

A hybrid aortic re-arching technique



Fuyuki Hirashima, MD,^{a,b} Marek Polomsky, MD,^{a,b} Willie Dong, BS,^b Jennifer L. Risi, BS,^b and Chris K. Rokkas, MD,^a Burlington, Vt

From the ^aUniversity of Vermont Medical Center, and ^bLamer College of Medicine, University of Vermont, Burlington, Vt.

Read at the American Association for Thoracic Surgery Aortic Symposium Workshop, Boston, Massachusetts, May 13-14, 2022.

Disclosures: The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

The current affiliation of Dr Rokkas is University of Wisconsin School of Medicine and Public Health, University of Wisconsin - Madison, Madison, Wis.

Received for publication June 2, 2022; revisions received July 26, 2022; accepted for publication July 29, 2022; available ahead of print Aug 6, 2022.

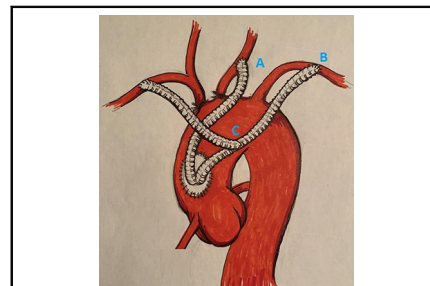
Address for reprints: Chris K. Rokkas, MD, University of Vermont Medical Center, H4/344A CSC, 600 Highland Ave, Madison, WI 53792 (E-mail: ckrokkas@yahoo.com).

JTCVS Techniques 2022;15:18-21

2666-2507

Copyright © 2022 The Author(s). Published by Elsevier Inc. on behalf of The American Association for Thoracic Surgery. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<https://doi.org/10.1016/j.jtc.2022.07.021>



Re-arching technique: Bypass grafts to the aortic arch branches.

CENTRAL MESSAGE

The re-arching technique includes a first stage of constructing bypass grafts to the arch branches by utilizing bilateral axillary artery cut-downs, and a second stage of endovascular completion.

Hybrid repair of aortic arch aneurysms involves technically challenging de-branching procedures requiring construction of graft anastomoses to the left subclavian and innominate arteries. Exposure of the intrathoracic segment of the aortic arch branches may be difficult, particularly that of the left subclavian artery, frequently requiring a left carotid to subclavian artery bypass before the de-branching procedure.¹ We present a simplified method of aortic arch revascularization, termed re-arching, where the bypass grafts are tunneled from the ascending aorta to the axillary arteries bilaterally. A subsequent thoracic endovascular aortic repair (TEVAR) of the aortic arch aneurysm is performed. This method precludes the need for a carotid to subclavian artery bypass before TEVAR.

METHODS

The patient reported on herein provided informed written consent for the publication of study data. As an individual case report with no identifiable patient information, our institutional review board deemed publication of the study exempt from approval.

A 58 year-old woman presented with an asymptomatic aneurysm of the distal aortic arch associated with a penetrating atherosclerotic ulcer (Figure 1). Due to multiple comorbidities and extensive atherosclerosis of the aortic arch, she would have been a high-risk patient for an open anatomic reconstruction under circulatory arrest. Bilateral axillary artery cut-downs were performed. A 10-mm graft was anastomosed to the right axillary artery, following administration of 3000 U heparin intravenously. A median sternotomy was then performed and cardiopulmonary bypass (CPB) was instituted via the right axillary artery and right atrium with the patient being fully heparinized. A multibranch aortic arch graft was used (Plexus; Terumo Aortic), and a patch including the origins of the 10-mm and 8-mm grafts was tailored from this graft (Figure 2 and Figure E1). This patch was anastomosed to the anterolateral aspect of the ascending aorta during a short period of cardioplegic arrest. It is important to avoid anastomosis to the anterior wall of the ascending aorta to prevent

