A prebifurcated axillobifemoral polytetrafluoroethylene graft simplifies carotid to carotid to subclavian bypass

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ABSTRACT

The use of thoracic endovascular aortic repair for thoracic aortic disease will necessitate cervical debranching in cases involving the proximal arch. We have presented the case of a 57-year-old athletic woman who had developed a type A dissection that extended to the bilateral iliac arteries. After hemiarch repair, she underwent staged cervical debranching with carotid–carotid–subclavian bypass using a prebifurcated axillobifemoral graft and subsequent thoracic endovascular aortic repair. We have detailed her successful clinical course and described the benefits of using a prebifurcated graft for cervical debranching in hybrid repairs of aortic arch pathology. (J Vasc Surg Cases Innov Tech 2022;8:664-6.)

Keywords: Aortic arch debranching; Carotid-carotid-subclavian bypass; Hybrid aortic arch repair

Evolving endograft techniques for aortic arch pathology have offered an alternative to the morbidity of open surgery.[1] However, extension into zone 1 of the proximal aorta will require cervical debranching to preserve perfusion of both the left carotid artery and the subclavian arteries.[2,3] Debranching with a right carotid–left carotid–left subclavian (CCS) bypass will generally be performed without carotid shunting; thus, expeditious completion of the anastomoses presents some obvious advantages to the patient.[4] In the present report, we have described the use of a prebifurcated axillobifemoral polytetrafluoroethylene (PTFE) bypass graft to expedite completion of the aortic debranching. The patient provided written informed consent for the report of her case details and imaging studies.

CASE REPORT

Presentation. An athletic 57-year-old woman with a history of hypertension, pulmonary embolism, and a dilated aortic root had presented with acute chest tightness, dizziness, and syncope after a marathon. The patient had a family history of sudden death among young family members thought to be attributed to aortopathy or connective tissue disease.

Computed tomography angiography (CTA) performed at an outside institution that had been limited to the chest revealed a type A aortic dissection, and the patient was transferred to our institution. Given her requirement for urgent root intervention without evidence of dissection into the arch branches, no findings of arch dilation, and no evidence of an entry tear in the proximal aorta, she underwent emergent hemiarch replacement (Bentall procedure). She was left with an open chest for correction of coagulopathy in the intensive care unit. The following day, she returned to the operating room for washout and closure.

Her postoperative period was complicated by pleural effusions requiring pigtail catheter placement. She was extubated on postoperative day 3. A complete, thin-cut CTA was obtained on postoperative day 4, which revealed dissection throughout the thoracoabdominal aorta into the iliac arteries and prompted consultation with vascular surgery.

Given the acute dilation of the descending thoracic aorta to 4.5 cm, her young age and family history of aortopathy with early sudden death, and substantial true lumen impingement, a thoracic endograft repair was offered for definitive therapy. The patient agreed and was scheduled for cervical debranching with CCS bypass, followed by thoracic endovascular aortic repair (TEVAR). In preparation for her debranching procedure, she underwent preoperative carotid duplex ultrasound to confirm the absence of significant stenosis of her bilateral carotid arteries. The patient was then taken to the operating room for retroesophageal CCS bypass 9 days after her aortic root replacement.

Operation. After induction of general anesthesia with the patient in the supine position, a shoulder roll was placed, and a longitudinal incision was created on the right neck with routine dissection of the right common carotid artery. A transverse incision was created 2 cm superior to the left clavicle to access the subclavian and carotid arteries. The left subclavian artery and left common carotid arteries were mobilized, and a retroesophageal tunnel was created, with dissection aided by a preoperatively placed nasogastric tube. Next, a prebifurcated, standard-wall, axillobifemoral, ringed PTFE graft (WL Gore & Associates, Flagstaff, AZ) was positioned, with the axillary limb oriented to the

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Author conflict of interest: none.

