From the Southern Association for Vascular Surgery

Back-table fenestrated endograft limb inversion for type Ia endoleak repair

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ABSTRACT

We present a case of a type Ia endoleak from an aortic endograft in close proximity to the renal arteries that was successfully treated with a back-table physician-modified endograft with inversion of the contralateral limb. This modification allowed for deployment of a fenestrated cuff and bifurcated distal main body over the flow divider of the previous endograft, thus avoiding the need for either an open aneurysm repair, physician-made fenestrations, or aorto-uni-iliac repair with femoral–femoral bypass. This case demonstrates that back-table physician-modified endograft contralateral limb inversion is an easy, reproducible, and effective technique. (J Vasc Surg Cases Innov Tech 2023;9:101358.)

Keywords: Abdominal aortic aneurysm; Endovascular aortic repair; Physician modified endograft

Although infrarenal endovascular aortic repair (EVAR) has been proved to be safe, the occurrence of endoleaks in ≤25% of patients leads to higher reintervention rates compared with open aortic repair.[1,2] The Society for Vascular Surgery guidelines recommend repair of all type I and III endoleaks and type II endoleaks associated with significant aneurysm sac expansion.[2] Type Ia endoleaks often arise in close proximity to the origins of the renal arteries. Additionally, many commercially available endografts are designed with a short main body.[1-6] These factors complicate the endovascular repair of type Ia endoleaks.[3-6] With patient consent, we present the technical details for performing a back-table endograft limb inversion for the treatment of a type Ia endoleak.

CASE REPORT

A 79-year-old man with coronary artery disease, myocardial infarction, stage 3 chronic kidney disease with an atrophic left kidney, lymphoma in remission, and a 60 pack-year smoking history underwent elective EVAR at an outside hospital for a 5.1- × 5.1-cm infrarenal abdominal aortic aneurysm. This repair used a 35-mm × 14-cm Gore Excluder endograft (W.L. Gore & Associates). The 30-month ultrasound revealed a type Ia endoleak with sac expansion. Subsequent computed tomography angiography confirmed expansion to 5.6 × 5.9 cm and poor proximal graft apposition consistent with a type Ia endoleak (Fig 1). He was then referred to us for repair.

The potential surgical options discussed with the patient included the following:

1. Open aortic endograft explantation and aneurysm repair
2. Proximal extension and EndoAnchors (Medtronic)
3. Parallel graft repair
4. Antegrade in situ laser fenestrated aortic endograft repair
5. Fenestrated aortic endograft repair

Open aortic aneurysm repair was deemed high risk due to the patient's comorbidities. Proximal extension with EndoAnchors was not feasible due to continued aneurysmal neck degeneration and poor graft apposition. Parallel graft repair was not suitable for this patient due to the risk of a gutter leak.[7] In situ laser fenestration was also not favored due to concerns about durability.[8] Therefore, a custom-manufactured fenestrated endograft repair was chosen because it offered a less morbid, yet durable, solution.

The aneurysm neck mandated a supraceliac proximal seal with fenestrations for the celiac artery, superior mesenteric artery (SMA), and right renal arteries (RRAs). His left kidney was atrophied; therefore, no left renal fenestration was required. The patient's anatomy allowed for a Cook Zenith fenestrated endograft with an 8-mm-diameter large fenestration for the celiac artery, a 6-mm × 8-mm fenestration for the SMA, and a 6-mm × 8-mm fenestration for the RRA, based on TeraRecon centerline measurements. To account for the short distance between the RRA and the Gore Excluder flow divider (Fig 2), we planned for a back-table modified limb inversion, which would allow for deployment of the distal main body without entrapment of the contralateral limb. This modification is not approved by the Food and Drug Administration; the patient was informed of the risks and consented to the operation.

