Technical Note

JOURNAL OF ENDOVASCULAR THERAPY
A SAGE Publication

Journal of Endovascular Therapy
1–5

DOI: 10.1177/15266028221102652
www.jevt.org
SAGE

Transaxillary Tri-Branch Aortic Endovascular Graft Repair of Recurrent Thoracoabdominal Aneurysm With Pararenal Aortic Occlusion

Luca Bertoglio, MD[1], Alice Lopes, MD[2], Enrico Rinaldi, MD[1], Matteo Bossi, MD[1], Raffaella Berchiolli, MD[3], Mauro Ferrari, MD[3], and Roberto Chiesa, MD[1]

Abstract

The absence of an adequate ileo-femoral access is usually considered an absolute contraindication to fenestrated and branched aortic repairs. Alternative routes and dedicated stent-graft designs have been advocated. Hereby, we describe the case of a 73-year-old man with a recurrent type IV thoracoabdominal aortic aneurysm and complete thrombotic pararenal aortic occlusion treated successfully with a tri-branch custom-made endograft deployed via a transaxillary access.

Keywords

aortic plug, branched stent-graft, aortic aneurysm, thoracoabdominal aorta, extra-anatomical bypass, recurrent, axillary

Introduction

The absence of an adequate femoral or iliac access to deliver a branched or fenestrated endograft is considered an absolute contraindication for endovascular repair.[1] Transapical and axillary access have been used anecdotally to deploy standard straight thoracic stent-grafts,[2,3] but, to the author knowledge, a transaxillary deployment of a branched graft in a case with a complete aortic-iliac occlusion was never reported.

This report describes the use of a custom-made triple-branched endovascular graft deployed from a transaxillary access to treat a recurrent visceral aortic patch (VAP) aneurysm associated with pararenal aortic occlusion.

Clinical Case

A 73-year-old man with history of hypertension, dyslipidemia, and hypothyroidism presented with a VAP aneurysm and critical limb ischemia. The patient had undergone an open thoracoabdominal aortic aneurysm (TAAA) repair with visceral and renal arteries reattachment with the inclusion technique through a left thoraco-phreno-laparotomy 30 years ago. A redo open surgery with the same surgical access was performed 8 years later due to a proximal anastomotic pseudoaneurysm, combined with right renal artery direct stenting. Early stent occlusion occurred, and the right kidney became atrophic at follow-up with stage 2 renal failure. A distal anastomotic pseudoaneurysm was also managed with a bifurcated endovascular exclusion (Gore Excluder; W.L. Gore & Associates, Flagstaff, Arizona) 14 years later.

At the out-clinic evaluation, the patient presented with a 56 mm recurrent aneurysmal dilatation of the VAP, right iliac limb graft occlusion with chronic claudication, and pararenal aortic thrombotic apposition involving the left renal ostium. Initially, the patient was anticoagulated with warfarin and a standard transfemoral branched endovascular repair with a custom-made device was planned.

One month later, the patient was re-admitted to the emergency department due to left limb ischemia with rest pain

[1]Division of Vascular Surgery, Vita-Salute San Raffaele University, IRCCS San Raffaele Hospital, Milan, Italy
[2]Serviço de Cirurgia Vascular, Hospital de Santa Maria, Lisboa, Portugal
[3]Vascular Surgery Unit, Department of Cardiothoracic Vascular, Azienda Ospedaliero Universitaria Pisana, Pisa, Italy

Corresponding Author:
Luca Bertoglio, Division of Vascular Surgery, Vita-Salute San Raffaele University, IRCCS San Raffaele Hospital, Via Olgettina 60, 20132 Milan, Italy.
Email: bertoglio.luca@hsr.it

