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Case Report

Two Cases of Intrathoracic Subclavian Artery Aneurysm Treated with Endovascular Treatment Combinations

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Summary

The surgical procedure for intrathoracic subclavian artery aneurysm requires thoracotomy and is therefore highly invasive. We experienced two cases of intrathoracic subclavian artery aneurysm, one of which underwent endovascular treatment and one hybrid treatment. In the first case, an 80-year-old woman had a covered stent placed in a left intrathoracic subclavian artery aneurysm (30 mm diameter) through the left brachial artery. The second case involved a 79-year-old man who had previously undergone thoracic endovascular aortic repair of an aortic arch aneurysm that covered the origin of the left subclavian artery with a stent graft. He had a 32-mm-diameter aneurysm on the proximal side of the right subclavian artery. The right vertebral artery branched from the aneurysm, and the right common carotid artery branched near the aneurysm. A bypass with an expanded polytetrafluoroethylene graft was placed from the extrathoracic right subclavian artery to the right common carotid artery and extrathoracic left subclavian artery. A covered stent was then inserted from the brachiocephalic artery to the right subclavian artery to completely exclude the subclavian artery aneurysm. Both patients were discharged 7 days postoperatively without endoleak or complications.

Key Words: subclavian artery aneurysm, endovascular treatment, hybrid treatment, intrathoracic cavity, Viabahn®

Introduction

The gold standard treatment for intrathoracic subclavian artery aneurysms is open surgical repair, which requires thoracotomy and is highly invasive. Recently, there have been significant advances in endovascular treatment devices and reports of peripheral aneurysm treatment using stent graft legs and Viabahn® endografts. We report two cases in which intrathoracic subclavian artery aneurysms were successfully treated: one with endovascular treatment and one with a hybrid procedure. Each patient provided consent for the publication of this report.

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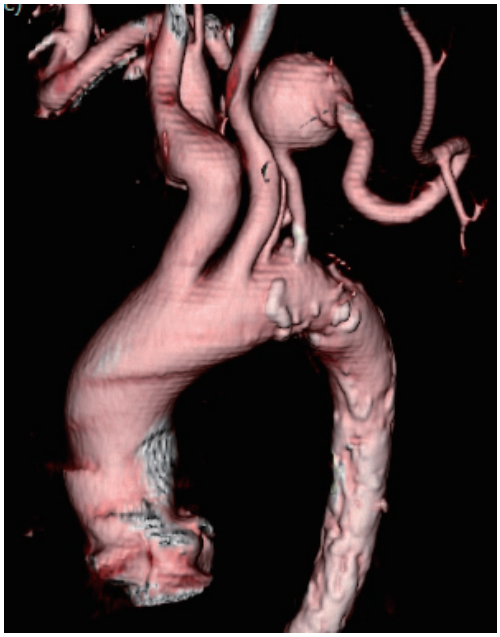

Figure 1 Preoperative three-dimensional computed tomography angiogram of case 1.
A 30-mm left subclavian artery aneurysm can be observed. The length of the central landing zone is 28 mm. The left vertebral artery branches directly from the aorta.

Case Presentation

Case 1

A 73-year-old woman with hypertension, osteoporosis, and hyperthyroidism was referred to our hospital because of an abdominal aortic aneurysm. Computed tomography (CT) revealed a 30-mm abdominal aortic aneurysm and 19-mm left subclavian artery aneurysm, which were monitored by our department. When the patient was 80 years old, the left subclavian artery aneurysm expanded to 30 mm, which was considered an indication for the treatment. The patient had no subjective symptoms and was undergoing treatment for hypertension, osteoporosis, and hyperthyroidism. There was a small difference in blood pressure between her left and right upper limbs; however, the ankle-brachial index scores were 0.85 and 0.83 in her right and left lower limbs, respectively, indicating lower blood pressure in the left than the right lower limb. A pulsatile mass was palpated in her abdomen. Her blood test data at admission revealed mild renal impairment (serum creatinine, 1.02 mg/dL; estimated glomerular filtration rate, 39.9 mL/min/1.73 m^2).

Preoperative contrast-enhanced CT showed an aneurysm located 28 mm distal to the origin of the left subclavian artery. The left vertebral artery branched directly from the aortic arch. Circumferential calcification and stenosis were observed in the descending aorta (Fig. 1), and the decrease in blood pressure in the lower limbs was attributed to this stenosis. The diameter of the left subclavian artery was 6 mm on the proximal side of the aneurysm and 7 mm on the distal side of the aneurysm. Additionally, an infrarenal abdominal aortic aneurysm with a maximum short axis of 42 mm was observed. The patient was of advanced age and had many comorbidities, and endovascular treatment was possible anatomically. Therefore, we decided to perform endovascular treatment using a covered stent.