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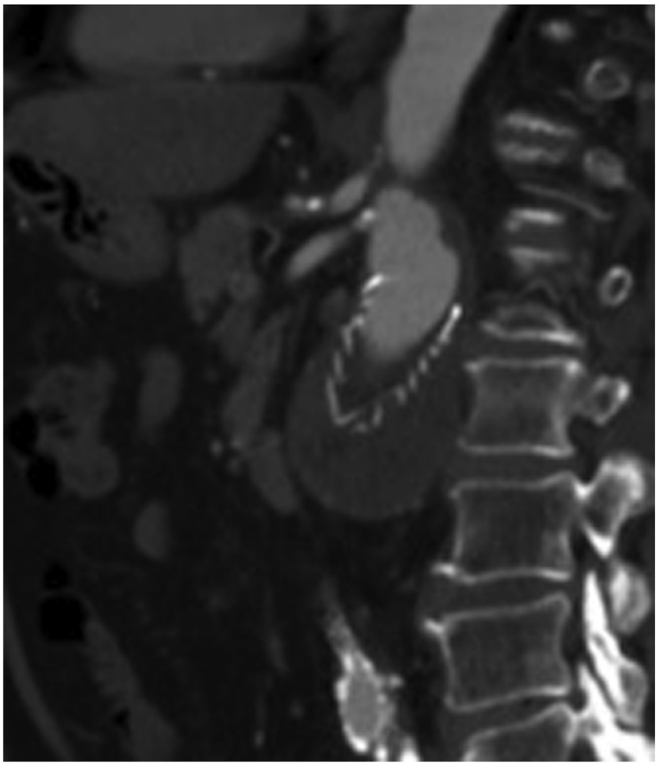

Fig 1. Sagittal computed tomography angiogram confirming poor proximal aortic endograft apposition suspicious for a type Ia endoleak.

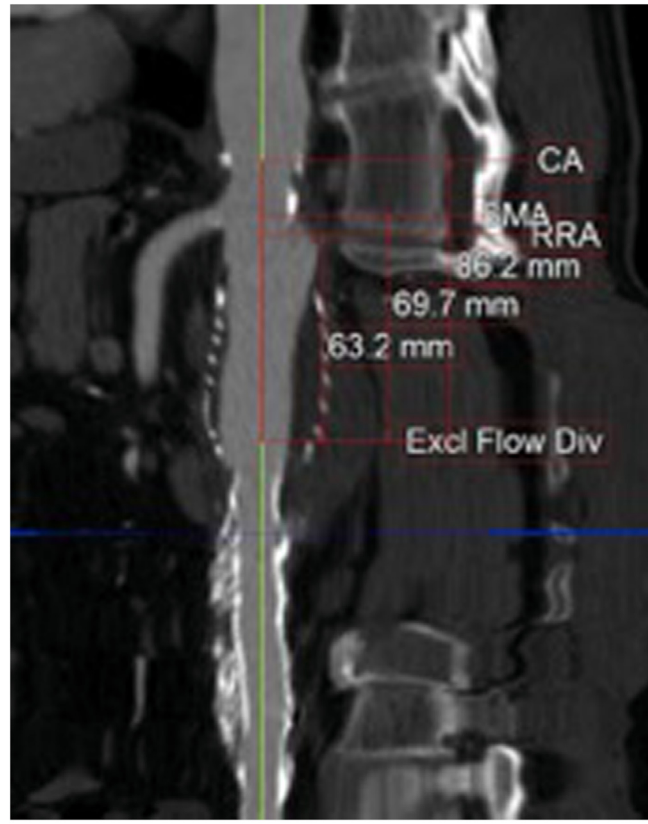

Fig 2. Computed tomography angiogram showing 6.32 cm between the ostium of the right renal artery (RRA) and the bifurcation of the Gore Excluder. This distance would lead to entrapment of the contralateral limb of the fenestrated endograft's distal main body. *CA,* Celiac artery; *Excl Flow Div,* Excluder flow divider; *SMA,* superior mesenteric artery.

MODIFICATION TECHNIQUE

The distal main body endograft was partially unsheathed in a retrograde fashion, such that the bifurcated limbs were accessible (Fig 3, *A*). The contralateral gate was then divided flush with the flow divider (Fig 3, *B* and *C*). The divided limb was intussuscepted backward and sewn into place (Fig 3, *D* and *E*). An additional holding suture was placed to add stability (Fig 3, *E*). The graft was carefully resheathed, ensuring the axial orientation was maintained (Fig 3, *F*).