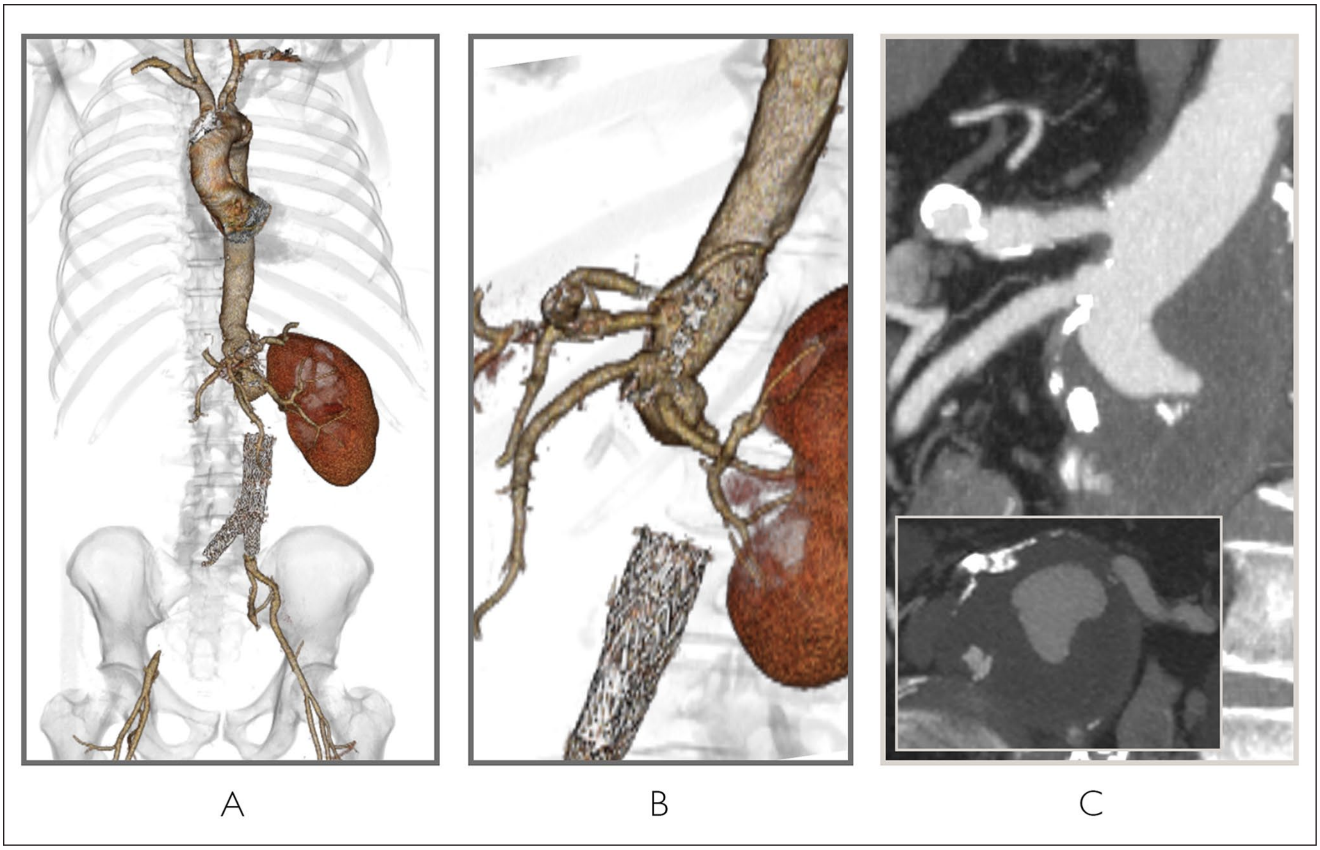

Figure 1. Preoperative computed tomography angiography (A, B: 3D volume rendering; C: multiplanar reconstruction and axial scan). The patient was previously treated with thoracoabdominal aortic aneurysm open repair with inclusion technique, infrarenal abdominal endovascular repair, and right renal stenting. The images show a recurrent visceral aortic patch aneurysm associated with occlusion of the pararenal aorta, the right iliac axis, and the right renal artery.

and a new computed tomographic angiography documented an ascending progression of the aortic thrombosis with total infrarenal aortic occlusion (Figure 1). A right axillo-bifemoral bypass was performed to solve the critical limb ischemia, also allowing the retrograde reperfusion of the only patent left hypogastric artery. With no lower extremity arterial access and 2 previous thoraco-phreno-laparotomies, a new graft was designed: a custom-made tri-branch device (Cook Medical LLC, Bloomington, Indiana) was ordered and planned to be deployed via the left axillary artery (Figure 2).