The surgery was performed in a hybrid operating room. After general anesthesia induction, the patient was placed in the supine position with the left arm in abduction. The left brachial artery was exposed, and a 7-French sheath was inserted up to the origin of the left subclavian artery. A 7 mm × 10 cm Viabahn® endograft (W.L. Gore & Associates, Newark, DE, USA) was placed at the origin of the left subclavian artery. Following this, an 8 mm × 10 cm Viabahn® endograft was placed on the distal side to exclude the aneurysm.

Postoperative contrast-enhanced CT showed no endoleak or migration of the Viabahn® endograft. The patient was discharged 7 days postoperatively, without any complications. CT performed 24 months postoperatively showed that the aneurysm had shrunk, and a favorable postoperative course was predicted (Fig. 2).

Case 2

A 79-year-old man was referred to our hospital for the treatment of a right subclavian artery aneurysm. When he was 60 years old, he had an abdominal aortic aneurysm treated via graft replacement. At the age of 69 years, he underwent thoracic endovascular aortic aneurysm repair with a Najuta® fenestrated endograft (Kawasumi Laboratories, Inc., Tokyo, Japan) for a distal aortic arch aneurysm. However, the diameter of the right subclavian artery aneurysm gradually increased to 30 mm. The patient had no subjective symptoms but had hypertension, emphysema, and chronic nephropathy. Additionally, he had undergone percutaneous coronary intervention for angina in the left circumflex

Figure 2 Three-dimensional computed tomography angiogram of case 1 performed 24 months postoperatively.
A Viabahn® endograft was placed in the left subclavian artery. There is no endoleak.

Figure 3 Preoperative three-dimensional computed tomography angiogram of case 2.
A 32-mm diameter right subclavian artery aneurysm can be observed. The brachiocephalic artery has a maximum diameter of 17 mm and length of 35 mm. The origin of the left subclavian artery is blocked by a thoracic stent graft (Najuta® fenestrated endograft). The right vertebral artery branches from the right subclavian artery aneurysm.

region when he was 78 years old and was receiving antiplatelet drug therapy.

There was no blood pressure difference between his left and right arm. His blood test results at admission showed mild renal dysfunction (serum creatinine, 1.28 mg/dl; estimated glomerular filtration rate, 42.3 mL/min/1.73 m^2). Preoperative respiratory function testing revealed a forced expiratory volume per second percentage to be 67.1%, suggesting chronic obstructive lung disease.

Preoperative contrast-enhanced CT showed that the origin of the left subclavian artery was covered by the Najuta® endograft, but the origin of the right common carotid artery and the brachiocephalic artery was patented by the fenestra of the Najuta® endograft. A right subclavian artery aneurysm (maximum diameter 32 mm) had formed in the area from the origin of the right subclavian artery to the right vertebral artery bifurcation. The brachiocephalic artery proximal to the aneurysm had a maximum diameter of 17 mm and length of 35 mm (Fig. 3); the diameter of the right subclavian artery distal to the aneurysm was 10 mm. Minimally invasive treatment was considered ideal because of the patient's advanced age and various comorbidities, such as emphysema, chronic kidney dysfunction, and history of percutaneous coronary intervention.

Anatomically, it was possible to exclude the aneurysm by placing a covered stent from the brachiocephalic artery to the right subclavian artery. However, because the covered stent would have occluded the right common carotid artery and the right vertebral artery, we chose a hybrid treatment with a bypass that would result in preserved blood flow to the left vertebral artery and right common carotid artery via the right subclavian artery. Magnetic resonance angiography of the head showed that the bilateral vertebral arteries were 4 mm in diameter and communicated with the basilar artery. Carotid ultrasonography revealed retrograde blood flow in the left vertebral artery. Based on the advice of a neurosurgeon in our hospital, no additional examinations such as cerebral blood flow scintigraphy were performed.

The surgery was performed in a hybrid operating

Figure 4 Computed tomography of case 2 on postoperative day 5.
The Excluder® leg and Viabahn® VBX endograft are placed in the area from the brachiocephalic artery to the right subclavian artery. There is no endoleak. Contrast enhancement of the right vertebral artery has disappeared, and that of the left vertebral artery has been obtained. The bypass graft is patent.

