Percutaneous In situ Left Subclavian Artery Fenestration Using Reentry Catheter during Endovascular Thoracic Aortic Aneurysm Repair

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Abstract

Keywords

- ▶ endovascular repair
- ▶ thoracoabdominal aortic aneurysm
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- ▶ endovascular procedure
- ▶ subclavian stenosis

Left subclavian artery (LSA) revascularization is recommended during elective thoracic endovascular aortic aneurysm repair (TEVAR) when coverage is required for adequate proximal seal. Reported method for LSA revascularization includes open bypass, covered stent placement using chimney technique, and in situ laser fenestration. We reported a novel technique using percutaneous Outback reentry device for LSA revascularization in a 68-year-old male patient who underwent TEVAR for a 9-cm thoracic aortic aneurysm. This technique can be used as an alternative method for LSA in situ fenestration, and laser equipment is not required.

Thoracic endovascular aortic aneurysm repair (TEVAR) has become an attractive alternative for treatment of thoracic aortic pathology including aneurysm and dissection since its approval by US Food and Drug Administration in 2005.^{1,2} In carefully selected patient with thoracic aortic aneurysm, TEVAR can be associated with improved outcomes as compared with traditional open repair.¹ Endovascular repair has also become the preferred modality for treatment of blunt thoracic aortic injury in suitable anatomy.^{3,4}

Up to 40% of patients undergoing TEVAR might require coverage of left subclavian artery (LSA) for adequate proximal landing zone.^{5,6} In the practice guideline published by Society for Vascular Surgery, routine LSA revascularization is recommended for elective TEVAR when coverage of LSA is required.⁷ LSA revascularization is traditionally performed with left carotid–subclavian bypass or transposition of LSA to common carotid artery.^{7,8} Recently retrograde laser fenestration of endograft has emerged as feasible and effective method for LSA revascularization during TEVAR.⁹ Branched and fenestrated devices have been used successfully but not widely available in the United States.¹⁰

In this report, we present a novel alternative technique for percutaneous LSA revascularization using Outback LTD reentry catheter (Cordis, Bridgewater, NJ) which was performed in a patient who underwent TEVAR for a large thoracic aortic aneurysm.

Case Report

We report a case of TEVAR after carotid–carotid bypass and successful percutaneous LSA revascularization using Outback LTD reentry catheter in a 68-year-old male patient with asymptomatic 9-cm thoracic aortic aneurysm. His medical history was significant for coronary artery disease, chronic obstructive pulmonary disease, and chronic renal insufficiency with baseline creatinine of 4.0. His glomerular filtration rate was 18 and he was anticipated to be requiring permanent dialysis within next 6 months. Left brachial and radial pulses were palpable on physical examination. On review of his computed tomography (CT) scan, his large arch aortic aneurysm extended up to left common carotid artery (▶ **Fig. 1**), left vertebrate artery was dominant in posterior circulation, and

Fig. 1 Computed tomographic scan with 3D reconstruction showed large thoracic aortic aneurysm extending to left common carotid artery. 3D, three-dimensional.

coverage of LSA and left common carotid artery will be required for adequate proximal seal. Decision was made to proceed with TEVAR after right-to-left carotid-carotid bypass followed by in situ LSA. The rationale for LSA revascularization was to preserve posterior circulation due to dominant left vertebrate artery and to preserve left arm arterial perfusion for future access in anticipation of dialysis.

General endotracheal anesthesia was administered with patient in supine position after placement of spinal drain. Right-to-left carotid-carotid artery bypass was performed using 8-mm ring-reinforced PTFE (polytetra fluoroethylene) graft. After obtaining vascular access in both groins, TAG endograft (W. L. Gore & Associates, Flagstaff, AZ) was deployed just distal to the origin of innominate artery across the orifices of left common carotid artery and LSA. Angiogram showed successful exclusion of aneurysm sac with no endoleak and patent right-to-left carotid-carotid bypass. The left carotid artery was subsequently ligated proximal to the bypass.

Left brachial artery was accessed using ultrasound guidance and a 7F sheath was inserted over the wire into proximal LSA. The Outback LTD reentry catheter was inserted over 0.014 wire against the deployed aortic endograft (►Fig. 2).

Fig. 2 The Outback LTD reentry catheter (Cordis, Bridgewater, NJ) was inserted over 0.014 wire against the deployed aortic endograft.

