Retrograde in situ branched stent grafting for a patient with type V thoracoabdominal aortic aneurysm

Kenyu Murata, MD, Yoshiaki Saito, MD, PhD, Shuto Watanabe, MD, Norihiro Kondo, MD, PhD, and Masahito Minakawa, MD, PhD, Aomori, Japan

ABSTRACT

We have presented the case of a 76-year-old patient with a type V thoracoabdominal aortic aneurysm treated by retrograde in situ branched stent grafting to the superior mesenteric artery (SMA). Via a 9-cm, median laparotomy, a percutaneous transhepatic gallbladder drainage needle was inserted from the distal part of the first jejunal artery to the origin of the SMA. After stent graft placement into the aorta, the graft was retrogradely punctured using the percutaneous transhepatic gallbladder drainage needle. The SMA ischemic time was 6 minutes. The puncture site was dilated, and a small, covered stent was deployed. Postoperative computed tomography scanning showed no endoleak with sac regression. (J Vasc Surg Cases Innov Tech 2022;8:748-51.)

Keywords: Endovascular; Fenestration; Stent graft; Superior mesenteric artery; Thoracoabdominal aortic aneurysm

Thoracic endovascular aortic repair (TEVAR) has been recently developed to treat thoracoabdominal aortic aneurysms (TAAAs). A physician-modified technique, including “antegrade” in situ fenestration TEVAR, has been reported to be effective for both emergency and elective cases, although the technical complexities have remained high. In the present report, we have described a case of TAAA, extent type V, that was successfully treated with a “retrograde” in situ fenestration technique via a small laparotomy. The patient provided written informed consent for the report of her case details and imaging studies. The ethics committee of Hirosaki University Graduate School of Medicine approved the use of the data included in our report.

CASE REPORT

A 76-year-old woman had been referred to our hospital for the treatment of a TAAA. Contrast-enhanced computed tomography showed an extent type V saccular TAAA with a maximum diameter of 50 mm (Fig 1, A and B). The length of the orifice of the saccular aneurysm was 23 mm. The distance from the distal end of the aneurysm to the origin of the celiac artery, superior mesenteric artery (SMA), and higher renal artery (ie, right renal artery) was 5 mm, 8 mm, and 25 mm, respectively (Fig 1, C). The right femoral artery was cut down, and the left femoral artery was percutaneously cannulated as a route for the contrast injections. Through a 9-cm median laparotomy incision, the first jejunal artery (~2.5 mm in diameter) was exposed in the mesentery, and a purse-string suture was made with 6-0 polypropylene suture. The SMA was confirmed to run within the mesentry; however, the SMA itself was not exposed at all. After a 20F DrySeal sheath (W.L. Gore & Associates, Flagstaff, AZ) had been inserted through the right femoral artery, a 9F introducer sheath (Cordis BRITE TIP; Cardinal Health Inc, Dublin, OH) was inserted from the first jejunal artery to the origin of the SMA (Fig 2, A). The retrograde in situ branched stent graft (RIBS) technique, which is primarily used for aortic arch pathology, was applied to treat the present visceral aortic aneurysm, as previously described. In brief, a 7F tip-cut sheath with a bent 18-gauge percutaneous transhepatic gallbladder drainage needle (Hanaco Medical Co, Ltd, Saitama, Japan) was inserted into the 9F sheath over a Lunderquist wire (Cook Medical Inc, Bloomington, IN). Next, a 26- to 31-mm × 10-cm tapered Gore cTAG endoprosthesis (W.L. Gore & Associates) was inserted through the DrySeal sheath. The stent graft was deployed with the distal end of the graft positioned just proximal to the origin of the right renal artery. Subsequently, the Lunderquist wire was gently pulled out into the bent percutaneous transhepatic gallbladder drainage needle, and the graft was punctured as the jejunal mesentery was gently tugged ventrally to make the puncture angle perpendicular. Subsequently, the guidewire was inserted into the stent graft. During these procedures, the entire SMA ischemic time, defined as the interval from cTAG placement to completion of the cTAG puncture, was 6 minutes. The puncture site was first dilated with a 7F inner sheath, followed by a 6-mm, high-pressure peripheral balloon (ConQuest; Bard Peripheral Vascular Inc, Tempe, AZ, Fig 2, B-D). An 8-mm × 2.5-cm VIABAHN endoprosthesis (W.L. Gore & Associates) was inserted and deployed with 1 cm of the VIABAHN graft positioned inside...
the cTAG to bridge the SMA and the punctured cTAG endoprosthesis. An 8-mm × 17-mm Express LD stent (Boston Scientific Corp, Marlborough, MA) was placed inside the VIABAHN graft to reinforce the connection between the VIABAHN and the cTAG. Angiography after the procedure demonstrated no endoleak after kissing balloon dilatation had been performed with an 8-mm balloon inside the VIABAHN and a Tri-Lobe Balloon (W.L. Gore & Associates) inside the cTAG. Thus, embolization of the origin of the celiac artery was unnecessary. (Whole procedures were shown in the Video clip.) The patient’s postoperative course was good, and she was discharged without complications. Computed tomography performed 6 months after the procedure demonstrated no endoleak and a decrease in aneurysm size (Fig 2, E and F).