One month after the lower limb revascularization, under general anesthesia and after systemic heparinization, the patient underwent an endovascular repair with the above-described custom-made device in a hybrid suite with fusion imaging capabilities (Supplemental Video 1). Through an infraclavicular incision, a 9 mm diameter Dacron graft (Maquet Hemashield, Baden-Württemberg, Germany) was sutured as a conduit to the left axillary artery. A 23F introducer sheath for Impella 5.0 (Abiomed, Danvers, MA, USA) was inserted and fixed in the conduit, and a 1 cm short-tip Amplatz guidewire (Cook Medical LLC) was exchanged at the level of the distal abdominal aortic occlusion. Then, a tapered upside-mounted thoracic stent-graft (Figure 2B) was implanted in the mid-portion of the descending thoracic aorta to create an adequate proximal landing zone, tapering down the aortic diameter for the branched graft (Figure 2C and D). The Tri-branch device was then deployed with the distal markers 2 cm above the celiac trunk through the same access (Figure 2C). Finally, the graft delivery system was exchanged with a 65 cm long 10F sheath (DrySeal; W.L Gore & Associates, Inc.), and the 3 branches were bridged with the corresponding target vessels with covered stents (VBX and Viabahn; W. L. Gore & Associates). At the end of the procedure, the axillary conduit was ligated at its origin. Completion angiogram and intraoperative DynaCT demonstrated the patency of all 3 aortic branches, and complete aneurysm exclusion with no signs of endoleak (Supplemental Video 1). The postoperative course was uneventful, and the patient was discharged home on postoperative day 4 under warfarin and aspirin therapy.