Using a trilobed aortic balloon (W. L. Gore & Associates) inserted from femoral access to provide additional support, the endograft was punctured with the reentry catheter. A 0.014 wire was inserted over the catheter into ascending aorta. The fenestration was dilated using 2.0-mm percutaneous angioplasty balloons. A 3.5-mm Flextome cutting balloon (Boston Scientific, Natick, MA) was then used to enlarge the fenestration on the PTFE graft. The 0.014 wire was exchanged to a 0.035 stiff wire and the fenestrated was again predilated using a 6-mm balloon. Based on the angiographic measurement, an 8 × 59 mm ICAST balloon expandable covered stent (Atrium, Hudson, NH) was deployed across the fenestration. The covered stent was deployed approximately one-third into the aortic endograft lumen and remaining into the LSA under fluoroscopic guidance. A 10-mm balloon was inserted carefully over the wire and balloon dilatation was performed at both ends of the stent graft to configure it into hour glass configuration. Completion angiogram showed exclusion of aneurysm sac, with patency of LSA fenestration and no endoleak (►Fig. 3).

His postoperative course was complicated by wound infection at the neck incision that was managed conservatively with serial debridement and antibiotic. There was no clinical evidence of prosthetic graft infection. Patient was discharged on postoperative day 10 with no evidence of neurological deficit. He had palpable pulse in brachial and radial arteries. Postoperative follow-up CT scan 6 months after the initial surgery showed patency of endograft, carotid-carotid bypass, and LSA fenestration with no endoleak (►Fig. 4).

Discussion

Coverage of LSA is often required during TEVAR to achieve adequate proximal seal zone.^{5,6} LSA is important for perfusion of brain stem and spinal cord. Coverage of LSA without revascularization is reported to be associated with increased risk of spinal cord ischemia, anterior circulation stroke, arm ischemia, and vertebrobasilar ischemia.^{11,12} Although routine LSA revascularization is controversial,¹³ it is recommended in elective TEVAR, and particularly important when there is dominant left vertebral artery, previous left internal mammary coronary artery bypass graft, patent dialysis access in left arm, and absence or hypoplastic right vertebrate artery.^{7,14}

Traditional LSA revascularization can be performed with transposition of LSA to left common carotid artery, carotid to subclavian artery bypass, or right-to-left carotid-carotid bypass with proximal LSA ligation to prevent endoleak.⁷ Open revascularization is associated with longer operating time and can be associated with risk of stroke, injury to cranial nerve, phrenic nerve, and thoracic duct. Recently, percutaneous LSA revascularization was performed using chimney technique,¹⁵ or in situ laser fenestration.⁹ Redlinger et al has recently reported their experience of in situ laser fenestration during TEVAR in 22 patients. No fenestration-related complications were observed and follow-up imaging showed 100% primary patency for the LSA stent.⁹ However, laser machine and catheter are required for the procedure.

Fig. 3 Completion angiogram showed patency of aortic endograft and left subclavian artery fenestration.

Outback LTD reentry catheter has been used successfully in treatment of peripheral artery disease during challenging subintimal angioplasty for reentry into true vessel lumen.¹⁶ We had successfully used the catheter for percutaneous LSA fenestration during TEVAR in place of laser catheter. Important technical steps are usage of aortic balloon in the endograft for additional support against the puncture site of Outback catheter during fenestration. The reentry catheter is advanced further proximally almost parallel to the aortic endograft and the needle is orientated down toward the aortic balloon against the endograft. The aortic balloon is inflated with 50% contrast, and needle penetrating is confirmed when the balloon is popped under fluoroscopy. The fenestration was serially dilated and enlarged using PTA balloon as well as cutting balloon. We believe it is an important step to perform balloon angioplasty the ICAST stent graft on each side of fenestration to configure it into hour glass shape. This is to prevent migration of the ICAST stent graft

Fig. 4 Postoperative follow-up CT scan showed patency of endograft, carotid-carotid bypass and LSA fenestration with no endoleak. CT, computed tomography.

during manipulation because there is no constrained wire around fenestration. Further extension using uncovered bare metal stent with deployment inside stent graft can be performed if stent graft migrations still a concern. Risk of endoleak is minimized by “flaring” both ends of the stent graft into hour glass configuration. If perfenestration endoleak is present, this can be treated by flaring using large balloon or extension using large stent graft.

We believe this technique using the Outback reentry catheter for LSA fenestration is a useful alternative method especially in institution where laser instrument is not available.

Conclusions

We reported a case of successful in situ LSA fenestration using the Outback reentry catheter during TEVAR for a large aortic arch aneurysm. This is a useful alternative technique for the patients who are high risk for open LSA revascularization, or laser fenestration system is not available.

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