A Case of Tandem Plug Embolization for an Aberrant Right Subclavian Artery during Debranching Thoracic Endovascular Aortic Repair

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Aberrant right subclavian artery embolization is problematic in debranching thoracic endovascular aortic repair, because concomitant bypass grafting to the right upper arm may hinder complete embolization. We report a case of a thoracic aortic aneurysm with aberrant right subclavian artery successfully treated with debranching thoracic endovascular aortic repair and bypass grafting. Although endoleakage was found from aberrant right subclavian artery after single use of Amplatzer vascular plug, additional deployment of Amplatzer vascular plug II completely eliminated residual endoleakage. This simple technique is useful for the aberrant right subclavian artery embolization in debranching thoracic endovascular aortic repair.

Keywords: TEVAR, aberrant subclavian artery, amplatzer vascular plug

Introduction

In the endovascular era, an aberrant right subclavian artery (ARSA) with thoracic aortic aneurysm (TAA) is often treated in combination with thoracic endovascular aortic repair (TEVAR). The ARSA embolization is essential procedure to prevent endoleak when debranching TEVAR is performed. On the other hand, the ARSA embolization is problematic when debranching TEVAR is performed with bypass grafting to the right upper arm, because the embolization site is exposed to the systemic blood pressure. Additionally, the stent-graft that runs along the greater curvature cannot cover the ARSA ostium. These unfavorable conditions may hinder complete ARSA embolization. We herein report a case of debranching TEVAR in which tandem use of vascular plugs completely eliminated residual endoleakage and ensured TAA exclusion from the systemic blood flow.

Case Report

An 80-year-old man was admitted to our hospital for evaluation of new-onset hoarseness with left recurrent nerve paralysis. His medical history revealed a thoracic aortic aneurysm detected 2 years earlier, for which he had undergone no treatment and had withdrawn from follow-up computed tomography (CT) examination. CT showed that the proximal descending TAA was enlarged to 80 mm (Fig. 1A). The arch vessels showed the following anomalous changes: the common trunk of the bilateral carotid artery (truncus bicaroticus) served as the first branch, the left subclavian artery (LSA) served as the second branch, and the ARSA arose from the proximal descending TAA as the third branch (Fig. 2A). The ARSA arose from the right side of the TAA and ran behind the esophagus. Its ostium was slightly enlarged to 12 mm, and the mid to distal ARSA was 8 to 9 mm in diameter with only slight tapering. (Figs. 1A and 2A). The ARSA showed no aneurysmal change, and related symptoms such as dysphagia were not apparent in our case.

The operation was performed 2 weeks after diagnosis. First, bypass grafting from the left carotid artery to the bilateral axillary arteries was performed. A T-shaped, 8-mm ringed Gore-Tex vascular graft (W.L. Gore & Associates, Flagstaff, AZ, US) was set under the upper precordial skin and left clavicles. Graft anastomosis to the left carotid artery was performed under the simple clamp. Next, a 7-French sheath was placed at both axillary arteries, and a 6-French, 45-cm-long sheath (Destination; Terumo Corp., Tokyo, Japan) was then placed from the right 7-French sheath into
Aberrant Subclavian Artery Embolization in TEVAR

Discussion

ARSA embolization is problematic in debranching TEVAR when bypass grafting to the right upper arm is performed. One reason is the systemic pressure on the AVP, which prevents complete blockage of blood flow. The other reason is the lack of the “covered” stent-graft. Unlike a covered case of LSA occlusion, the stent-graft often runs along the greater curvature of the TAA and thus cannot fill the ARSA ostium. An endoleak was observed through the AVP into the TAA. An AVP II was additionally inserted into the ARSA. The tandem AVPs eliminated the residual endoleakage and ensured complete embolism between the ARSA and aneurysm. CT: computed tomography; TAA: thoracic aortic aneurysm; TEVAR: thoracic endovascular aortic repair; ARSA: aberrant right subclavian artery; LSA: left subclavian artery; SG: stent-graft; AVP: Amplatzer vascular plug; EL: endoleak

Fig. 1  CT images of the thoracic aorta (A) before surgery, (B) after debranching TEVAR and bypass grafting, and (C) at discharge. (A) The ARSA arose from the right side of the proximal descending TAA and ran toward the opposite side of the aortic arch. (B) The AVP was inserted into the ARSA. The stent-graft that ran along the greater curvature could not fill the ARSA ostium. An endoleak was observed through the AVP into the TAA. (C) An AVP II was additionally inserted into the ARSA. The tandem AVPs eliminated the residual endoleakage and ensured complete embolism between the ARSA and aneurysm. CT: computed tomography; TAA: thoracic aortic aneurysm; TEVAR: thoracic endovascular aortic repair; ARSA: aberrant right subclavian artery; TB: truncus bicaroticus; LSA: left subclavian artery; SG: stent-graft; AVP: Amplatzer vascular plug; EL: endoleak

The ARSA. Following angiography, a 16-mm-diameter, 8-mm length of Amplatzer vascular plug (AVP) (St. Jude Medical Inc., St. Paul, MN, US) was deployed through a 6-French long sheath into the mid-portion of the ARSA to avoid compression of the esophagus. To avoid dislodgement and endoleak formation, we selected a 1.5× oversized, 16-mm AVP. After bypass grafting and ARSA embolization, a 36 × 200-mm RELAY thoracic stent-graft (Bolton Medical Inc., Barcelona, Spain) was deployed between the truncus bicaroticus and descending aorta. An additional 38 × 100-mm RELAY thoracic stent-graft was deployed to the proximal end because of intraoperative type Ia endoleakage. Finally, the LSA was occluded with an embolization coil (Cook Inc., Bloomington, IN, US).