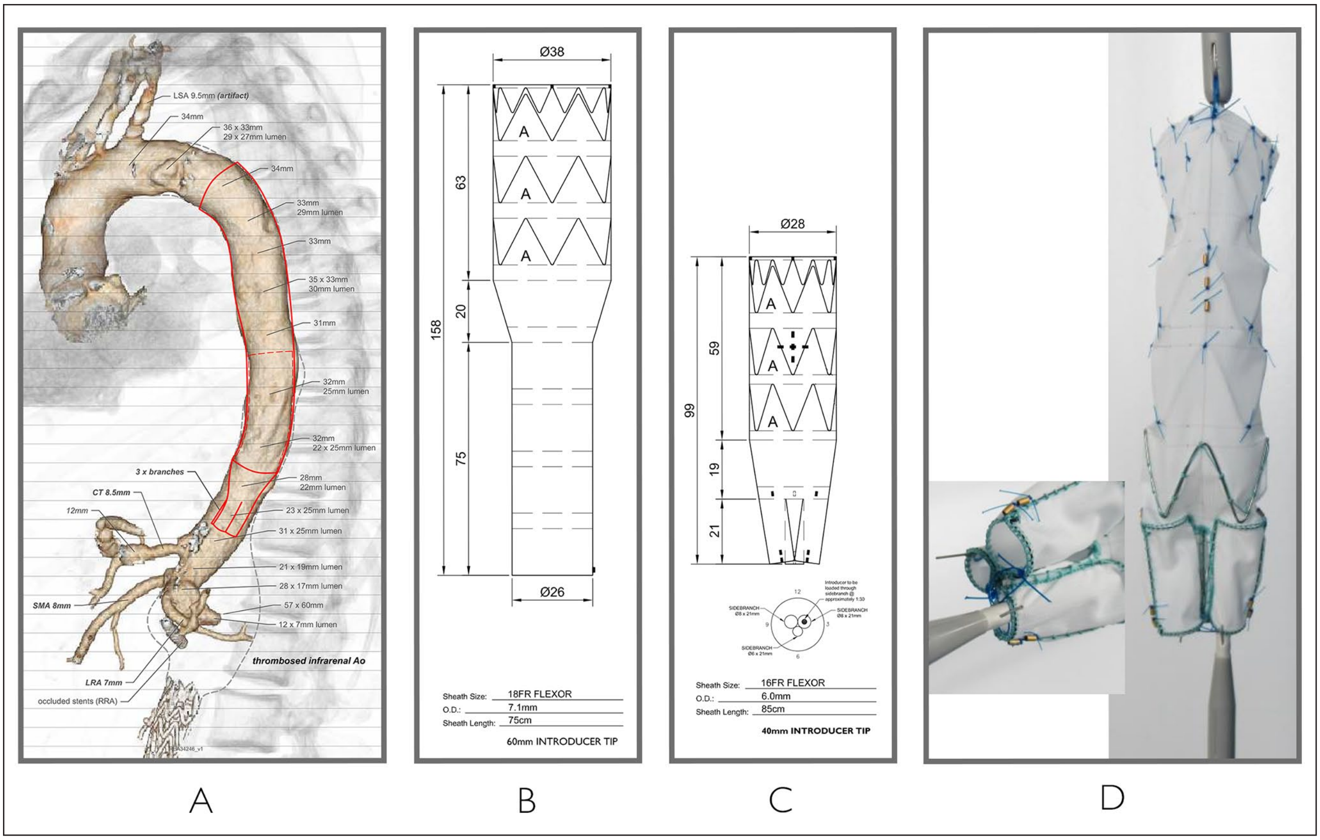

Figure 2. The planned aortic implant (A) consisted of a low-profile (18F) proximal tapered thoracic endograft (B) and a low-profile (16F) tri-branch endovascular aortic plug (C and D) with 3 leveled branches to target the celiac trunk, the superior mesenteric artery, and the left renal artery. Being intended to be deployed via an axillary access, the graft was loaded into the delivery system inverted to allow a distal-to-proximal deployment. The delivery system has a short 40 mm introducer tip that exits from one of the 8 mm branches. CT, computed tomography; LSA, left subclavian artery; CT, celiac trunk; SMA, superior mesenteric artery; LRA, left renal artery; RRA, right renal artery.

The 3-month computed tomographic scan confirmed the successful exclusion of the aneurysm, and the patency of the visceral vessels and the left renal artery (Figure 3).

Discussion

Open TAAA repair offers in general durable results, but the risk of recurrent VAP when inclusion technique is employed is not negligible.[4] While secondary open procedures are more complex and associated with high mortality and morbidity rates, transfemoral endovascular procedures have emerged as a less invasive alternative to treat this postsurgical aortic complication.[5] In the presented case, the multiple aortic surgeries contraindicated an in situ aortic repair; thus, an extra-anatomical approach was used to restore the flow to the lower limbs and solve the critical limb ischemia. However, the endovascular exclusion of the recurrent VAP required a dedicated design and the use of an alternative deployment route.

Interestingly, branched grafts, with a similar design to the one described above, were deployed via a transfemoral access to create a supra-celiac aortic stump in patients with aortic graft infections, allowing surgical removal of the infected grafts without aortic cross-clamping and complex open aortic reconstructions.[6] However, despite a similar design, the use of this device via a transaxillary access required some modifications and posed technical challenges. The use of an axillary access required the manufacture of a low-profile device (≤18F) not only because of the access artery diameter, but also to limit aortic arch and supra-aortic vessels manipulation, preventing cerebrovascular and upper limb complications. The branched custom-made graft profile was lowered thanks to the proximal thoracic stent-graft that tapered down the aortic diameter to 26 mm, but component had to be mounted in an upside-down configuration to allow a deployment from the axillary artery. Despite the use of low-profile devices, the creation of a surgical conduit is of paramount importance: it allowed