room. After general anesthesia induction, the patient was placed in the supine position. During the operation, cerebral oxygen saturation was monitored by in vivo optical spectroscopy. An expanded polytetrafluoroethylene graft T-tube with an 8-mm ring (Gore-Tex, Flagstaff, AZ, USA) was used to bypass the right extrathoracic subclavian artery to the right common carotid artery and the left extrathoracic subclavian artery. The right common carotid artery was ligated proximal to the anastomotic site. The bypass to the left subclavian artery restored antegrade blood flow in the left vertebral artery. Right vertebral artery coil embolization was then performed via the right subclavian artery. Additionally, a covered stent was placed from the brachiocephalic artery to the right subclavian artery. As the brachiocephalic artery had a maximum diameter of 17 mm, no covered stent could have been placed in an antegrade direction. Therefore, an Excluder® leg (W.L. Gore & Associates, Flagstaff, AZ, USA) was placed using the upside-down technique[1]. In this procedure, a 12-French Gore® DrySeal flex introducer sheath (W.L. Gore & Associates, Flagstaff, AZ, USA) was inserted up to the origin of the brachiocephalic artery. Next, a 20 mm × 12 cm Excluder® leg was inserted into the sheath upside down and deployed. The Excluder® leg was then inserted from the brachiocephalic artery to the right subclavian artery by pulling out the sheath mantle while supporting the Excluder® leg with the sheath inner cylinder. The aneurysm was excluded by sufficiently extending the landing zone of the right subclavian artery with an 8 mm × 6 cm Viabahn® VBX endograft (W.L. Gore & Associates, Newark, DE, USA).

Postoperative contrast-enhanced CT showed no endoleak or migration (Fig. 4). The patient was discharged without any complications 7 days postoperatively. CT performed 1 month postoperatively showed that the aneurysm had shrunk by 1 mm, and no endoleak was observed.

Discussion

Subclavian artery aneurysms are considered rare, accounting for less than 1% of all peripheral aneurysms[2-4]. Most subclavian artery aneurysms are asymptomatic but may be associated with rupture and embolism. Although subclavian artery aneurysms are life-threatening, the appropriate timing of surgical intervention has not yet been elucidated[5].

For subclavian artery aneurysms located outside the thorax, a supraclavicular approach can be used to perform graft replacement with relatively less invasiveness[6,7]. However, graft replacement using the direct approach for intrathoracic subclavian artery aneurysms requires a highly invasive approach, such as median sternotomy combined with a collar incision approach, trap door approach, or lateral thoracotomy[7-11]. Therefore, minimally invasive endovascular treatment is an attractive option that has been reported for intrathoracic subclavian artery aneurysms[12].

The method of endovascular or hybrid treatment for intrathoracic subclavian artery aneurysms is selected based on the location of the aneurysm. As in our first case, an aneurysm that is located away from the left vertebral artery and has a sufficiently long neck on both the proximal and distal sides can be treated simply with a covered stent alone. However, a hybrid procedure is required in some cases when the aneurysm

is located near the origin of the subclavian artery[12,13]. In our second case, a thoracic stent graft had been previously placed to cover the left subclavian artery. Thus, there was no antegrade blood flow in the left vertebral artery, and the blood flow in the basilar artery depended on the right vertebral artery. However, the right vertebral artery branched from the right subclavian artery aneurysm, and occlusion was necessary. Therefore, it was necessary to resume antegrade blood flow in the left vertebral artery to maintain the blood flow in the basilar artery. Furthermore, the right common carotid artery branched in the vicinity of the aneurysm and required revascularization. To achieve these conditions, it was necessary to perform extraanatomical bypass surgery via a complicated surgical procedure.

A systematic review reported that surgical procedure-related death occurred in 0.7% of 142 patients who underwent endovascular treatment or hybrid treatment of subclavian artery aneurysms between 1991 and 2017[14], indicating a good result. However, there was a relatively high (15.5%) incidence of complications, such as stenosis or breakage of a covered stent, thrombotic obstruction, and endoleak[14]. Another systematic review of open repair for subclavian artery aneurysms performed between 1915 and 2009 reported a surgical mortality rate of 5% and 26% incidence of complications, such as thrombotic obstruction or graft infection and nerve injury[15]. Thus, endovascular treatment or hybrid treatment do not produce inferior results to open repair and are considered useful treatment methods. However, the long-term results of endovascular treatment for subclavian artery aneurysms remain unknown and require close follow-up.

The endovascular aortic aneurysm repair device used in our case was the Excluder® leg, which does not easily bend or flatten and has been applied in the endovascular treatment of peripheral aneurysms[12,16]. The Viabahn® endograft and Viabahn® VBX endograft are also highly flexible and have been used in the treatment of subclavian artery aneurysms[17].

In conclusion, we successfully treated two cases of intrathoracic subclavian artery aneurysms with endovascular treatment and hybrid treatment using covered stents, namely the Excluder® leg and Viabahn® endograft. Such treatments may be useful in high-risk patients.

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Disclosure Statement

All authors declare that they have no conflict of interest.

Author Contributions

Study conception: M.S., H.T.
Data collection: M.S., K.N., N.A.
Writing: M.S., H.T.
Critical review and revision: all authors.

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