On postoperative day (POD) 6, CT showed endoleakage through the AVP (Fig. 1B). On POD 13, the patient underwent additional ARSA embolization with a second-generation version of the AVP (AVP II; St. Jude Medical Inc.). A 14-mm AVP II was inserted into the ARSA through a right brachial approach and deployed next to the AVP (Fig. 3). The distal part of the ARSA was slightly tapered to 8 mm in diameter after re-evaluation. We selected a 14-mm AVP II, which was suitable to serve as the additional device. CT on POD 15 showed complete thrombosis between the tandem AVPs and TAA (Figs. 1C and 2B). There has been no evidence of endoleak in 6 months since the surgery.

Discussion

ARSA embolization is problematic in debranching TEVAR when bypass grafting to the right upper arm is performed. One reason is the systemic pressure on the AVP, which prevents complete blockage of blood flow. The other reason is the lack of the “covered” stent-graft. Unlike a covered case of LSA occlusion, the stent-graft often runs along the greater curvature of the TAA and thus cannot fill the ARSA ostium (Fig. 1B). These unfavorable conditions promote postoperative endoleakage and incomplete TAA exclusion. This is not merely regarded as a type II endoleak because the TAA is not excluded from the systemic blood flow. Rather, this is similar to a type I endoleak. Persistent endoleakage will dilate both the TAA and ARSA itself and requires re-intervention.

Considering such unfavorable conditions, we used an additional AVP II for residual endoleakage. The recently developed AVP II ensures complete thrombosis owing to its multiple-lobe design and substantial mesh density. The constant diameter of the ARSA secured a sufficient sealing zone, and the AVP II was thus appropriate in the present case. Tandem use of AVPs completely eliminated residual endoleakage and ensured TAA exclusion from the systemic blood flow (Figs. 1C, 2B and 3).

We have several experiences using the AVP to embolize the internal iliac artery (IIA) during EVAR, and all cases were successfully embolized. In addition, some case reports
AVP II because of its multiple-lobe design and substantial mesh density. Single use of the AVP may reduce blood flow but cannot seal the blood flow completely, even if a large AVP is deployed. Although initial single use of the AVP II or double use of the AVP during debranching TEVAR should be sufficient, this was not confirmed in our case. We speculated that initial single use of the AVP II was desirable to treat the ARSA in this case of debranching TEVAR. Although this was not directly demonstrated in the present case and is not supported by previously published studies, we consider that it is feasible.

van Bogerijen et al. reported 12 cases of aberrant subclavian artery occlusion during debranching TEVAR with bypass grafting, which was the largest endovascular series ever reported. In their cases, occlusion was accomplished by a vascular plug in seven patients, three of whom developed endoleak that did not require re-intervention. Unfortunately, the details of these patients’ AVP failure were not clear in the report.

Another reported method is total endovascular treatment, including subclavian artery snorkel revascularization and the chimney technique. Although they may be less invasive, their disadvantage is “gutter leak” along the main stent-graft. The branched stent-graft may be the ideal endovascular treatment in the future. Despite technological development, ARSA embolization remains clinically

have described use of the AVP for LSA embolization during debranching TEVAR. Thus, we thought that the AVP would be adequate for embolization of the IIA or LSA at the time of the operation. However, we have had no opportunity to use the AVP II and did not recognize the necessity of the AVP II at that time. Based on our experience with EVAR, we simply thought that ARSA embolization could be achieved with use of the AVP and did not consider the necessity of the AVP II in this case of debranching TEVAR. This was our misjudgment. An endoleak was apparent on postoperative CT evaluation. We realized then for the first time that embolization of the ARSA is not a simple procedure. The major difference between IIA embolization and ARSA embolization is, as discussed above, the existence of systemic blood pressure on the AVP. The AVP on the IIA was exposed to decreased blood pressure, but the AVP on the ARSA was exposed to the systemic blood pressure brought by the bypass graft to the ARSA.

We concluded that elimination of the endoleak was achieved by tandem use of the plugs, and mainly by the
important because debranching TEVAR might serve as a bailout procedure.3)

**Conclusion**

Our simple technique described herein is useful for debranching TEVAR if bypass grafting is needed. We believe that our experience may contribute to the treatment of ARSA-related endovascular surgery.

**Disclosure Statement**

No authors have conflicts of interest or financial relationships to disclose.

**Statement of Patient Consent**

The patient provided written informed consent for their clinical information and images to be published.

**Author Contributions**

Study conception: TO
Data collection: TO
Writing: TO
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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