Erasing narrow paravisceral true lumen with endoseptostomy to favor adequate expansion of branched endograft during postdissection thoracoabdomimal aortic aneurysm endovascular repair

Michele Piazza, MD, *and* Michele Antonello, MD, *Padova, Italy*

ABSTRACT

Narrow paravisceral aortic true lumen in postdissection thoracoabdominal aneurysm, represents a challenging situation when branched endovascular aneurysm repair is required; it may be responsible for intraprocedural technical difficulties, such as inadequate main endograft deployment, difficult vessels catheterization, or long-term branch instability related to compression. We describe the case of a 56-year-old man with post-type B thoracoabdominal aortic aneurysm and a severely narrow true lumen (10 mm) at the paravisceral segment. Endovascular aortic septostomy was performed first, to erase the narrow paravisceral aortic true lumen, and subsequently allow branched endograft adequate expansion and regular vessels catheterization. (J Vasc Surg Cases Innov Tech 2024;10:101461.)

Total endovascular postdissection thoracoabdominal aortic aneurysm (pdTAAA) repair with fenestrated and branched endograft, even if technically challenging, is today a valid option associated with excellent early outcomes and low mid-term complication rates.[1] In these cases, a narrow true lumen may represent a pitfall for main body correct deployment, with the risk for inadequate position or compression, especially in cases of branched grafts.[2] Total endovascular longitudinal fenestration of a chronic dissection flap has already been reported to allow the creation of a single lumen landing zone and achieve endograft wall apposition.[3]

We report a case where an endoseptostomy was performed to erase a very narrow paravisceral true lumen, thus facilitating subsequent branched endograft correct deployment in a pdTAAA.

METHODS

A 56-year-old man presented with an asymptomatic extent V pdTAAA; the patient gave his consent for this report. Four years prior, he had been emergently treated in another institution for acute complicated type B dissection with lower left limb malperfusion; a short C-TAG graft 36 × 100 mm (W. L. Gore & Associates, Inc, Flagstaff, AZ) was deployed in zone 3 to exclude the proximal entry tear and a femorofemoral right-left bypass performed because of persistent limb malperfusion.

He came to our attention after 4 years with a follow-up computed tomography angiogram (CTA) that demonstrated postdissecting aneurysmal evolution with a maximum aortic aneurysm transverse diameter of 6.7 cm at the level of the celiac trunk (CT), with a compressed paravisceral true lumen, and a mild infrarenal aortic dilation of 3.3 cm. The previous CTA had been performed 3 years before, with no evidence of aneurysm or true lumen compression.

The narrow paravisceral true lumen measurements are both presented in Fig 1, *A* according to the Society for Vascular Surgery reporting standards[4] as longer-shorter axis. Also, the sites of the proximal and distal preexisting reentry tears are depicted.

The CT and superior mesenteric artery originated from the true lumen, the right renal artery was chronically occluded with an hypotrophic kidney secondary to the previous acute dissection, and the left renal artery was dissected in the first segment (Fig 1, *B-D*).

The patient underwent a multidisciplinary evaluation with an anesthesiologist and a vascular surgeon and was excluded from an open repair because of multiple comorbidities. He was selected for endovascular exclusion in two steps: the first step was based on thoracic endovascular aneurysm repair (TEVAR) extension with Relay-Plus NBS 40-36, 150 mm in length (Terumo Aortic, Sunrise, FL), landing distally above the proximal reentry tear in the descending thoracic aorta. To secure access throughout the procedure to the true lumen of the left renal artery, a Rosen guidewire was advanced and parked in the renal from a percutaneous left axillary access; this was not required for the CT and superior mesenteric artery

From the Vascular and Endovascular Surgery Division, Department of Cardiac, Thoracic, Vascular Sciences and Public Health, Padova University.

Correspondence: Michele Piazza, MD, Associate Professor of Vascular Surgery, Vascular and Endovascular Surgery Division, Department of Cardiac, Thoracic, Vascular Sciences and Public Health, Padova University, School of Medicine, Via Giustiniani 2, Padova, Italy 35125 (e-mail: michele.piazza@unipd.it).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

