

One size does not fit all – Staged hybrid approach of a challenging aortic arch aneurysm using a double-branch custom-made device

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ABSTRACT

BACKGROUND: The anatomical complexity of the aortic arch poses significant challenges to its repair, particularly in high-risk patients. The introduction of branched endografts, specifically designed to overcome these challenges, has revolutionised this field, as demonstrated in the present case report.

CASE REPORT: A 60-year-old male, with a prior history of smoking and neurosyphilis, was referred to our outpatient clinic due to a computed tomography finding of a 66mm aortic arch aneurysm with complex anatomical features, including a short brachiocephalic trunk and narrow iliac arteries.

Thus, a staged hybrid approach was planned. The patient was initially submitted to a left carotid-subclavian bypass, followed by a right subclavian-carotid bypass. Later, an endoconduit was constructed using two Viabahn® stent grafts (11x100mm), deployed in the left common and external iliac arteries, facilitating subsequent TEVAR. Finally, the aneurysm was excluded using a custom-made Terumo-Relay® double inner-branched endograft (46x32x270mm) deployed in zone 0, with two inner branches for the brachiocephalic trunk (BCT)/right subclavian artery (RSA) and left common carotid artery (LCCA). The inner branches were catheterized via trans-carotid (left) and trans-axillary (right) accesses. An iliac extension GORE-Excluder® (16x12x100mm) to the BCT/RSA and a Viabahn® stent graft (7x75mm) to the LCCA were deployed. An additional extension endograft (34x30x150mm) was deployed to complete distal exclusion. The left subclavian artery was subsequently occluded using a vascular plug. Postoperatively, the patient experienced a minor posterior circulation stroke, with full recovery within two weeks. Six-month follow-up imaging showed endograft patency, complete aneurysm exclusion, and no evidence of endoleaks. The patient remained asymptomatic, with no further vascular or neurological events.

CONCLUSION: This case highlights the feasibility of a staged hybrid approach for complex aortic arch aneurysms in patients with challenging anatomy. The use of a custom-made endograft and careful preoperative planning proved critical to the success of the procedure.

Keywords: Endovascular Aneurysm Repair (MeSH); Branched TEVAR; Hybrid procedures; Aortic Aneurysm, Thoracic (MeSH); Stroke (MeSH)



BACKGROUND

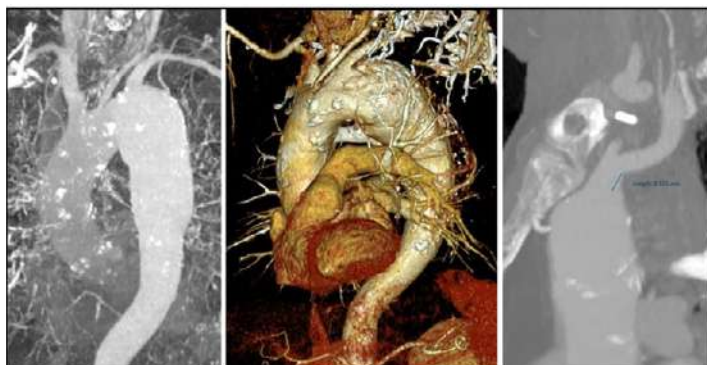
The management of aortic arch pathology is frequently demanding and poses significant anatomical challenges. In fact, the history of aortic arch repair has evolved from traditional open surgery to hybrid debranching procedures and, ultimately, total endovascular approaches. Despite its effectiveness, open arch repair carries significant morbidity and mortality, particularly in elderly patients with multiple comorbidities. The advent of hybrid techniques, combining open debranching with endovascular stent grafting, brought a less invasive alternative for these patients. More recently, total endovascular strategies, such as parallel graft techniques or custom-made devices, have emerged as viable options for surgically unfit patients.^[1,2] The latter include branched and fenestrated endografts, which enable a more anatomical reconstruction by preserving the native supra-aortic trunks through dedicated inner branches or fenestrations. Additionally, some studies suggest that Branched Thoracic Endovascular Aortic Repair (B-TEVAR) is associated with a lower rate of type I and III endoleaks.^[3]

We herein present a case of an anatomically complex aortic arch aneurysm with unfavourable accesses, successfully managed with a combination of hybrid and endovascular techniques.

CASE REPORT

This case report is about a 60-year-old male, with a past medical history of smoking and neurosyphilis, who was referenced to our outpatient clinic due to an incidental finding on Computed Tomography Angiography (CTA) of an aortic arch aneurysm with a maximum diameter of 66 mm. Preoperative evaluation revealed particularly challenging anatomical features, including a short brachiocephalic trunk (8 mm in length) and narrow iliac arteries (diameters ranging from 5 to 7 mm), [Figure 1](#). After multidisciplinary evaluation, including Vascular and Cardiothoracic surgeons, the patient was considered unfit for open repair. Thus, a staged hybrid approach was meticulously planned to optimise both access and preservation of branch vessels.