We established percutaneous access and deployed the proximal fenestrated main body. Side branch cannulation was performed, and iCast stents (Getinge) were placed through the small fenestrations for the SMA and RRA. The large celiac fenestration did not require stenting. The distal bifurcated main body was then inserted, ensuring that the modified contralateral limb was properly oriented relative to the previous endograft. It was advanced and partially deployed. Fluoroscopy imaging confirmed proper placement above the flow divider. The contralateral gate was cannulated, and intravascular ultrasound was used to confirm cannulation. The distal main body and iliac limb extensions were fully deployed, with the ipsilateral iliac limb extension matching the internal height of the inverted contralateral limb, mimicking a kissing stent configuration (Fig 4). The completion angiogram showed patent visceral and hypogastric arteries and no endoleak. The patient was discharged on postoperative day 1. The 11-month follow-up computed tomography scan showed a stable aneurysm sac without evidence of endoleak.

DISCUSSION

Commercially available endograft devices do not allow for repair of type Ia endoleak in the absence of adequate proximal extension options. During endovascular repair, a short distance between the renal arteries and bifurcation of the previous endograft would lead to entrapment of the contralateral iliac limb within the ipsilateral iliac limb of the prior endograft. Back-table inversion of the contralateral limb allows for repair of a type Ia endoleak in close proximity to the renal arteries.

It is important to highlight the potential limitations of this technique. First, the technique is not approved by the Food and Drug Administration. Additionally, this

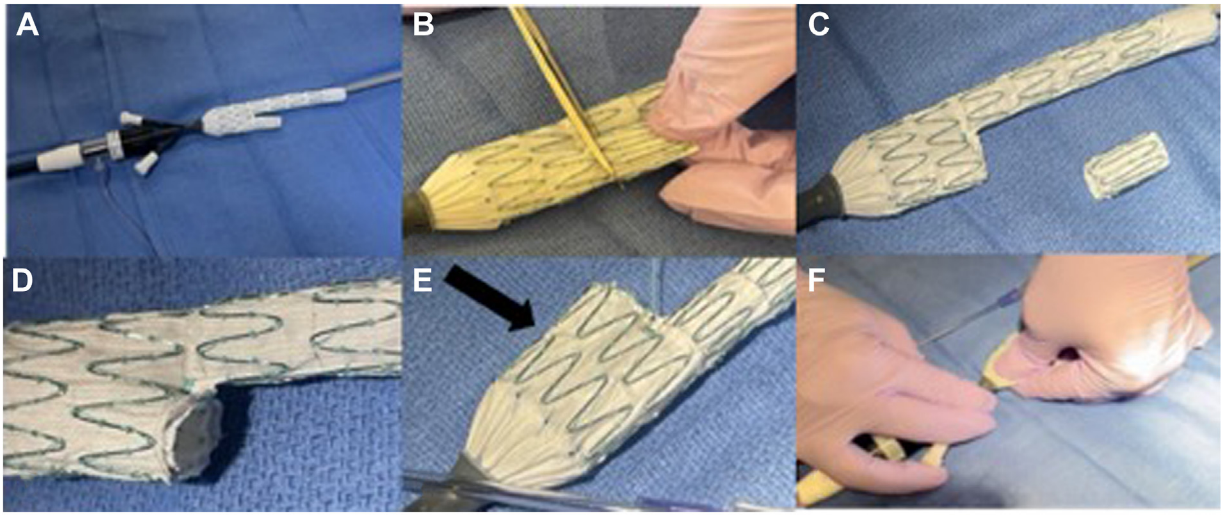

Fig 3. Steps for back-table inverted limb modification. **A,** The distal main body endograft was partially unsheathed in a retrograde fashion, such that the bifurcated limbs were accessible and the most proximal segment of the distal main body remained constrained in the sheath. **B,C,** The contralateral gate was then divided flush with the flow divider, taking care not to damage the fabric between the limbs.[9] **D,E,** The divided limb was intussuscepted backward and sewn into place, incorporating a gold snare for intraoperative visualization, with 5-0 Ethibond suture in a running-locking fashion.[9] **F,** An additional simple interrupted holding suture was placed between the main body and the inverted limb to add stability. The *black arrow* in **E** indicates the holding suture.