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2468-4287

https://doi.org/10.1016/j.jvscit.2022.08.029

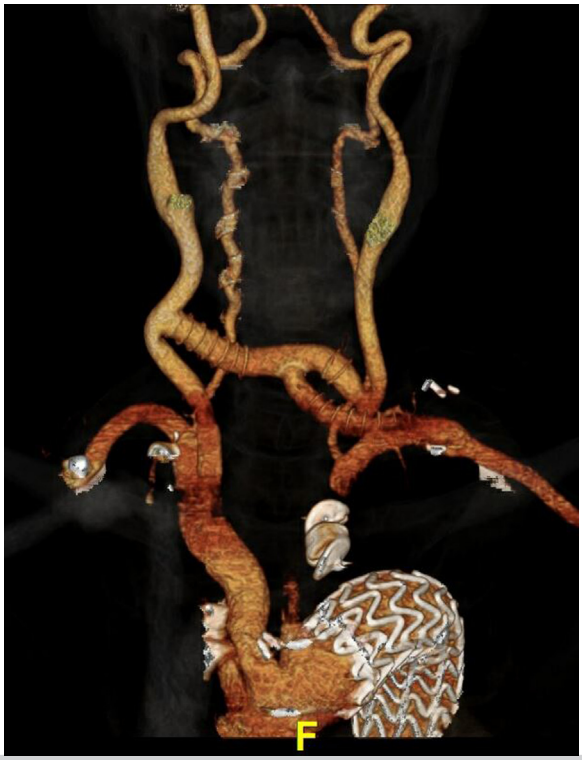

Fig 1. Computed tomography angiography (CTA) reconstruction revealing patent prebifurcated bypass from the right carotid artery to the left carotid and left subclavian arteries.

right carotid artery, the ipsilateral femoral limb to the left carotid artery, and the contralateral femoral limb to left subclavian artery. The graft was then tunneled posterior to the esophagus without kinking or torsion. Heparin was administered, and, under proximal and distal control, the axillary limb was anastomosed to the right carotid artery. To ensure optimal positioning of the left carotid limb, the bifurcation was placed slightly under the left side of the esophagus. Although an end-to-end anastomosis was considered for the left carotid artery, it did not appear to sit properly, prompting the end-to-side anastomosis. The left carotid artery was then ligated proximally to avoid the development of an endoleak from retrograde flow after eventual TEVAR deployment. Finally, the contralateral femoral limb was anastomosed to the left subclavian artery in an end-to-side fashion. Ligation of the proximal left subclavian artery was considered; however, it was not safely accessible at the time. Heparinization was reversed with protamine, and wound closure was completed.

The patient recovered well from her debranching procedure. Her swallow study identified no defects. Four days later, the patient underwent TEVAR via femoral access and Amplatzer plug (Abbott Laboratories, Chicago, IL) occlusion of the left subclavian artery proximal to the left vertebral artery to prevent retrograde flow into the false lumen. The patient recovered without complications and was discharged 4 days after TEVAR on hospital day 17. She was seen for follow-up at 1 and 4 months postoperatively,

Fig 2. Sagittal image revealing location of the bypass between the esophagus anteriorly and spine posteriorly.

with normal swallowing test results. Duplex ultrasound showed a patent CCS bypass. Three-dimensional CTA reconstruction demonstrating her cervical bypass is shown in Fig 1.

DISCUSSION

Arch debranching with CCS bypass is an important tool in the treatment of aortic arch pathology. It will be even more useful because these conditions have been increasingly managed as hybrid procedures that can extend up to and sometimes into zone 0 of the aortic arch.[2,5] CCS bypass has been described by a number of groups who used both Dacron and PTFE grafts. However, these configurations will typically require separate grafts that will be anastomosed intraoperatively, unlike the prebifurcated graft used in our patient.[6-9]

Use of a prebifurcated graft offers several advantages for CCS bypass. First, the utility is obvious when the debranching has occurred unexpectedly and urgent repair is required, such as during a rupture or proximal graft misalignment. Use of a prefabricated graft will simplify an urgent procedure by eliminating a fourth anastomosis. Second, for some CCS bypass techniques, it will be necessary to clamp the carotid-to-carotid graft to suture a sidearm for the subclavian artery, thereby increasing the risk of left carotid artery ischemia and the potential for embolization. In contrast, only the side limb will be clamped when using a prebifurcated graft. Third, by eliminating the graft-to-graft anastomosis, the overall risk of needle hole and anastomotic bleeding will, theoretically, be reduced. Alternate approaches to CCS bypass include transection of the left carotid artery, end-to-side anastomosis of the carotid artery to the bypass, and end-to-end anastomosis with the subclavian artery, which can also result in a three-anastomosis bypass and minimize the repeated interruption of carotid artery flow.

In the present case, we found the lie of the graft to be optimal when the graft was oriented with the axillary–femoral segment directed retroesophageally between the carotid arteries and the contralateral limb oriented to the subclavian artery. We recommend placement of the bifurcation slightly behind the left side of the retroesophageal tunnel to allow for adequate space to create the carotid artery anastomosis. A lateral image revealed the retroesophageal graft situated between the esophagus anteriorly and the spine posteriorly (Fig 2). Although our patient did not experience dysphagia, it can occur after any retroesophageal bypass.

