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# Laser assisted trans-endograft coil embolization of a type II endoleak

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## ABSTRACT

A type II endoleak after endovascular aneurysm repair can be challenging to stop. Numerous methods have been described, including trans-arterial, trans-lumbar, trans-caval, trans-endograft, peri-endograft, and open and laparoscopic surgical techniques. We present our experience with a laser-assisted trans-endograft approach, including technical variations of previous descriptions that might improve efficacy. In select cases, the laser-assisted trans-endograft approach might provide the most direct method of accessing and occluding the vessels feeding type II endoleaks. (J Vasc Surg Cases Innov Tech 2024;10:101442.)

**Keywords:** Endovascular aneurysm repair; Laser fenestration; Type II endoleak

A type II endoleak is the most common complication after endovascular aortic aneurysm repair, with reported rates of 8% to 44%.[1,2] The natural history is generally benign, with an overall rupture rate of approximately 1%.[3] However, when associated with aneurysm growth, they can contribute to loss of the endograft seal and have been associated with aneurysm-related complications, including rupture and death.[2] Although the optimal management of type II endoleaks remains debated, guidelines from the Society for Vascular Surgery and the European Society for Vascular Surgery recommend treatment of type II endoleaks when associated with aneurysm sac expansion.[1,2,4,5]

Numerous techniques have been described to address type II endoleaks. These include embolization of the aneurysm sac and/or feeding vessels via trans-arterial, trans-caval, trans-lumbar, trans-endograft, and peri-endograft approaches and feeding vessel ligation via open or laparoscopic surgery.[1,2,6-12] Each technique poses advantages and disadvantages, and the preferred approach varies depending on patient physiology and anatomy.

We describe our experience with laser-assisted trans-endograft (LATE) coil embolization of type II feeding vessels. All patients gave procedural consent for off-label use of laser catheters and consent for publication.

## TECHNICAL DESCRIPTION

Careful preoperative planning and clear intraoperative imaging (preferably with overlay guidance) is critical to this approach. A preoperative computed tomography (CT) scan is closely analyzed, ensuring that a subtle type I or III endoleak is not being overlooked. The endoleak cavity and its feeders are identified, and a planned fenestration site is selected. An ideal entry site is in a location of a single-layer endograft, immediately adjacent to a patent endoleak cavity, with plenty of offset from the aortic sac wall to minimize the risk of sac perforation, and with ≥15-mm centerline distance from any flow divider to allow for hemostatic coverage of the fenestration at case completion. Once a site has been chosen, it is mapped onto the CT overlay and displayed on live fluoroscopy to facilitate intraoperative targeting.

From femoral arterial access, a 7F TourGuide (Medtronic) is advanced to the target and torqued to orient a Philips Spectranetics Turbo-Elite 1.7-mm over-the-wire catheter (Philips Healthcare) perpendicular to the endograft wall. Proper catheter orientation is confirmed in multiple projections (Fig 1), and test pressure is applied to the catheter tip to ensure it does not slide away from the target. With antegrade pressure applied, a brief burst of laser energy (fluence, 60 mJ/mm$^2$; cadence, 60 Hz) results in catheter advancement through a de novo fenestration, providing access to the sac. The catheter is withdrawn over a 0.018-in. wire, and the fenestration undergoes angioplasty with a 4-mm balloon. After upsizing to a stiff 0.035-in. wire, the TourGuide with introducer is

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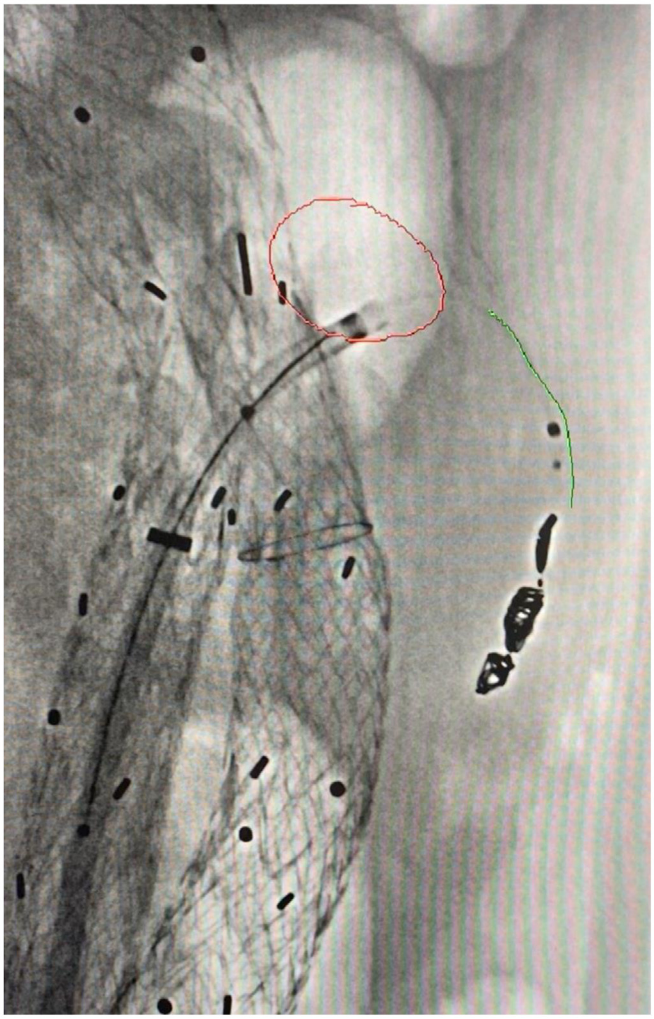