https://doi.org/10.1016/j.jvscit.2024.101461

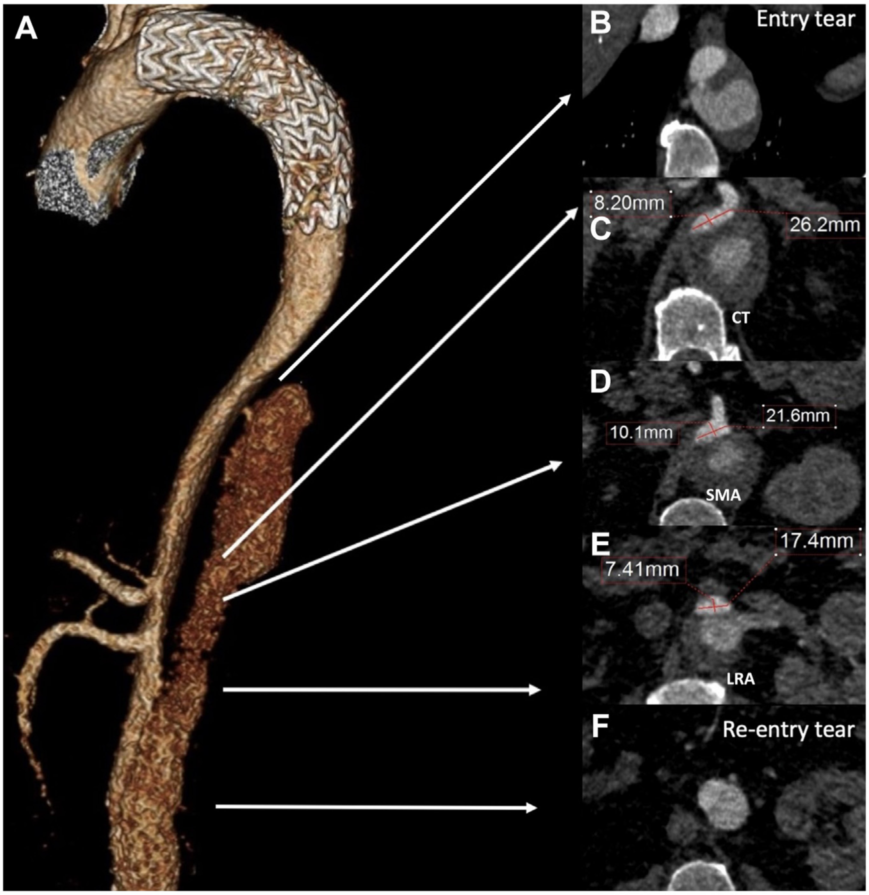

Fig 1. (**A**) Three-dimensional computed tomography angiogram (CTA) reconstruction in lateral view, showing the narrow paravisceral true lumen; dotted arrows indicate the proximal and distal reentry tears. (**B**) Axial image of the dissected aorta at the level of proximal reentry tear (**C**) at the level of celiac trunk (CT) with a compressed true lumen diameter of 8.2 mm. (**D**) Axial image of the dissected aorta at the level of the superior mesenteric artery with a true lumen diameter of 10.1 mm. (**E**) Axial image of the dissected aorta at the level of the left renal artery with a true lumen diameter of 7.4 mm. (Measurements with dotted underline, are based on the Society for Vascular Surgery reporting standards[4]). (**F**) Axial image of the dissected infrarenal aorta at the level of distal reentry tear. *SMA*, Superior mesenteric artery; *LRA*, left renal artery; *CT*, celiac trunk.

because they originated from the true lumen. Subsequently, guided by a combination of Fusion system-intravascular ultrasound (IVUS) imaging, from the bilateral femoral access, a through-and-through wire within the aortic true and the false was establish at the level of the preexisting proximal reentry tear. The cheese-wire technique[3] was then performed with an endoseptostomy of the membrane from the proximal to the distal reentry tear (Fig 2, *A-C*). The septostomy was performed using a 0.014″ Astato XS wire (ASAHI Intecc Medical, Irvine, CA) that was angled at the cutting edge and protected on its two sides within 5F ber catheter, one from the true lumen and one from the false lumen. To cut the septum an electrification of the wire was performed with cautery and the two catheters fixed to the guidewire were pulled down to the desired level of septum section. The differences on aortic diameter and membrane septostomy between the pre and postoperative angiography and IVUS imaging are depicted in Fig 3, *A-D*. After septostomy, we double-checked via IVUS examination the origin of major vessels to asses for their patency; subsequently, we performed a completion aortography to evaluate distal visceral and renal vessels perfusion.