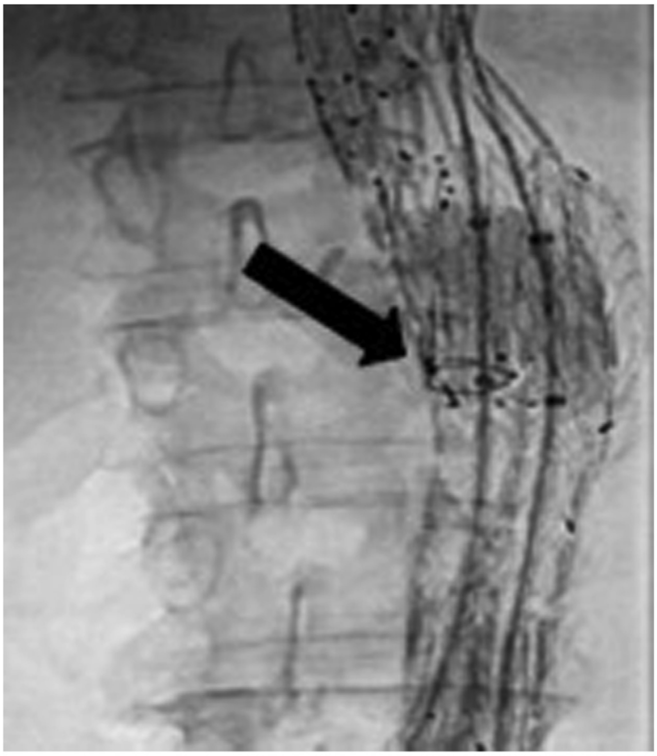

Fig 4. Fluoroscopy imaging confirming the modified distal main body deployed above the Gore Excluder bifurcation (*black arrow*).

technique is not universally feasible. In the present patient, the distance between the Gore flow divider and the RRA was 6.32 cm. The inverted limb modification shortened the distance from the top of the distal main body to the contralateral gate from 7.6 cm to 5.4 cm, allowing for deployment below the RRA and above the flow divider. If the distance between the bifurcation of the previous EVAR and the distal renal artery ostium had been <5.5 cm, this technique would not have been feasible.

Alternative options include parallel graft repair, antegrade in situ laser fenestration, back-table fenestrations, open surgical repair, fenestrated cuff extension with aorto-uni-iliac repair, and femoral—femoral bypass. Although a single-vessel parallel graft technique has been associated with a 5.9% risk of a type Ia endoleak and gutter leak, the need for two or more parallel grafts increases the risk to 33%.[7] Therefore, a parallel graft technique conveys a high risk of a continued endoleak. In situ laser fenestration was excluded because it does not allow for reinforcement of the fenestrations, which could compromise the durability and lead to type IIIb endoleaks.[8] Additionally, we find back-table limb inversion of a custom fenestrated endograft to be a simpler modification than creation of back-table fenestrations or antegrade in situ laser fenestration because limb inversion does not require the surgeon to precisely measure and create fenestrations to match the patient's anatomy. The technical ease of modified limb inversion might also lead to a decreased operative time, radiation dosage and contrast usage.

Several institutions with investigational device exemption for the use of custom-made inverted limb devices have demonstrated excellent short- and mid-term outcomes.[5,10,11] However, few institutions have access to these custom-made devices, and many patients are unable to travel to these centers.[5,10,11] Cook Medical's 2019 5-year Zenith fenestrated endograft data for 88 patients demonstrated excellent durability, with a 95.5% rate of decrease or stabilization in aneurysm size and type Ia and III endoleak rates of 0% and 3.6%, respectively.[12] Limb inversion should parallel this durability, because it does not significantly alter graft integrity in the proximal seal zone. Surgeons performing this technique should adhere to the standard Zenith fenestrated indications for use regarding fenestrations and the landing zone. Finally, this back-table modification allows for avoidance of an aorto-uni-iliac repair with femoral–femoral bypass, thereby diminishing the risk of bypass graft complications, iliac occlusive disease, and lower extremity ischemia. This technique maintains perfusion to the bilateral common iliac arteries and preserves the option for bilateral lower extremity vascular access in future interventions.

CONCLUSIONS

This case demonstrates the technical ease, reproducibility, and effectiveness of back-table inversion to the contralateral endograft limb in treating type Ia endoleaks.

DISCLOSURES

None

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