

One-stage hybrid procedure for aberrant right subclavian artery and thoracic aneurysm

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A 60-year-old man without any symptoms was referred to our department because computed tomography revealed an aberrant right subclavian artery (ARSA) and a saccular aortic aneurysm arising opposite to the ARSA. We performed the following procedures through a median sternotomy: total arch replacement, insertion of a frozen elephant trunk to exclude the aneurysm and ARSA, placement of a vascular plug under transesophageal ultrasonography to occlude the dilated ARSA, and right axillary artery bypass. Postoperative computed tomography showed complete occlusion of the ARSA and exclusion of the aneurysm. This procedure should be considered an alternative strategy for treatment of patients with an ARSA. (*J Vasc Surg Cases* 2015;1:232-5.)

Because of variations in the anatomy of an aberrant right subclavian artery (ARSA) and aortic aneurysms, many procedures have been developed to treat each of these conditions. Here, we report a case of an ARSA and a saccular aortic aneurysm arising opposite to the ARSA that were successfully treated in one stage by total arch replacement (TAR) with a frozen elephant trunk (FET) and vascular plug occlusion of the ARSA under transesophageal ultrasonography. The patient consented to publication of this report.

CASE REPORT

A 60-year-old man without any symptoms was admitted to our department. Computed tomography after an operation for prostate cancer showed an ARSA originating from the aorta as the fourth branch passing behind the trachea and esophagus, and there was an 18-mm saccular aneurysm on the lateral side of the aortic arch, opposite to the orifice of the ARSA (Fig 1). The size of the ARSA was dilated to 19 mm at its origin and was reduced to 9 to 11 mm from 10 mm distal to the side of its origin. The right and left common carotid arteries arose from a common trunk. The estimated proximal neck length from the common trunk to the aneurysm was 6 mm, and there was no space between the common carotid trunk and the left subclavian artery. Based on his anatomy, this patient was classified as group 4 according to Kieffer's classification, and we chose to perform TAR with a

FET. Moreover, the ARSA was occluded with a closure device that was placed under transesophageal ultrasonography.

After median sternotomy, cardiopulmonary bypass was established with arterial lines through knitted polyester grafts anastomosed to the bilateral axillary arteries and venous lines in the superior and inferior vena cava. The bilateral common carotid arteries and left subclavian artery were exposed. Under circulatory arrest with moderate hypothermia (rectal temperature of 28°C), the bilateral carotid arteries were cannulated and selective cerebral perfusion was achieved. The aorta was dissected between the common trunk and left subclavian artery, and a stent graft of 6 cm in length (*J Graft Open Stent Graft*; Japan Lifeline Co, Ltd, Tokyo, Japan) was inserted through an open arch with a 4-cm distal landing zone under transesophageal ultrasonographic guidance; the proximal edge of the stent graft was fixed circumferentially at the level of the left subclavian artery. The stent graft completely covered the origin of the ARSA and the aneurysm. The proximal edge of the stent graft was sutured to the distal side of gelatin-sealed graft with four branches (*Gelweave*, four-branch Plexus; *Vascutek*, Glasgow, United Kingdom) using 4-0 polypropylene suture, and antegrade distal perfusion was restarted (circulatory arrest time was 33 minutes). The bilateral carotid arteries, the left subclavian artery, and the proximal side of the aorta were anastomosed to the branched grafts and aortic graft. Under transesophageal ultrasonography, a 12-mm vascular plug (*Amplatzer vascular plug [AVP]*; *St. Jude Medical*, St. Paul, Minn) was inserted through the arterial line of the right axillary artery to the origin of the ARSA, and complete occlusion was confirmed (Fig 2). Then, the graft, anastomosed to the right axillary artery, was moved into the mediastinum through the right thorax and anastomosed to the right carotid artery during cross-clamping of the right carotid artery.

The patient had no postoperative complications including hoarseness. Postoperative computed tomography showed that the aneurysm and ARSA were thrombosed (Fig 3). He was discharged from the hospital uneventfully.

DISCUSSION

An aberrant subclavian artery (ASA) results from an abnormal interruption of the fourth aortic arch, and

