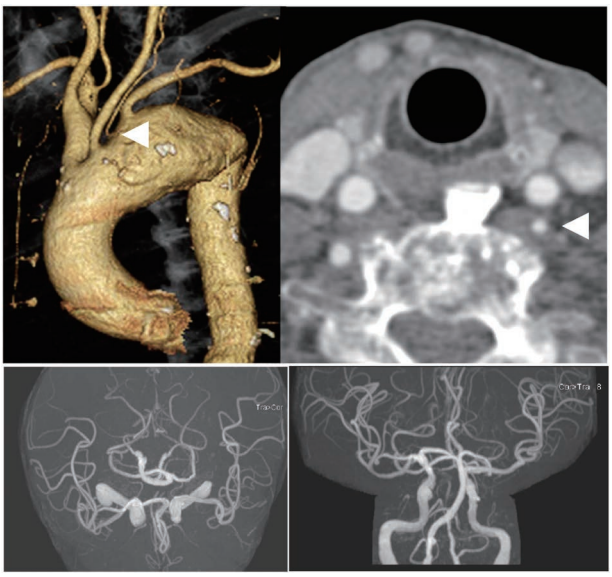

Fig. 1 Preoperative computed tomography angiography and magnetic resonance angiography findings.
A left aberrant vertebral artery (arrows) arises from aortic arch between the left common carotid and left subclavian arteries and courses along the dorsal side of the left common carotid artery at the neck. Magnetic resonance imaging revealed that the right vertebral artery was not hypoplastic, and that the circle of Willis network was incomplete.

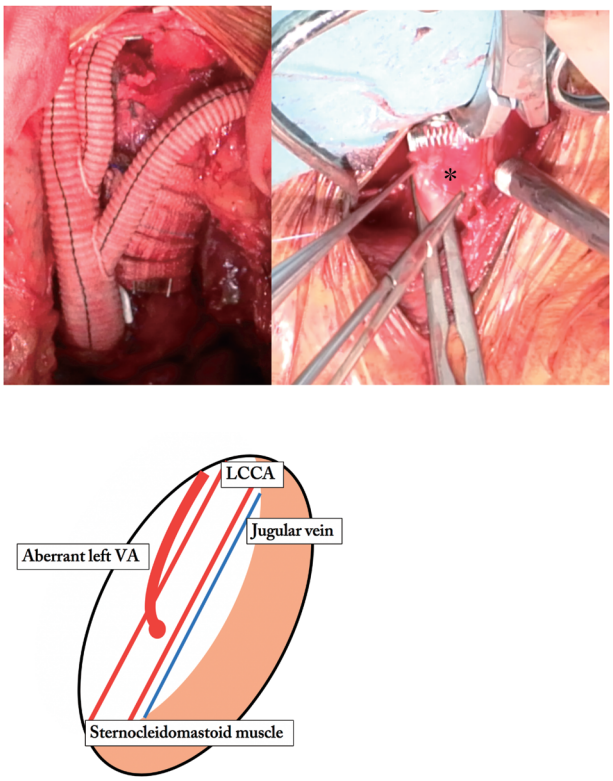

Fig. 2 Supra-aortic arch debranching with banding of the ascending aorta and transposition of aberrant vertebral artery.
The skin incision for transposition of aberrant vertebral artery is conducted along the edge of sternocleidomastoid muscle. The reconstructed aberrant vertebral artery (asterisk) is easily transposed directly onto the left carotid artery with end-to-side anastomosis using a 6-0 monofilament in a comfortable working space in the left neck.
LCCA: left common carotid artery; VA: vertebral artery

suture along the great curvature immediately above the sinotubular junction to maximize and optimize the proximal zone 0 landing area for the stent graft. On completion of the anastomosis, the side-biting clamp was removed with individual isolation of each limb of the branch graft, and the graft was flushed to eliminate any thrombus or air. The great vessels were then anastomosed end-to-end with a 5-0 monofilament running suture individually on proximal ligation. The LCCA was followed by the innominate artery and then LSA was reconstructed end-to-side in the left axillary artery with the limb of branch graft passing through the left second intercostal space. The proximal landing zone of the ascending aorta was banded with a Dacron graft wrap using 3-0 monofilament mattress sutures around the aorta to obtain a diameter of 34 mm, which allowed for better fixation of the stent graft and would prevent type 1 endoleaks over the long term. These manipulations proceeded under a cardiopulmonary bypass (CPB) because of the dilated ascending aorta. After the patient was weaned from the CPB, the left aberrant VA was reconstructed by direct transposition onto the left carotid artery with end-to-side anastomosis using a 6-0 monofilament running suture in the neck rather than in the thoracic cavity (**Fig. 2**).

