» **Case Report** «

Thoracic Stent Graft with Distal Fenestration for the Superior Mesenteric Artery for Treatment of Thoracic Aortic Aneurysm

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An 86-year-old man with a 75-mm TAA that terminated just above the celiac artery was treated with a customized Zenith stent graft that had a distal fenestration for the superior mesenteric artery (SMA). Because angiography demonstrated a type IB endoleak, an additional extension stent graft was deployed, and coil embolization of the aneurysmal sac was performed. Three months later, there was no endoleak and good visceral blood flow. Placement of a fenestrated thoracic stent graft with a scallop-like fenestration for the SMA is a promising procedure for the treatment of TAAs with a short distal neck.

Keywords: fenestrated stent graft, thoracic aorta, aneurysm

Introduction

Endovascular aneurysm repair of thoracic aortic aneurysms (TAAs) has become an efficient, safe, minimally invasive alternative to open surgery because of its lower perioperative mortality and morbidity rates.^{1,2)} A limitation of the endovascular technique is the need for an appropriate landing zone for secure fixation of the endograft. Approximately, 15% of patients with descending TAAs have an insufficient distal landing zone for endovascular aneurysm repair.³⁾ The use of a branched or fenestrated endograft is a potential endovascular repair option, and the published literature shows encouraging results.^{4–6)} We herein, report our experience with a thoracic stent

graft with distal fenestration for the superior mesenteric artery (SMA) in the treatment of a TAA.

Case Report

An 86-year-old man was diagnosed with a 75-mm TAA that terminated just above the celiac artery (CA). Computed tomography showed that the aneurysm had an 8-cm-long proximal neck below the left subclavian artery; however, there was no landing zone between the aneurysm and the CA and only a 10-mm-long distal neck above the SMA (Fig. 1). The patient had been under investigation for arterial hypertension, chronic renal failure, ischemic heart disease, bilateral internal carotid artery stenosis, and right common iliac artery aneurysm, which had been treated with endovascular aneurysm repair. The patient's risk factors made him a poor candidate for classic surgical repair. We confirmed the collateral flow between the CA and SMA using the angiographic CA ballooning test at 3 days before operation. Then, we decided to treat the TAA with a custom-made fenestrated stent graft. Informed consent was obtained from the patient and his family.

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Fig. 1 Preoperative computed tomography showing the thoracic aorta aneurysm, celiac artery (CA), and superior mesenteric artery (SMA). There was no landing zone between the aneurysm and CA and only a 10-mm-long distal neck above the SMA. The larger arrow indicates the CA. The small arrow indicates the SMA.

The fenestrated thoracic graft was custom-made from a 120-mm-long, 28-mm-diameter Zenith TX2 thoracic stent graft (William A. Cook Australia, Brisbane, Australia). The fenestration was positioned at the distal end of the stent graft with a 10-mm-deep, 10-mm-wide scallop. Radiopaque markers made of snare wire were sutured onto the graft to surround the scallop (Fig. 2).

Under general anesthesia, oblique skin incisions were made on the bilateral groin areas to expose the common femoral artery (CFA). A 6-F sheath (Medikit, Tokyo, Japan) was inserted proximally from the right CFA, and a 6-F sheath was inserted proximally from the left CFA. A 4-F sheath (Medikit, Tokyo, Japan) was then inserted into the left brachial artery.

Coil embolization of the CA was performed first. A microcatheter (Renegade 18; Stryker, Kalamazoo, Michigan, USA) was placed at the celiac trunk. The coil embolization of the celiac trunk was performed with microcoils (Interlock; Boston Scientific, Natick,

Fig. 2 The fenestrated stent graft. The scallop-like fenestration was created at the distal end of the endograft (circle).

Massachusetts, USA) measuring 10 mm × 20 cm (n = 3), 8 mm × 20 cm (n = 2), 6 mm × 20 cm (n = 4), and 5 mm × 15 cm (n = 2).

Next, the custom-made fenestrated stent graft was inserted via the right CFA over a Lunderquist Extra Stiff guidewire (Cook Diagnostic and Interventional Products, Bloomington, Indiana, USA). The Radifocus guidewire (Terumo, Tokyo, Japan), which was inserted via the left brachial sheath, was positioned in the SMA to serve as a landmark for the distal landing zone of the fenestrated stent graft. Aortography was performed for accurate determination of the positions of the aneurysm, CA, and SMA, which were marked on the overhead projector sheet placed on the monitor of the digital subtraction angiography instrument. The prosthesis was deployed in the constrained configuration, then pulled down to the scallop that was positioned at the orifice of the SMA. The trigger wire was released to complete the expansion of the graft. Ballooning was performed using the Coda Balloon (Cook Diagnostic and Interventional Products, USA).