A standard, off-the-shelf E-nside inner branch device 38-26-222 (Artivion, Kennesaw, GA) was deployed at the desired position, with full spontaneous expansion and non-upward slip of the graft. Distally, an EVAR with Excluder Endoprosthesis 32 mm in proximal diameter (W. L. Gore & Associates Excluder) was implanted in a standard way; the right distal iliac sealing was completed with an appropriate size iliac limb extension; distal exclusion of the left limb was not performed to maintain temporary reperfusion of the sac and favor adequate spinal cord adaptation. A multistage approach was preferred over spinal drainage in this case because of preexisting multiple lumbar disc hernia. The CT, superior mesenteric

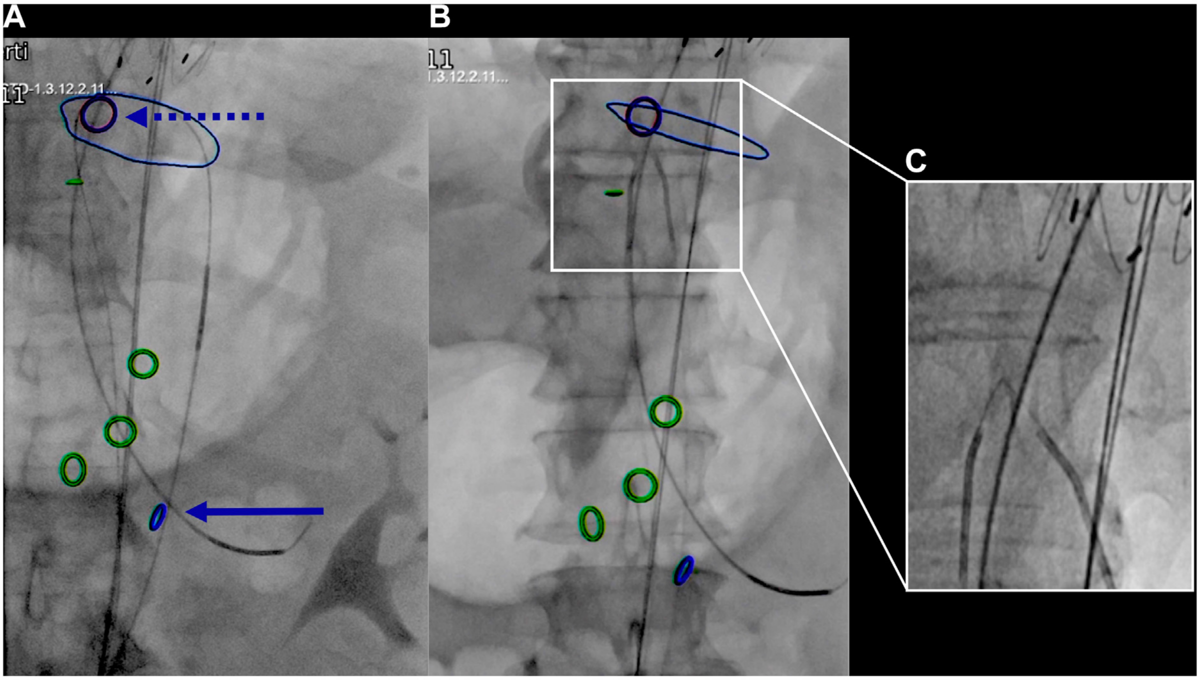

Fig 2. (**A**) Static fluoroscopy image showing the true-false lumen through-and-through guidewire passed at the proximal reentry tear (dotted arrow) and the Rosen guidewire into the left renal artery true lumen (solid arrow). (**B**) Static fluoroscopy image demonstrating the guidewire for endoseptostomy in place at the level of the proximal reentry tear. (**C**) Detail of the cheese wire system at the same level.

artery, and true lumen of the left renal artery were sequentially cannulated and stented with Covera (BD, Franklin Lakes, NJ) self-expandable covered bridging stents; no difficulties were encountered in vessel catheterization and no signs of compression or kinking after bridging stent implantation were identified. The patient had a regular postoperative course, with no major or minor early complications, and was discharged after 3 days. The postoperative CTA within 1 month demonstrated complete expansion of the main body in the paravisceral segment, with a nominal diameter of 24 mm with no compression or kinking of any of the branches. There was also a rapid positive aortic remodeling with false lumen near-complete thrombosis (Fig 4, *A-D*). The distal exclusion was completed in a second separate stage after 5 weeks from the index intervention. A contralateral leg endoprosthesis was deployed landing distally into the left common iliac artery. There were no related complications.