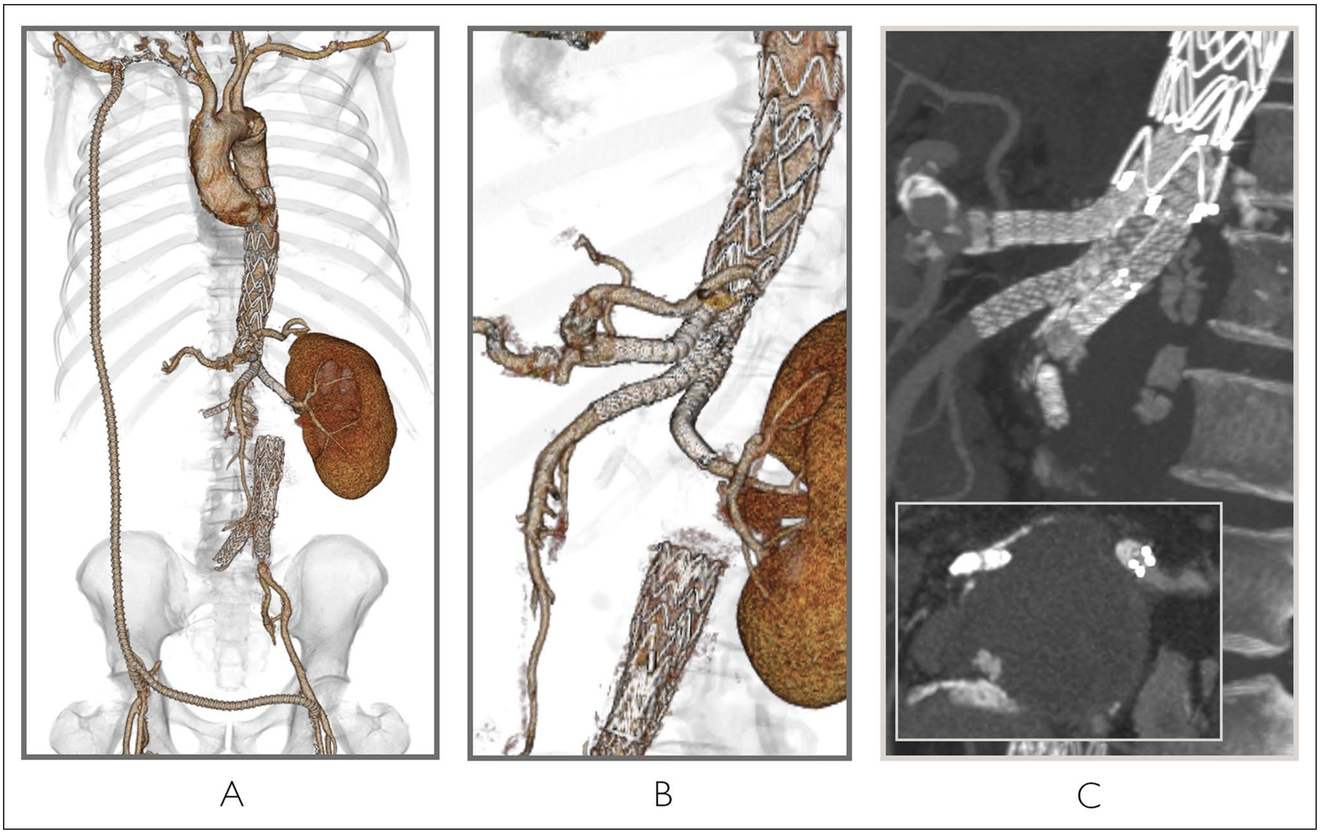

Figure 3. Postoperative computed tomography angiography with 3D volume rendering (A and B) and multiplanar reconstruction (C) showing the complete exclusion of the aneurysm, patency of all target vessels arising from the visceral aortic stump and patency of the extra-anatomical revascularization of lower limb. Due to proximal exclusion with the stent-graft and distal aortic occlusion, a small quantity of contrast media remained entrapped in the aneurysm sac (C).

the delivery of different aortic components without damaging the access vessel wall and the early revascularization of the left arm and vertebral artery during the deployment of visceral covered stents with the use of a nonocclusive 10F sheath. To deploy the stent-grafts as close as possible to the aortic occlusion, considering the need of a conduit interposition, devices were created with an introducer sheet of 70 to 80 cm in length, and with proximal short tips. The Impella 5.0 introducer sheath was ideal to achieve optimal hemostasis while exchanging the different materials during the procedure, limiting the blood loss and the risk of subsequent possible spinal cord ischemia (SCI).

Regarding SCI, it remains one of the major issues of TAAA endovascular repair and was considered as a possible complication in this case. Spinal cord preconditioning with the use of a procedural staged approach offers good results during TAAA endovascular repair, and it is part of our standard of care.[7] However, in this case, a double transaxillary surgical access would have been required for procedural staging, with a higher risk of stroke. Therefore, we relied on the protective role of the historical staging considering the previous multiple aortic surgeries of this patient[8] and on enhancing the collateral network inflow with the preemptive retrograde surgical revascularization of the only patent hypogastric artery. Prophylactic cerebrospinal fluid drainage was not employed preoperatively but a therapeutic postoperative placement was considered as a bailout procedure in case of new onset of SCI during the postoperative period.[7]

Regrettably, custom-made devices are not available in all countries and for emergencies, and alternative approaches, such as chimney and sandwich techniques, may be used to treat similar conditions, especially in urgent or emergent settings. The feasibility of thoracic stent-graft insertion and deployment, using transaxillary, transcarotid, or even transapical access, has been previously demonstrated in patients with aorto-iliac occlusion or severe atherosclerotic disease.[9–11] Chimney procedures have also been reported in patients with juxtarenal aortic occlusion, with favorable results.[12,13] Thus, in case of unavailability of custom-made devices, other approaches are theoretically feasible; however, they would have required a bilateral upper extremity access with the use of simultaneous sheaths thus increasing the risk of stroke due to excessive arch endo-manipulation.