**Fig 1.** A steerable sheath is used to orient the laser catheter perpendicular to the endograft wall. The three-dimensional overlay shows the endoleak cavity (*red circle*) and the course of the inferior mesenteric artery (IMA) target (*green line*).

advanced through the fenestration into the endoleak cavity. Sac angiography is performed to clearly visualize the feeding vessels. The TourGuide is then used to direct a glide catheter, microcatheter, and soft-tipped 0.014-in. wire and stably cannulate the feeding vessels. Once cannulated, the vessels can be directly occluded using the embolic agent of choice (Figs 2 and 3). When finished, sac access is withdrawn, and the fenestration is sealed by relining the endograft with an appropriately sized cuff or limb.

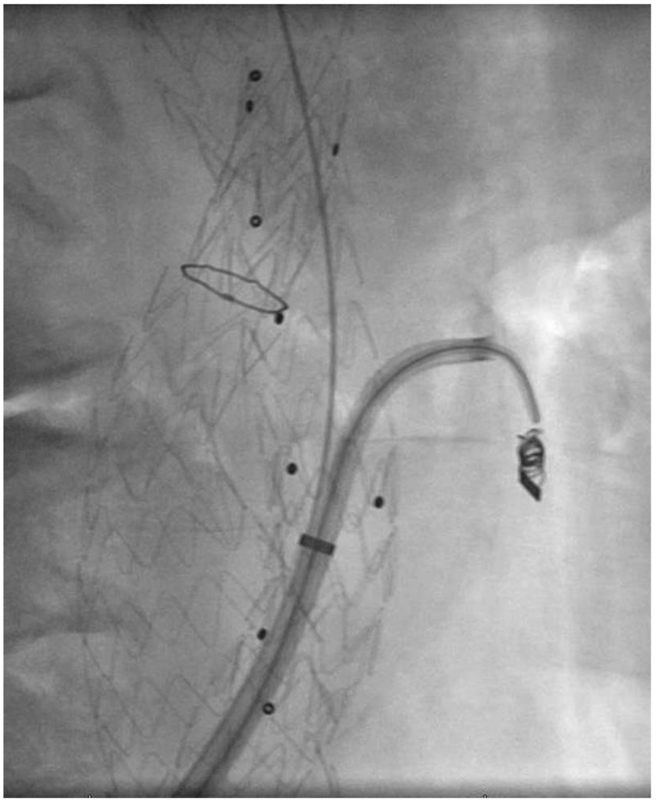

**Fig 2.** Direct access to an inferior mesenteric artery (IMA) with successful coil delivery.


**Fig 3.** Direct access to a lumbar artery.

## CASE REPORT

Five cases were performed at Dartmouth-Hitchcock Medical Center using the LATE approach for endoleak treatment (Table). In three cases, multiple bilateral lumbar target vessels made laser fenestration most parsimonious. In one case, a patent inferior mesenteric artery (IMA) without an identifiable superior mesenteric artery (SMA) collateral pathway made the LATE approach the most direct. In one case, the LATE approach provided equal access to both an IMA and an accessory renal artery.