DISCUSSION

Endovascular aortic repair of chronic pdTAAA with fenestrated or branched EVAR has demonstrated to be safe and effective. A recent multicenter trans-Atlantic experience of 246 patients reported a more frequent use of fenestrations rather that directional branches (58% vs 24%) with a low 30-day mortality rate (3%), at a cost of a high reintervention rate of 44% at 5 years.[5]

Some of the main anatomical challenges in these types of endovascular procedures are represented by a stiff and thickened aortic septum or a narrow true lumen. A narrow paravisceral aortic lumen by itself in cases of branched EVAR is a predicting factors of branches instability particularly when associated to a longitudinal extension of >25 mm or severe wall calcification.[6] However, in case of a narrow true lumen in pdTAAA, even if the limited room may rise concern about graft compression and difficult guidewire and catheter manipulation, increasing experience and endovascular adjunctive tool showed that this was not a relevant issue.

Some experience demonstrated how using a wider planned fenestrated endograft in relation to a narrow paravisceral true lumen may allow, after target vessel catheterization, graft ballooning with septum disruption and graft complete expansion with reduction of gap distance between the fenestration and the vessel ostium.[7] The use of a branched endograft may represent a pitfall in case of narrow true lumen, because of a higher risk of graft upward migration during deployment or partial compression of the branches. Even if all these factors can be overcome by experienced operators, they may represent a risk to technical success and early branch stability. Branched devices in these situations allow for a stable and durable bridging system over time, especially in the case of a target vessel originating from the false lumen with a long bridging distance from the

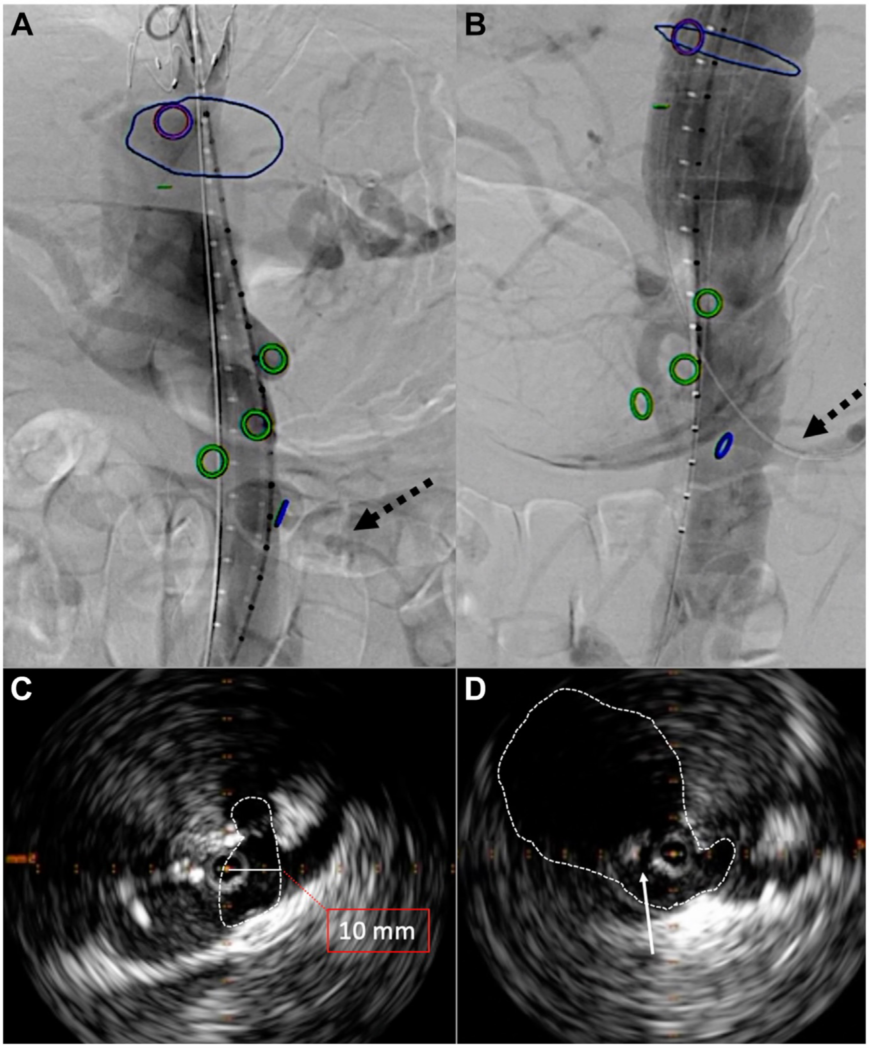

Fig 3. (**A**) Static aortic angiography before septostomy and (**B**) after septostomy; to note paravisceral aortic lumen diameter increase and improved left renal artery perfusion (dotted arrow). (**C**) Static axial intravascular ultrasound (IVUS) image of the aortic true lumen (dotted line) and diameter (solid line) at the level of the superior mesenteric artery before septostomy and (**D**) after septostomy; to note the increased space of true lumen (dotted line) and the cut septum (solid arrow).