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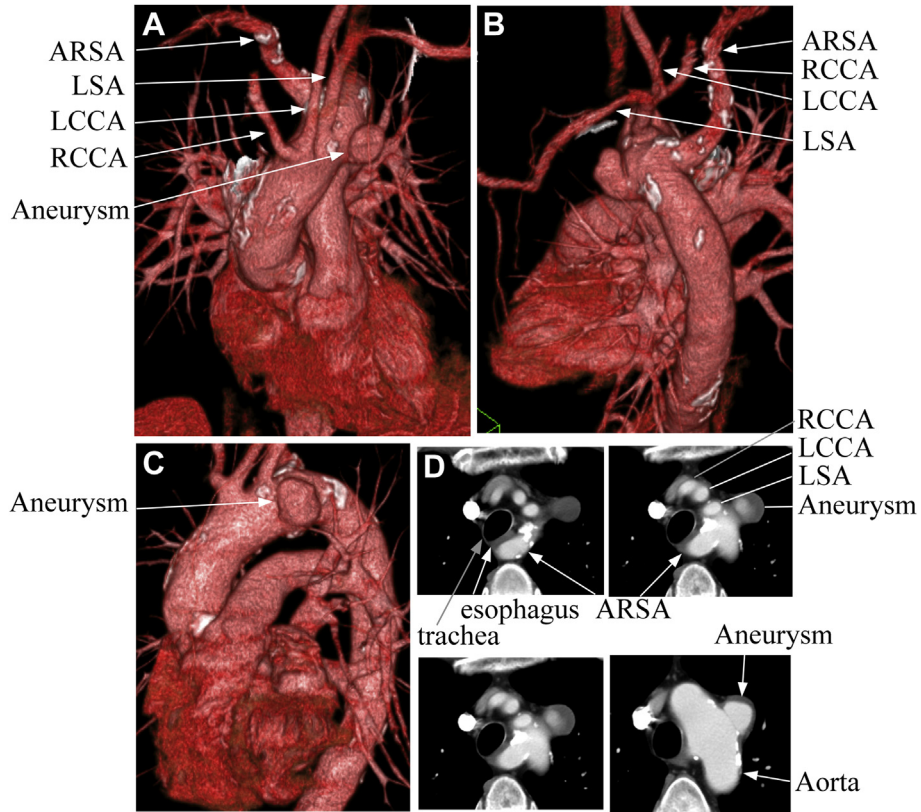


Fig 1. Preoperative three-dimensional computed tomography (A, front view; B, posterior view; C, left lateral view) showed an aberrant right subclavian artery (ARSA) with dilation at its origin and the saccular aneurysm at the lateral side of the left subclavian artery (LSA). Preoperative computed tomography (D) showed the ARSA passing behind the trachea and esophagus. LCCA, Left common carotid artery; RCCA, right common carotid artery.

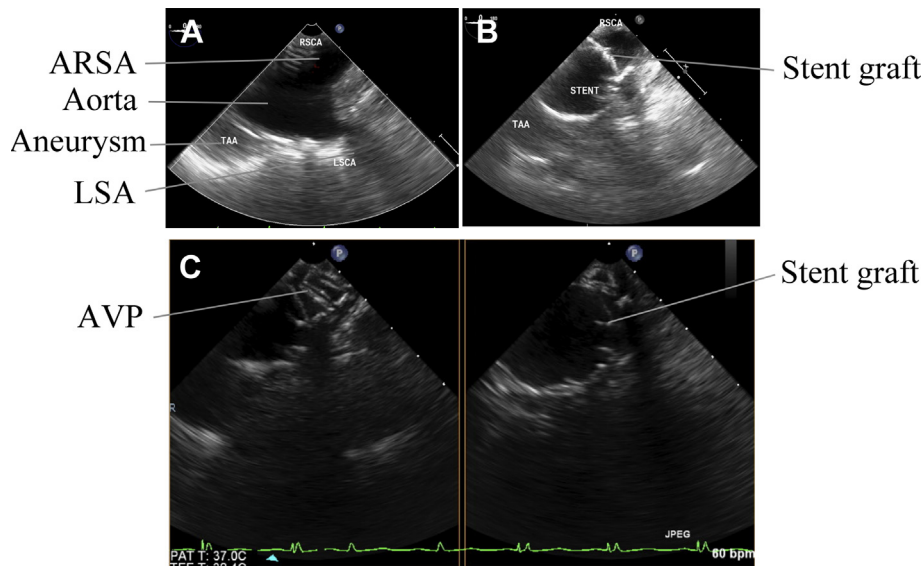


Fig 2. Transesophageal ultrasonography showed the descending aorta, the aberrant right subclavian artery (ARSA), and the thoracic aneurysm (A), exclusion of the ARSA and aneurysm by the stent graft (B), and occlusion of the ARSA by the vascular plug on the biplane image (C). AVP, Amplatzer vascular plug; LSA, LSCA, left subclavian artery; RSCA, right subclavian artery; TAA, thoracic aortic aneurysm.