In total, 11 vessels were targeted, with 7 successfully cannulated and coiled (63%). The vessels that could not be

**Table.** Cases with targeted laser-assisted trans-endograft coil embolization (n = 5)

| Pt. No. | EVAR device | Target vessels coiled | AAA sac diameter at procedure, cm | Subsequent endoleak therapy | Last CTA | AAA sac diameter, cm (change) | Endoleak on most recent imaging | Death |
|---|---|---|---|---|---|---|---|---|
| 1 | Medtronic Endurant | 1 of 1 accessory renal vessel; 1 of 1 IMA | 5.8 | POD 308: planned proximal advancement with 4-vessel PMEG, distal advancement with left IBE | POD 1008 | 5.1 (−0.7) | No | No |
| 2 | Gore Excluder | 2 of 3 lumbar vessels | 5.9 | None | POD 250 | 5.9 (0) | Possible small type II | POD 565: cause of death unknown |
| 3 | Medtronic Endurant | 1 of 1 IMA | 7.6 | None | POD 87 | 7.9 (0.3) | No | POD 93: myelodysplastic syndrome; sepsis with infected EVAR |
| 4 | Gore Excluder | 1 of 2 lumbar vessels; 0 of 1 IMA | 7.5 | POD 46: completion treatment with SMA-IMA, hypogastric lumbar coiling; POD 123: planned proximal advancement with 4-vessel PMEG | POD 653 | 7.7 (0.2) | No | No |
| 5 | Gore Excluder | 1 of 2 lumbar vessels | 6.3 | POD 29: completion treatment with hypogastric lumbar coiling | POD 245 | 6.8 (0.5) | Type II from IMA (previously coiled) | POD 334: metastatic squamous cell carcinoma |

*AAA*, Abdominal aortic aneurysm; *CTA*, computed tomography angiography; *EVAR*, endovascular aortic aneurysm repair; *IBE*, iliac branch endoprosthesis; *IMA*, inferior mesenteric artery; *PMEG*, physician-modified endograft; *POD*, postoperative day; *Pt. No.*, patient number; *SMA*, superior mesenteric artery.

cannulated included one IMA and three lumbar vessels. All except for one lumbar vessel were subsequently coiled at later procedures via a trans-arterial approach. Two of the five patients subsequently underwent planned seal zone advancement procedures as a part of staged treatment (two thoracoabdominal fenestrated branched endografts and one iliac branch endograft).

All the patients underwent postoperative CT angiography. At mean follow-up of 449 days (range, 87-1008 days), the aneurysm sac diameter had regressed in one case, remained stable (<0.5 cm change) in three cases, and increased in one. Three of five patients had no endoleak on the most recent imaging study, and no patient developed a type III endoleak. A small residual type II endoleak was seen in one patient due to the uncoiled lumbar vessel; however, the sac was nearly thrombosed and demonstrated no expansion. The patient with sac growth of 0.5 cm had a persistent type II endoleak from an IMA despite it having been coiled from an SMA-IMA approach.

Three patients died during follow-up. One patient with baseline myelodysplastic syndrome and immunodeficiency died on postoperative day (POD) 93 of sepsis and an infected endovascular aortic aneurysm repair. Whether the LATE procedure had contributed by seeding the endograft is unknown. One patient died on POD 565 of unknown causes. A CT scan on POD 250 had demonstrated a stable aneurysm sac of 5.9 cm with a small type II endoleak. One patient died on POD 334 of squamous cell cancer.

## DISCUSSION

We describe our experience using the LATE approach for the treatment of type II endoleaks. Although LATE access has been previously described, sac access in those reports was restricted to a 4F catheter or microcatheter, and coils were nonselectively deposited into the sac.[13,14] In addition, fenestrations were not covered at case completion and were left to spontaneously thrombose.[13,14] We believe that delivery of a deflectable sheath (9.5F outer diameter) through the fenestration likely improves procedural efficacy by yielding sufficient steerability and stability to directly cannulate and coil the feeding vessels.

One concern is the creation of an endograft fabric defect, which in theory might predispose to the development of a subsequent type III endoleak.[15] However, limb relining with a sufficient proximal and distal seal around the fenestration is likely to be as, or more, effective than relining for other kinds of type III endoleaks, such as modular endograft component separation, which has been well-described with excellent long-term outcomes.[16,17] Furthermore, in bench-top studies, ballooning unreinforced fenestrations to 8 mm in diameter has been shown to induce minimal fabric tearing.[18]

Given the wide variation in aortic sac and endoleak anatomy, no single approach to type II endoleak treatment is universally superior. Cases likely to benefit from the LATE approach include those with endoleak cavities directly adjacent to a graft limb and those in which there is a favorable angle of attack between the planned fenestration site and target vessel orifices. It is well-suited to accessing anterior endoleak cavities, which are less amenable to trans-caval and trans-lumbar approaches. It is also attractive when targets cannot be accessed through SMA-IMA or hypogastric lumbar approaches. The LATE approach adds to the array of options for the treatment of type II endoleaks and, in certain cases, could be the optimal choice.