main graft. Inner branched devices, with or without preloaded guidewires, may be a good compromise while they allow for a facilitated technical success and maintain branches stability over time after the index procedure during aortic remodeling.

Having the possibility to erase the differences between the narrow true lumen and the large false lumen, not only in terms of free space but also in terms of equal flow pressurized lumen, may provide several advantages. The concept of aortic septostomy to optimize landing zone during TEVAR has already been safely established with different endovascular techniques, in particular with laser aortic septostomy and cheese-wire septostomy.[8]

We applied the cheese-wire technique with electrocautery to perform aortic septostomy for creation of a large single lumen at the level of paravisceral aorta for safe and precise main branched graft deployment. During the procedure, the graft spontaneously fully expanded at deployment and target vessel catheterization was performed similarly to a standard chronic atherosclerotic TAAA.

Aside from facilitating graft deployment and target vessel catheterization, with a potential reduction of operative time and increased technical success, aortic septostomy allows for pressure equalization between the true and the false lumen in cases with a narrow paravisceral true lumen of pdTAAA. This last factor may allow immediate reexpansion of the partially dissected target vessel, as in this case was for the left renal artery. In contrast, the pitfall of this technique may be that, with septostomy, you do not have control of where the membrane will

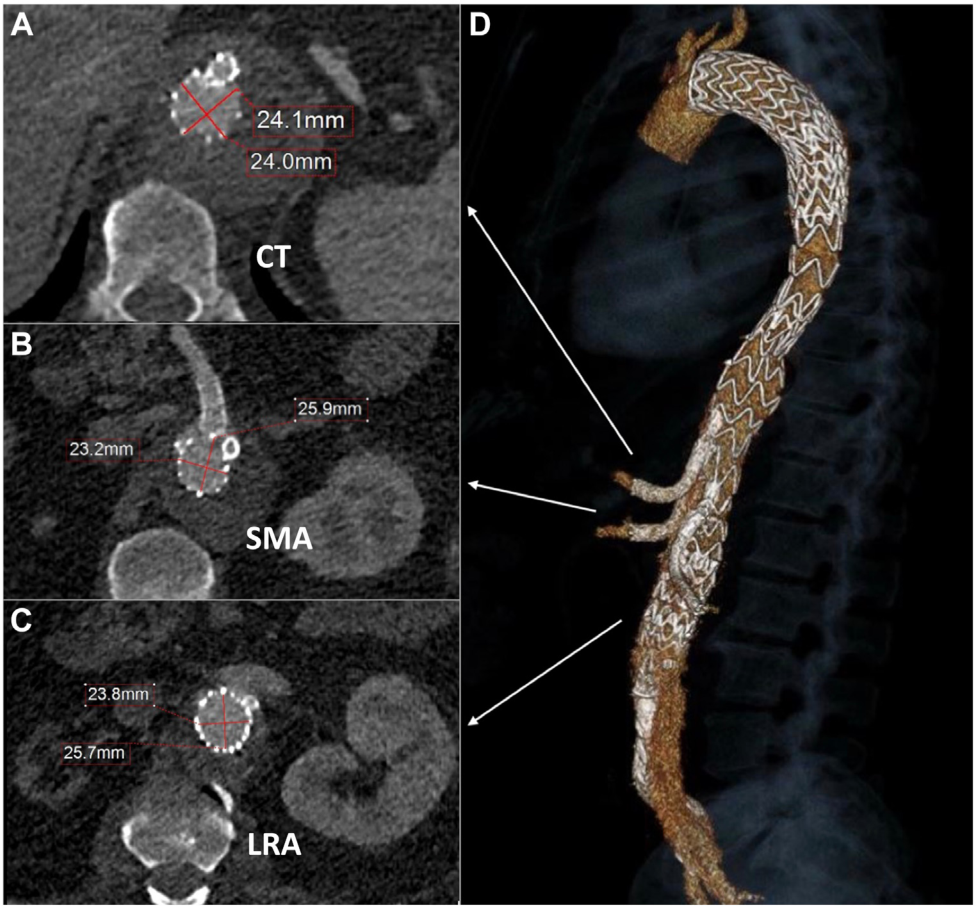

Fig 4. (**A**) Axial postprocedure computed tomography angiogram (CTA) of the aorta at the celiac trunk (CT) level; note the early positive aortic remodeling with complete false lumen thrombosis. (**B**) Aorta at the superior mesenteric artery level; note the complete main graft expansion at its nominal diameter (24 mm) and no signs of compression on bridging stents. (**C**) Aorta at the left renal artery level. (**D**) Three-dimensional CTA reconstruction of the entire endovascular repair. *SMA*, Superior mesenteric artery; *LRA*, left renal artery; *CT*, celiac trunk.

be repositioned after longitudinal cutting; for this reason, the use of electrocautery wire may favor a precise septum cutting rather than performing completely uncontrolled septum disruption. We indeed suggest to preventively cannulate the vessel involved in the dissection or originating from the false lumen before septostomy. Being that a septostomy is a traumatic procedure, we avoid it in the acute-subacute phase of a dissection; we reserve it for chronic conditions with an aortic wall septum thickness. Also accurate angiography or IVUS control before and after septostomy is mandatory to promptly identify and fix eventual complication, such as acute aortic branches occlusion, distal embolization, or aortic wall rupture.