DISCUSSION
To date, the retrograde in situ fenestration technique has been chiefly used to treat arch pathology. Fenestration of the left subclavian artery is the most common procedure, with catheter access from the left axillary artery or left brachial artery. Fenestration can be performed using a laser catheter, radiofrequency catheter, or long needle. Ohki et al described a single-center experience of RIBS that had required zone 0 landing thoracic endografting, with promising results. They had exclusively used Gore cTAG for the main graft, along with needle punctures, and reported no type III endoleaks at the junction between the main graft and branch grafts by adding bridging bare metal stents inside. We applied this RIBS technique in the present TAAA case.

In situ fenestration techniques can be divided into antegrade and retrograde approaches. Le Houérou et al reported antegrade laser fenestrated stent grafting for TAAAs with successful results. They attempted SMA fenestration in four cases with SMA ischemia and reported an average ischemia time of 13.8 minutes. Although the results were praiseworthy, the procedure of SMA fenestration might cause high psychological pressure to the operator, and procedural success might depend on the physician’s clinical experience and...
Fig 2.  

A, Graphic schema of arterial access of the puncture procedure. A 9 F sheath was inserted from the distal part of the first jejunal branch of the superior mesenteric artery (SMA). Fluoroscopic images of the fenestration procedure. 

B, An 18-gauge percutaneous transhepatic gallbladder drainage needle was advanced to the origin of the SMA. 

C, After successful puncture, a guidewire was advanced into the stent graft. 

D, A 6-mm, high-pressure balloon was inflated to dilate the puncture hole. 

E, Postoperative three-dimensional computed tomography image of the presented procedure. 

F, An axial image showed no endoleak.
patient anatomy, including iliac access. Although our procedure requires a small laparotomy, keeping the distal SMA in the surgical field will enable extra aortic shunting if the reperfusion procedure requires a long time.

The puncture procedure of RIBS can be more consistently performed than that for antegrade fenestration, because iliac access will not affect the process. However, a very acute angle between the target artery and the aorta is one of the greatest obstacles when performing the RIBS technique. In the present patient, we were able to puncture the graft easily by simply tugging the mesentery ventrally. Regarding the jejunal artery approach, the marginal arteries can maintain distal jejunal blood flow even when the artery has been injured. Gentle maneuver will enable insertion of the 9F sheath even if the jejunal artery is slightly smaller than the sheath. The approach from the main SMA could result in devastating complications if the dissection occurs from the insertion site.

A major limitation of the RIBS technique for TAAA is that the procedure can only be performed for TAAA extent type I or type V. Additionally, RIBS of the celiac artery and SMA is possible, although that of renal arteries will not be technically possible via a median laparotomy. Thus, a combination of retrograde and antegrade in situ fenestration or the debranching procedure might be an option when performing TEVAR for TAAA extent types II to IV.

Using a company-manufactured branched stent graft is a well-established option. However, these grafts are not commercially available everywhere, and their use is limited in emergent situations or because of anatomic variations. A physician-modified fenestration technique is another option, although the incidence of type III endoleak has been reported to be high, ≤14%. Abdominal RIBS is an excellent alternative to those techniques in terms of being less free of anatomic variations and avoiding type III endoleak.

CONCLUSIONS

RIBS was a practical and feasible option for our elderly patient with a TAAA extent type V. Long-term follow-up is necessary to determine the durability of this technique.

We thank Drs Takao Ohki and Kota Shukuzawa for their dedication to developing the RIBS technology and their technical support.

REFERENCES
1. Le Houérou T, Fabre D, Alonso CG, Brenot P, Bourkaib R, Angel C, et al. In situ antegrade laser fenestrations during endovascular aortic repair. Eur J Vasc Endovasc Surg 2018;56:356-62.
2. Ohki T, Maeda K, Baba T, Kaneko K, Shukuzawa K, Hara M, et al. Early clinical outcomes of retrograde in situ branched stent grafting for complex aortic arch aneurysms. J Vasc Surg 2022;75:803-11.e2.
3. Sonesson B, Dias N, Abdulrasak M, Resch T. Midterm results of laser generated in situ fenestration of the left subclavian artery during thoracic endovascular aneurysm repair. J Vasc Surg 2019;69:1664-9.
4. Li Y, He C, Chen X, Yao J, Zhang T, Zhang H. Endovascular in situ fenestration technique of aortic arch pathology: a systematic review and meta-analysis. Ann Vasc Surg 2021;76:472-80.
5. Canonge J, Jayet J, Heim F, Chakfé N, Coggia M, Coscas R, et al. Comprehensive review of physician modified aortic stent grafts: technical and clinical outcomes. Eur J Vasc Endovasc Surg 2021;61:560-9.

Submitted Jul 26, 2022; accepted Sep 28, 2022.