## CONCLUSIONS

In this small series, LATE sac access for the treatment of type II endoleaks was feasible and yielded reasonable rates of successful targeted coil delivery into feeding vessels. Combined with other approaches, it led to high rates of sac stabilization. No type III endoleaks were identified during follow-up. This technique should be regularly considered as one component of a complementary, multimodality approach to the treatment of type II endoleaks.

## DISCLOSURES

None.

## REFERENCES

1. Moulakakis KG, Klonaris C, Kakisis J, et al. Treatment of type II endoleak and aneurysm expansion after EVAR. *Ann Vasc Surg*. 2017;39:56–66.
2. Ultee KHJ, Büttner S, Huurman R, et al. Editor's choice - systematic review and meta-analysis of the outcome of treatment for type II endoleak following endovascular aneurysm repair. *Eur J Vasc Endovasc Surg*. 2018;56:794–807.
3. Brown A, Saggu GK, Bown MJ, Sayers RD, Sidloff DA. Type II endoleaks: challenges and solutions. *Vasc Health Risk Manag*. 2016;12:53–63.
4. Chaikof EL, Brewster DC, Dalman RL, et al. SVS practice guidelines for the care of patients with an abdominal aortic aneurysm: executive summary. *J Vasc Surg*. 2009;50:880–896.
5. Moll FL, Powell JT, Fraedrich G, et al, European Society for Vascular Surgery. Management of abdominal aortic aneurysms clinical practice guidelines of the European society for vascular surgery. *Eur J Vasc Endovasc Surg*. 2011;41:S1–58.
6. Gandini R, Chiocchi M, Loreni G, et al. Treatment of type II endoleak after endovascular aneurysm repair: the role of selective vs. nonselective transcaval embolization. *J Endovasc Ther*. 2014;21:714–722.
7. Kreusch AS, Samuels S, Benenati JF, Schernthaner M, Uthoff H. Direct percutaneous sac injection for treatment of a thoracic type II endoleak. *J Vasc Interv Radiol*. 2013;24:1071–1073.
8. Krueger K, Zaehringer M, Gawenda M, Brunkwall J, Lackner K. Successful treatment of a type-II endoleak with percutaneous CT-guided thrombin injection in a patient after endovascular abdominal aortic aneurysm repair. *Eur Radiol*. 2003;13:1748–1749.
9. Kumar L, Cowled P, Boult M, Howell S, Fitridge R. Type II endoleak after endovascular aneurysm repair: natural history and treatment outcomes. *Ann Vasc Surg*. 2017;44:94–102.
10. Mansueto G, Cenzi D, Scuro A, et al. Treatment of type II endoleak with a transcatheter transcaval approach: results at 1-year follow-up. *J Vasc Surg*. 2007;45:1120–1127.
11. Scali ST, Vlada A, Chang CK, Beck AW. Transcaval embolization as an alternative technique for the treatment of type II endoleak after endovascular aortic aneurysm repair. *J Vasc Surg*. 2013;57:869–874.
12. Yamada M, Takahashi H, Tauchi Y, Satoh H, Matsuda H. Open surgical repair can be one option for the treatment of persistent type II endoleak after EVAR. *Ann Vasc Dis*. 2015;8:210–214.
13. Boehme T, Rastan A, Noory E, Fluegel PC, Zeller T. Laser-assisted transprosthesial coil embolization combined with thrombin injection for treatment of an endoleak type II after endovascular aneurysm repair. *Vasa*. 2018;47:63–67.
14. Mewissen MW, Jan MF, Kuten D, Krajcer Z. Laser-assisted transgraft embolization: a technique for the treatment of type II endoleaks. *J Vasc Interv Radiol*. 2017;28:1600–1603.
15. Manzur M, Magee GA, Ziegler KR, Weaver FA, Rowe VL, Han SM. Caudally directed in situ fenestrated endografting for emergent thoracoabdominal aortic aneurysm repair. *J Vasc Surg Cases Innov Tech*. 2021;7:553–557.
16. Marques de Marino P, Ibraheem A, Gafur N, et al. Limb occlusion rate after EVAR with individualized graft limb selection and a liberal protocol of primary relining. *Ann Vasc Surg*. 2021;75:445–454.
17. Mirza AK, Skeik N, Manunga J. Relining of infrarenal stent-graft with preloaded modified Gore Excluder for occult endoleak with sac expansion. *J Vasc Surg Cases Innov Tech*. 2021;7:669–674.
18. Lin J, Guan X, Nutley M, et al. Stent-graft fabrics incorporating a specific corona ready to fenestrate. *Materials*. 2023;16:4913.

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