The endovascular procedure immediately followed the debranching bypass. Conformable Gore TAG stent grafts measuring 45 mm × 20 cm and 34 mm × 15 cm (W.L. Gore & Associates, Newark, NJ, USA) were accurately deployed in retrograde fashion from the right femoral access under rapid ventricular pacing. Lastly, angiography confirmed the absence of endoleaks and patency of the debranching bypass graft. The patient was extubated on the same day as the surgery and spent one day in the intensive care unit without complications. He was discharged home on postoperative day 15. Postoperative CT images revealed aneurysm exclusion and patent arch vessels, including the left VA (**Fig. 3**).

Discussion

The prevalence of an aberrant origin of the VA is 4.2% according to a large CT angiography series.[1] A single direct aortic origin of the left VA between the LCCA and the LSA is the most frequent anatomical variant, with a prevalence of 84.8%, and it is not hypoplastic.[2]

Although most patients with thoracic aortic aneurysms

Fig. 3 Postoperative computed tomography angiography findings.
The arch aneurysm is excluded and all arch vessels including the left vertebral artery (arrows) are patent.

are treated by conventional total arch replacement including the frozen elephant trunk method, patients aged >75 years[3] with extensive comorbidities, high operative mortality risks, and clinical frailty scores >5 are treated by hybrid repair at our institution. We decided to proceed with supra-aortic total arch debranching and TEVAR for the present patient to enable an adequate proximal landing zone 0. The short-term rates of in-hospital mortality, stroke, and major endoleaks associated with this method were 1%–9%, 0%–5%, and 0%, respectively,[4,5] and the rates of freedom from aorta-related death and aortic events were 91% and 89%, respectively, at 3 years.[4] If the diameter of the ascending aorta is much larger than 40 mm and requires a stent graft with the largest diameter, we generally reshape the ascending aorta with banding and optimize fixation of the endovascular stent graft. Aortic banding prevents further dilation of the aorta and reduces the risk of proximal type 1 endoleaks.[6] A partial clamp is generally applied to the ascending aorta to fashion the inflow anastomosis without the need of CPB. However, we established a CPB to partially clamp the decompressed ascending aorta in the present patient because we experienced iatrogenic type A aortic dissection when attempting to apply a side-biting clamp to the ascending aorta at a diameter of 40 mm.

Total arch debranching TEVAR for complex aortic arch aneurysm with a left aberrant VA was introduced by Moss and colleagues at the Montreal Heart Institute in 2013.[7] They transposed the left aberrant VA directly onto the LCCA with end-to-side anastomosis in the thoracic cavity. We initially considered performing this procedure for our patient but believed that reconstructing the left aberrant VA would be difficult, and anastomosis in the thoracic cavity would be relatively poor. Because the aneurysm was expanded toward the median side, the anastomotic space was narrow, and the origin of the VA was close to the aneurysm. Therefore, we reconstructed the left VA at the left neck, which had a better visual field and operability than the thoracic cavity. This view of a cervical incision is common with routine debranching bypass. The left VA coursed along the dorsal side of the LCCA and it was easy to anastomose under careful consideration of the vagus nerve. Although we created an additional incision, the wide and shallow working space of the cervical site allowed higher quality anastomosis and a more immediate response to sudden bleeding compared with intrathoracic end-to-side anastomosis.

Some may consider that left VA reconstruction would be unnecessary when the collateral circulation does not depend on flow from the left aberrant VA. However, revascularization of the LSA including the left VA does not significantly reduce the incidence of either neurological complications or mortality in patients undergoing TEVAR with coverage of the LSA origin.[8] In contrast, LSA revascularization is associated with significantly better outcomes for the combined measures of death, stroke, and paraplegia.[9] The probability of stroke as an unfavorable outcome is higher when it involves the posterior, rather than the anterior, cerebral circulation.[10] Therefore, we always reconstruct the LSA to prevent perioperative stroke after TEVAR, except under emergency conditions. We believe this modified method provides a comfortable working view and prevents stroke associated with anastomosis.

Additionally, we should have performed pre-angiography. If the angiogram revealed absence of any posterior communication arteries, we required to reconstruct it using shunt.

Conclusion

We performed modified total arch debranching TEVAR, in which an aberrant left VA was reconstructed in the neck, rather than in the thoracic cavity, because the patient also had a huge thoracic aortic aneurysm. The aberrant VA was safely and easily anastomosed at a surgical site in the neck, and complications did not arise even in this high-risk patient.

Disclosure Statement

The authors have no conflicts of interest.

Author Contributions

Study conception: YT
Data collection: YT
Investigation: YT

Writing: YT
Critical review and revision: all authors
Final approval of the article: all authors
Accountability for all aspects of the work: all authors

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