The use of this custom-made tri-branched device, combined with the transaxially access, allowed to treat this recurrent VAP aneurysm through a less invasive approach. Unfortunately, the customization time required 1 month and makes this technical option available only for elective cases. However, the configuration with branches at the same level, and therefore universal, means that in the future this may possibly become an off-the-shelf solution. Longer follow-up and further investigations are needed to prove the effective durability of this visceral aortic stump.

Conclusion

The tri-branch custom-made endovascular graft deployed via a transaxillary access, combined with extra-anatomical surgical lower limb revascularization, allowed the successful treatment of a recurrent VAP aneurysm in a patient where femoral or iliac retrograde access was not an option.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Professor Luca Bertoglio is consultant for Cook Medical (Bloomington, IN, USA).

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iDs

Luca Bertoglio https://orcid.org/0000-0001-6871-2176
Alice Lopes https://orcid.org/0000-0002-1957-7614
Enrico Rinaldi https://orcid.org/0000-0002-9501-0812
Matteo Bossi https://orcid.org/0000-0002-5274-2861

Supplemental Material

Supplemental material for this article is available online.

References

1. Bertoglio L, Grandi A, Carta N, et al. Comparison of anatomic feasibility of three different multibranched off-the-shelf stent-grafts designed for thoracoabdominal aortic aneurysms. *J Vasc Surg*. 2021;74:1472–1482. doi:10.1016/j.jvs.2021.04.066.
2. Saouti N, Vos JA, van de Heuvel D, et al. Thoracic aorta stent grafting through transapical access. *Ann Vasc Surg*. 2015;29(2):362.e5–e9. doi:10.1016/j.avsg.2014.09.018.
3. Saadi EK, Dussin LH, Moura L, et al. The axillary artery—a new approach for endovascular treatment of thoracic aortic diseases. *Interact Cardiovasc Thorac Surg*. 2010;11(5):617–619.
4. Trans-Atlantic Aortic Research Consortium Investigators. Endovascular repair of intercostal and visceral aortic patch aneurysms following open thoracoabdominal aortic aneurysm repair. *J Thorac Cardiovasc Surg*. 2021;S0022-5223(21):00747–00749. doi:10.1016/j.jtcvs.2021.04.063.
5. Coselli JS, Rosu C, Amarasekara HS, et al. Reoperative surgery on the thoracoabdominal aorta. *J Thorac Cardiovasc Surg*. 2018;155:474–485. doi:10.1016/j.jtcvs.2017.08.024.
6. Gavali H, Mani K, Furebring M, et al. Branched endovascular aortic plug in patients with infrarenal aortic graft infection and hostile anatomy. *J Endovasc Ther*. 2020;27(2):328–333. doi:10.1177/1526602819900988.
7. Bertoglio L, Katsarou M, Loschi D, et al. Elective multistaged endovascular repair of thoraco-abdominal aneurysms with fenestrated and branched endografts to mitigate spinal cord ischaemia. *Eur J Vasc Endovasc Surg*. 2020;59(4):565–576.
8. Bertoglio L, Kahlberg A, Gallitto E, et al. Role of historical and procedural staging during elective fenestrated and branched endovascular treatment of extensive thoracoabdominal aortic aneurysms. *J Vasc Surg*. 2022;75:1501–1511.
9. Malik K, Poletto G, Zhao Y, et al. Unconventional endovascular access for symptomatic thoracic aortic ulcer with infrarenal aortic occlusion-a case report. *Ann Vasc Surg*. 2019;58:381.e1–e4.
10. Heidenreich MJ, Neschis DG, Costanza MJ, et al. Endovascular repair of a penetrating thoracic aortic ulcer by way of the carotid artery. *J Vasc Surg*. 2003;38:1407–1410.
11. de Beaufort HW, van den Heuvel DA, Heijmen RH. A challenging double bubble thoracic aortic and proximal subclavian aneurysm treated via transapical access. *J Vasc Surg Cases Innov Tech*. 2020;6(1):80–83.
12. Bin Jabr A, Sonesson B, Lindblad B, et al. Chimney grafts preserve visceral flow and allow safe stenting of juxtarenal aortic occlusion. *J Vasc Surg*. 2013;57(2):399–405.
13. Cheng M, Lee KY, Kwok PC, et al. Endovascular management of aortoduodenal fistula arising from recurrent mycotic aneurysm in an aortic stump. *Ann Vasc Surg*. 2013;27(8):1188.e13–e17.