compression and crowding of the graft. The 8-mm graft off the ascending aorta was anastomosed to the proximal left common carotid artery in an end-to-side fashion (anastomosis A), and the origin of the left common carotid artery was ligated. The patient was then weaned off CPB. Next, the 10-mm branch off the ascending aorta was tunneled to the left infraclavicular space through the second intercostal space, and it was anastomosed to the left axillary artery in an end-to-side fashion (anastomosis B). The second intercostal space is mostly a fixed area not prone to kinking. Tunneling is performed with a long curved blunt clamp in a direction from the left infraclavicular area towards the anterior mediastinum under direct visualization. An adequate opening is created within the intercostal space to provide comfortable passage of the graft. The 10-mm graft to the right axillary artery that had been previously used as an arterial inflow conduit was tunneled into the mediastinum through the right second intercostal space. Tunneling is performed in a direction from the posterior chest wall to the right infraclavicular area. The graft was then anastomosed to the 10-mm graft supplying the left axillary artery in an end-to-side configuration (anastomosis C). The innominate artery was ligated at its origin. The patient returned 4 weeks later to undergo a TEVAR procedure with a 32 × 28 × 178-mm endograft deployed to zone 0. Angiography showed no type 2 endoleak, therefore endovascular occlusion (plug) of the left subclavian was not required (Figure 3).

RESULTS

Bilateral radial arterial monitoring showed equal and appropriate systemic blood pressures. Follow-up computed

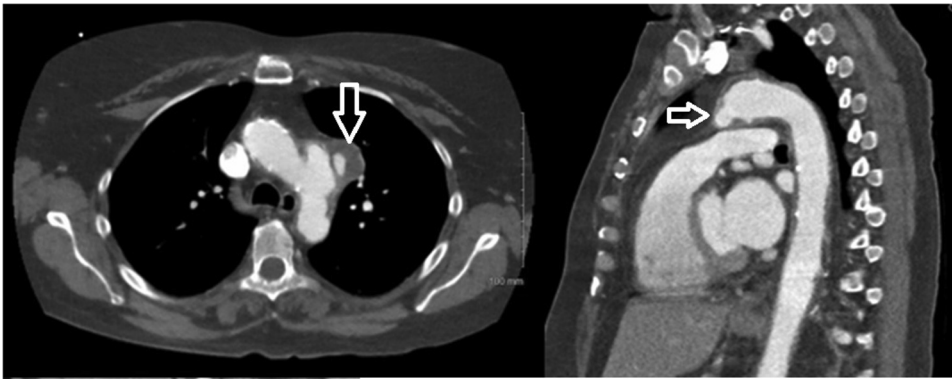


FIGURE 1. Aneurysm of the distal aortic arch associated with a penetrating atherosclerotic ulcer (arrows).

tomography angiogram showed no evidence of endoleak; a completely thrombosed aneurysm sac; and patent grafts supplying the right axillary, left axillary, and left common carotid arteries (Figure 3).

DISCUSSION

We believe that low-risk patients who require extensive replacement of the aortic arch should still have an anatomic repair. However, a hybrid approach is preferred to anatomic reconstruction in high risk patients.^{2,3} This staged procedure frequently requires the additional step of a left carotid to subclavian artery bypass or a subclavian artery transposition to revascularize the hard-to-reach left subclavian artery.⁴ This is often necessary even when the de-branching operation is performed on CPB.

For our patient, we used CPB and a brief period of cardioplegic arrest to safely perform the anastomosis of the patch graft island to the aorta, given the relatively small size of the

patient’s aorta. We believed that the application of a partial occlusion clamp on the ascending aorta would not have been entirely safe. In other de-branching cases, we have performed the aortic anastomoses without the use of CPB.⁵ For the proximal aortic anastomoses, a bifurcating graft or even 2 separate grafts can be used. By using the multibranch graft, the branches are optimally oriented without protruding through the side of the aorta. The remaining graft material is also used in the reconstruction.