Over time, the absence of a difference in pressures between true and false camera should facilitate positive remodeling with a low risk of branch instability in the long run; however, for this last factor, extended follow-up is still needed. In our experience, 30-day CTA demonstrated positive aortic remodeling with near-complete false lumen thrombosis and adequate main graft and branch positions. Theoretically, also in cases of planned fenestrated EVAR, preventive aortic membrane septostomy may allow for a more precise fenestration to target vessel apposition at the moment of main graft deployment thus facilitating cannulation and long-term adequate alignment.

CONCLUSIONS

The present case demonstrates that expansion of narrow paravisceral true lumen in pdTAAA with endoseptostomy allows for a safe aortic branched graft deployment and facilitate target vessel cannulation. Future studies with larger number of cases and longer follow-up are required to evaluate its role on positive aortic remodeling after complete endovascular repair.

DISCLOSURES

None.

REFERENCES

1. Gallitto E, Faggioli G, Melissano G, et al. Fenestrated and branched endografts for post-dissection thoraco-abdominal aneurysms: results of a national multicentre study and literature review. *Eur J Vasc Endovasc Surg*. 2022;64:630–638.
2. Marques de Marino P, Ibraheem A, Tesinsky P, Abu Jiries M, Katsargyris A, Verhoeven EL. Fenestrated and branched stent grafts for the treatment of post-dissection thoracoabdominal aortic aneurysms. *Semin Vasc Surg*. 2022;35:312–319.
3. Stern JR, Cafasso DE, Schneider DB, Meltzer AJ. Totally percutaneous fenestration via the "cheese-wire" technique to facilitate endovascular aneurysm repair in chronic aortic dissection. *Vasc Endovascular Surg*. 2018;52:218–221.
4. Lombardi JV, Hughes GC, Appoo JJ, et al. Society for vascular Surgery (SVS) and society of thoracic surgeons (STS) reporting standards for type B aortic dissections. *J Vasc Surg*. 2020;71:723–747.
5. Abdelhalim MA, Tenorio ER, Oderich GS, et al. Multicenter trans-Atlantic experience with fenestrated-branched endovascular aortic repair of chronic post-dissection thoracoabdominal aortic aneurysms. *J Vasc Surg*. 2023;78:854–862.e1.
6. Piazza M, Squizzato F, Forcella E, et al. Effect of narrow paravisceral aorta on target vessels instability after fenestrated and branched endovascular aortic repair. *J Vasc Surg*. 2023;79:217–227.e1.
7. Tenorio ER, Oderich GS. Wider is better for endovascular repair of post-dissection thoracoabdominal aortic aneurysms. *Cardiovasc Intervent Radiol*. 2022;45:1682–1683.
8. Fukuhara S, Khaja MS, Williams DM, et al. Aortic septotomy to optimize landing zones during thoracic endovascular aortic repair for chronic type B aortic dissection. *J Thorac Cardiovasc Surg*. 2023;165:1776–1786.e5.

Submitted Dec 4, 2023; accepted Feb 13, 2024.