At present, several approaches for total endovascular debranching are available and include chimney grafts, periscope grafts, fenestrated thoracic endografts, and newer zone 0 endografts.[5,10-15] Although recent trials of total endografting have shown potential, these techniques involve a custom endograft and might not be practical in situations of emergent arch pathology. One primary advantage of a prebifurcated graft is that it is "off the shelf" in many institutions for use in axillobifemoral bypass surgery. The hybrid approach with cervical debranching is likely to endure until total endovascular options have become more mature.

CONCLUSIONS

The hybrid approach consisting of cervical debranching and TEVAR is becoming a common option to treat aortic arch pathology, especially in urgent situations. In the present case report, we have demonstrated the value of using a prebifurcated graft for CCS debranching. Compared with some other methods of CCS bypass, the prebifurcated graft offers a readily available conduit with a reduced operative time, reduced clamping of inflow to the left carotid artery, and theoretical mitigation of postoperative hemorrhage owing to fewer anastomoses.

REFERENCES

1. De Rango P, Ferrer C, Coscarella C, Musumeci F, Verzini F, Pogany G, et al. Contemporary comparison of aortic arch repair by endovascular and open surgical reconstructions. J Vasc Surg 2015;61:339-46.
2. Bellamkonda KS, Yousef S, Nassiri N, Dardik A, Guzman RJ, Geirsson A, et al. Trends and outcomes of thoracic endovascular aortic repair with open concomitant cervical debranching. J Vasc Surg 2021;73:1205-12.e3.
3. Appoo JJ, Tse LW, Pozeg ZI, Wong JK, Hutchison SJ, Gregory AJ, et al. Thoracic aortic frontier: review of current applications and directions of thoracic endovascular aortic repair (TEVAR). Can J Cardiol 2014;30:52-63.
4. Andersen ND, Williams JB, Hanna JM, Shah AA, McCann RL, Hughes GC. Results with an algorithmic approach to hybrid repair of the aortic arch. J Vasc Surg 2013;57:655-67.
5. Al-Hakim R, Schenning R. Advanced techniques in thoracic endovascular aortic repair: chimneys/periscopes, fenestrated endografts, and branched devices. Tech Vasc Interv Radiol 2018;21:146-55.
6. Andacheh I, Lara G, Biswas S, Nurick H, Wong N. Hybrid aortic arch debranching and TEVAR is safe in a private, community hospital. Ann Vasc Surg 2019;57:41-7.
7. Seike Y, Matsuda H, Fukuda T, Inoue Y, Omura A, Uehara K, et al. Total arch replacement versus debranching thoracic endovascular aortic repair for aortic arch aneurysm: what indicates a high-risk patient for arch repair in octogenarians? Gen Thorac Cardiovasc Surg 2018;66:263-9.
8. Chan YC, Cheng SWK, Ting AC, Ho P. Supra-aortic hybrid endovascular procedures for complex thoracic aortic disease: single center early to midterm results. J Vasc Surg 2008;48:571-9.
9. Benedetto F, Piffaretti G, Tozzi M, Pipito' N, Spinelli D, Mariscalco G, et al. Midterm outcomes of carotid-to-carotid bypass for hybrid treatment of aortic arch disease. Ann Vasc Surg 2014;28:860-5.
10. Yoshida RA, Kolvenbach R, Yoshida WB, Wassijew S, Schwierz E, Lin F. Total endovascular debranching of the aortic arch. Eur J Vasc Endovasc Surg 2011;42:627-30.
11. Piffaretti G, Rivolta N, Fontana F, Carrafiello G, Mariscalco G, Castelli P. Aortic arch aneurysm repair with a new branched device. J Vasc Surg 2013;57:1664-7.
12. Kudo T, Kuratani T, Shimamura K, Sawa Y. Early and midterm results of thoracic endovascular aortic repair using a branched endograft for aortic arch pathologies: a retrospective single-center study. JTCVS Tech 2020;4:17-25.
13. Hughes GC, Vekstein A. Current state of hybrid solutions for aortic arch aneurysms. Ann Cardiothorac Surg 2021;10:731.
14. Han DK, Jokisch C, McKinsey JF. Expanding the landing zone for TEVAR: a discussion of the longevity and durability of commonly used extrathoracic debranching techniques. Endovasc Today 2016;15:1-5.
15. Dake MD, Bavaria JE, Singh MJ, Oderich G, Filinger M, Fischbein MP, et al. Management of arch aneurysms with a single-branch thoracic endograft in zone 0. JTCVS Tech 2021;7:1-6.

Submitted Jun 10, 2022; accepted Aug 31, 2022.