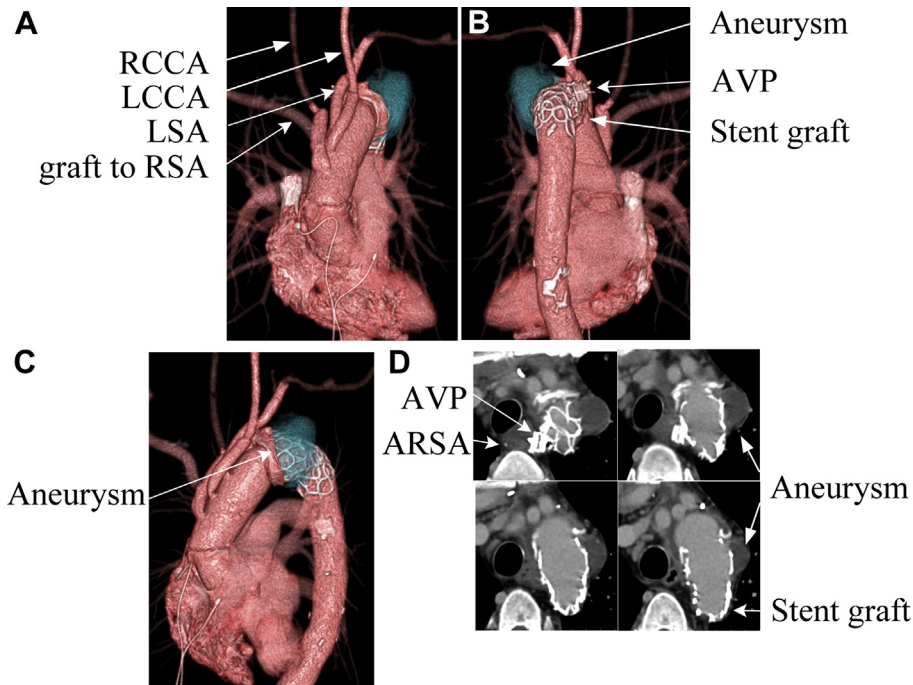


Fig 3. Postoperative three-dimensional computed tomography (**A**, front view; **B**, posterior view; **C**, left lateral view) showed the stent graft excluding the aberrant right subclavian artery (*ARSA*) and aneurysm and the *ARSA* that was occluded by the stent graft and Amplatzer vascular plug (*AVP*). Postoperative computed tomography (**D**) showed occlusion of aneurysm and the *ARSA* by the *AVP*, which did not affect the trachea or esophagus. *LCCA*, Left common carotid artery; *LSA*, left subclavian artery; *RCCA*, right common carotid artery; *RSA*, right subclavian artery.

persistence of the left or right aortic arch results in a right or left ASA, respectively.¹ The prevalence of an *ARSA* is 0.5% to 2%.²

Patients with an *ARSA* are usually asymptomatic; however, some of them present with dyspnea and dysphagia, which are related to the course of the *ARSA* passing behind the trachea and esophagus. Dilation and aneurysm at the origin of the *ARSA* is called Kommerell diverticulum and may cause symptoms by compressing surrounding tissues. Surgical treatment is indicated in patients with these symptoms or an aneurysm to prevent rupture.¹

Kieffer et al¹ divided patients with an ASA into four groups according to their clinical presentation, the condition of the ASA including occlusion and aneurysm, and the presence of an aortic lesion. Patients with Kommerell diverticulum (group 3) or an aortic lesion (group 4) usually undergo cervicotomy for transposition of the ASA to the carotid artery and thoracotomy for treatment of the ASA aneurysm or aortic lesion. To replace the entire ASA and aortic lesions, thoracotomy was preferred to expose the ASA, although a median sternotomy was used in limited cases.^{1,3-5} However, outcomes have been improved by other procedures for exclusion of an *ARSA* and Kommerell diverticulum, including an elephant trunk with endovascular completion, FET, transposition or bypass of the subclavian artery to the carotid artery, and *ARSA* occlusion using an occlusion device.⁶ Endovascular repair using a stent

graft with or without an *ARSA* bypass or transposition has recently become a common procedure for *ARSA*; however, a limited proximal landing zone may lead to a type I endoleak.^{2,7} The optimal procedure to use for repair should be selected according to the patient's anatomy.

In this case, we did not perform transposition of the *ARSA* to the carotid artery because we had no experience with this procedure. A short proximal landing zone and limited dilation of the origin of the *ARSA* were managed by TAR with a FET, and a vascular plug was placed through a median sternotomy. The FET was directly sutured to the aortic arch, allowing a short landing zone.^{6,8} However, in this case, as the distance between the common carotid trunk and left subclavian artery was very short, closing the aorta without affecting the common trunk was considered difficult, and thus TAR was chosen instead of partial replacement to preserve the carotid arteries. The vascular plug that we used was a self-expanding nitinol wire mesh device for occluding the iliac artery during endovascular repair of the abdominal aorta, and it is commonly used for ASA occlusion under angiography.^{7,9} Transesophageal ultrasonography visualized the *AVP* with minimal artifact and the *ARSA* from the origin of the aorta to 5 cm on the distal side, and it allowed placement of the *AVP* to occlude the *ARSA* without angiography and contrast medium. The size of *AVP* selected was the same size as the *ARSA* to avoid compression of the trachea

and esophagus.⁷ Long-term results are unknown; however, AVP insertion into the residual ARSA through the right brachial approach may be straightforward.

In this case, the aorta distal to the left subclavian artery and ARSA were not exposed to avoid unintended injury of the recurrent and nonrecurrent inferior laryngeal nerves.¹ Other anatomic anomalies are often associated, and a less invasive procedure would reduce the risk of complications.

CONCLUSIONS

In this report, we describe a successful one-stage procedure for a thoracic aneurysm and an ARSA that consisted of TAR with a FET. Endovascular occlusion of the ARSA by an AVP was performed under transesophageal ultrasonography. This operation was performed without angiography and represents an alternative strategy for the treatment of patients with an ARSA.

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