Angiography confirmed normal perfusion of the SMA and a massive type IB endoleak (Fig. 3A). Hence, the microcatheter (Renegade 18) was introduced into the aneurysm cavity from the right CFA sheath. Coil embolization between the aneurysm wall and the stent graft was performed with microcoils (IDC; Boston Scientific, USA) measuring 20 mm × 20 cm (n = 2), 8 mm × 10 cm (n = 1), Interlock 10 mm × 30 cm

Fig. 3 (A) Angiography showing the type IB endoleak (arrowheads). (B) Angiography 3 months after the operation showing no endoleak and good blood perfusion of the superior mesenteric artery (SMA).

($n = 3$), and 6 mm $\times$ 10 cm ($n = 5$). The 80-mm-long, 28-mm-diameter Zenith TX2 extension stent graft was deployed just proximal to the SMA to reinforce the radial force. Completion angiography demonstrated a slight type IB endoleak. The operative time was 418 minutes and the volume of the contrast medium was 85 ml.

There was a slight elevation in the creatinine level, which recovered to the preoperative level at discharge. There was no paraplegia or alterations of hepatic or pancreatic function. At the 3-month angiographic follow-up, no endoleak and good blood perfusion of the SMA were recognized (Fig. 3B).

Discussion

For many years, open surgical repair was the mainstay therapy for TAA; regardless, the risks of perioperative mortality and paraplegia are generally near 10%.⁷⁾ More recently, endovascular stent grafting has emerged as a therapeutic option for TAA. This endovascular repair significantly reduces mortality and neurological morbidity.¹⁾ A limitation of endovascular repair is the need for an adequate sealing zone of at least 2 cm to 3 cm above and below the aneurysm. TAAs with shorter necks are not suitable for endovascular repair without surgical adjunctive procedures involving vital side branches of the aorta. To accomplish this, two endovascular systems have been trialed, namely fenestrated grafts and branched grafts.

In our patient, the distal neck was only 1 cm long above the SMA. The aorta formed the aneurysm precisely at the CA level. Hence, we chose a distally fenestrated stent graft to preserve the blood flow of the SMA with coil embolization of the CA. The concept of using a distally fenestrated graft for TAAs with a short distal landing zone is not new. Stanley, et al. reported a case involving a TAA that reached distally up to 5 mm from the CA.⁴⁾ They used the Cook Zenith thoracic stent graft with a distal fenestration to accommodate the CA. In addition, Tiellu, et al. reported 3 cases involving treatment of thoracic aneurysms with a too-short distal neck.⁵⁾ They used a stent graft with a scallop for the CA. However, the present report describes the first case involving the use of a distally fenestrated stent graft for the SMA. In our case, the aneurysmal formation began just above the CA bifurcation. Therefore, the distal landing zone of the stent graft needed to be located between the CA and SMA. We used a stent graft with a scallop for the SMA, and the CA was embolized with coils. Bleyne, et al. reported that if the CA is included in the aneurysmal process, a sided-branched stent graft is a useful tool.⁸⁾ However, this technique is very complex and takes a long time to perform. Our technique, namely SMA fenestration and CA occlusion, is comparatively simple.

Obviously, our technique is a challenging procedure and has some concerns. The first is whether coverage of the CA without concomitant revascularization is a reasonable procedure. Approximately 15% of patients with a descending TAA have an insufficient distal landing zone for a stent graft;³⁾ therefore, these patients must undergo occlusion of the CA or fenestrated stent graft. Jim, et al. reported that if a collateral network of vessels between the CA and SMA is present, intentional coverage of the CA is technically safe but has a significant risk of death and morbidity.⁹⁾ He recommended close postoperative monitoring for the development of foregut ischemia. In addition, SMA angiography during temporary CA balloon occlusion has been considered mandatory to demonstrate the presence of collateral circulation.¹⁰⁾ We confirmed collateral flow between the CA and SMA using the CA ballooning test preoperatively.

A second concern is the development of distal type IB endoleak. Jim, et al. reported that 6.5% of distal type IB endoleaks occurred in TEVAR with CA coverage,¹⁰⁾ and Bakoyiannis, et al. reported that 18.4%

of endoleaks occurred in the fenestrated or branched endograft during thoracoabdominal aortic aneurysm repair.⁶⁾ Likewise, our patient demonstrated a type IB endoleak. We deployed the extension stent graft just proximal to the SMA to reinforce the radial force and performed coil embolization of the aneurysmal cavity. Three months after the procedure, the type IB endoleak had disappeared.

This is only a preliminary report. Longer follow-up is required to establish the reliability and safety of fenestrated stent grafts.

Conclusions

Placement of a fenestrated thoracic stent graft with a scallop-like fenestration for the SMA is a promising procedure for the treatment of TAA with a short distal neck. With this technique, the distal landing zone can be extended to the SMA. When intentional coverage of the CA is needed, it is necessary to confirm sufficient collateral flow between the CA and SMA.

Disclosure Statement

The authors declare no conflict of interest.

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