CONCLUSIONS

Our novel hybrid re-arching approach of aortic arch reconstruction simplifies the standard de-branching technique by avoiding the technically challenging intrathoracic anastomoses to the innominate and the left subclavian arteries. In addition, the anastomosis to the left axillary artery eliminates any

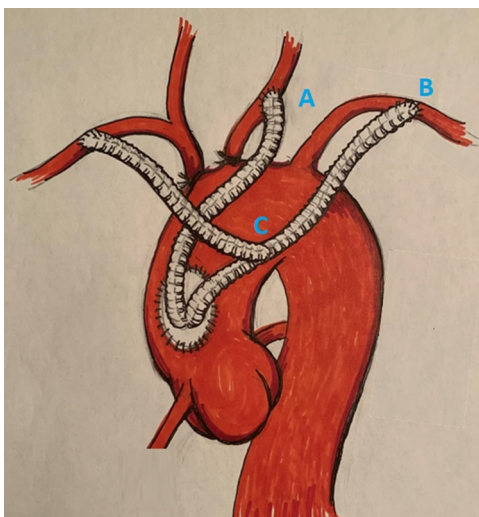


FIGURE 2. The re-arching technique: Bypass grafts to the aortic arch branches. A: Aorta to left common carotid artery bypass. B: Aorta to left axillary artery bypass. C: Interposition bypass graft to the right axillary artery.



FIGURE 3. Completion angiography following deployment of endovascular graft to zone 0 shows opacification of the aortic arch branches and obliteration of the aneurysm.

need for a left carotid to left subclavian artery bypass or subclavian artery interposition before TEVAR, thus simplifying the staging of the hybrid procedure. Use of the technique in selected high-risk patients may be indicated.

References

1. Hage A, Ginty O, Power A, Dubois L, Dagenais F, Appoo JJ, et al. Management of the difficult left subclavian artery during aortic arch repair. *Ann Cardiothorac Surg.* 2018;7:414-21.
2. Cao P, De Rango P, Czerny M, Evangelista A, Fattori R, Nienaber C, et al. Systematic review of clinical outcomes in hybrid procedures for aortic arch dissections and other arch diseases. *J Thorac Cardiovasc Surg.* 2012;144:1286-300. 1300.e1-2.
3. Milewski RK, Szeto WY, Pochettino A, Moser GW, Moeller P, Bavaria JE. Have hybrid procedures replaced open aortic arch reconstruction in high-risk patients? A comparative study of elective open arch debranching with endovascular stent graft placement and conventional elective open total and distal aortic arch reconstruction. *J Thorac Cardiovasc Surg.* 2010;140:590-7.
4. Canaud L, Ziza V, Ozdemir BA, Berthet JP, Marty-Ane CH, Alric P. Outcomes of left subclavian artery transposition for hybrid aortic arch debranching. *Ann Vasc Surg.* 2017;40:94-7.
5. Kollias VD, Lozos V, Angouras D, Toumpoulis I, Rokkas CK. Single-stage, off-pump hybrid repair of extensive aneurysms of the aortic arch and the descending thoracic aorta. *Hellenic J Cardiol.* 2014;55:355-60.

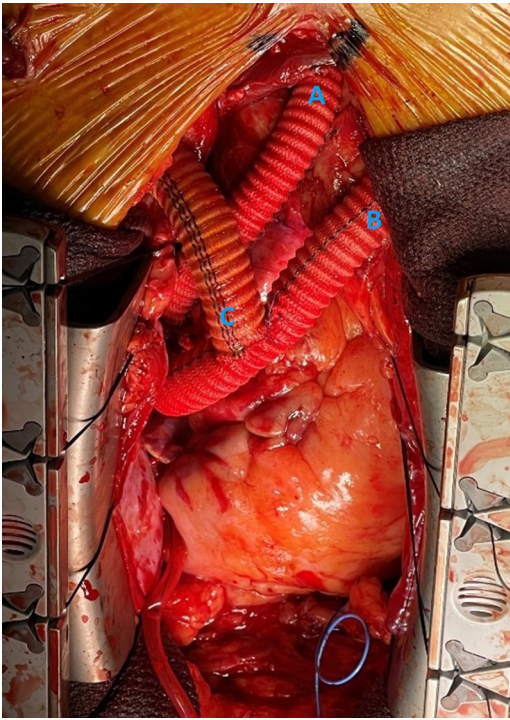


FIGURE E1. Intraoperative view following completion of bypass grafts. A: Aorta to left common carotid artery bypass. B: Aorta to left axillary artery bypass. C: Interposition bypass graft to the right axillary artery.