Figure 1. Preoperative computed tomography angiography, showing a 66 mm aortic arch aneurysm and a short (<1 cm) brachiocephalic trunk.



In the left panel, maximum intensity projection, coronal view; in the centre panel, 3D reconstruction; in the right panel, maximum intensity projection detailing the short brachiocephalic trunk.

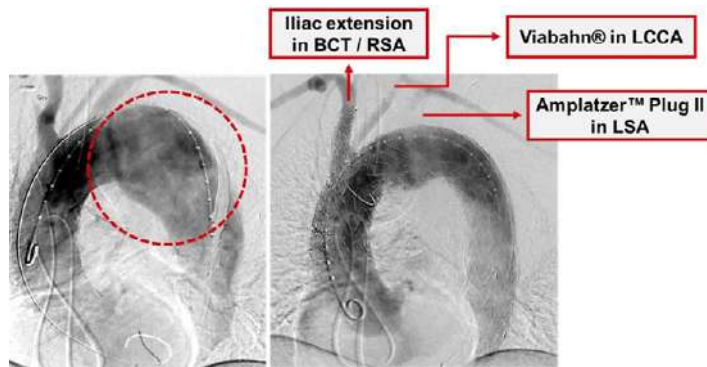
The patient was initially submitted to a left carotid-subclavian bypass, followed by a right subclavian-carotid bypass, both using polytetrafluoroethylene (PTFE) grafts, to ensure adequate cerebral perfusion following endograft deployment. Later, given the patient's narrow iliac arteries, an endoconduit was constructed using two GORE-Viabahn® (Flagstaff, AZ, USA) stent grafts (11x100mm), deployed from the origin of the left common iliac artery to the proximal segment of the left common femoral artery, covering the left hypogastric artery after ensuring that the right hypogastric artery remained patent. This procedure was performed to facilitate the subsequent deployment of the aortic endograft during B-TEVAR.

The final stage of treatment was the aneurysm exclusion using a custom-made Terumo-Relay® double inner-branched endograft (46x32x270mm) (Terumo Aortic, Renfrewshire, UK) deployed in zone 0, with two inner branches for the brachiocephalic trunk (BCT)/right subclavian artery (RSA) and left common carotid artery (LCCA). The inner branches were catheterised via trans-carotid (left) and trans-axillary (right) accesses. An iliac extension GORE-Excluder® (16x12x100mm) (Gore, Flagstaff, AZ, USA) was deployed in the BCT landing distally in the RSA. A GORE-Viabahn® stent graft (7x75mm) (Gore, Flagstaff, AZ, USA) was deployed in the LCCA. To ensure complete exclusion of the aneurysm, an additional extension endograft (34x30x150 mm) was deployed distally. The left subclavian artery was subsequently occluded using an Abbott Amplatzer™ Plug II (Abbott Vascular, Chicago, IL, USA) to prevent type II endoleaks, [Figures 2](#) and [3](#).

Figure 2. Schematic representation of the procedures (Branched TEVAR preceded by left carotid-subclavian bypass and right subclavian-carotid bypass, with ligation of the right common carotid artery and occlusion of the left subclavian artery using a vascular plug).

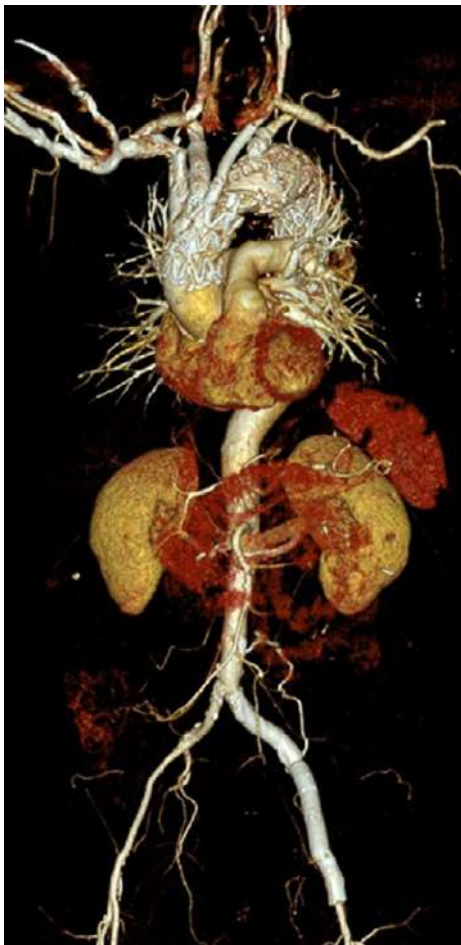


Postoperatively, the patient experienced a minor posterior circulation stroke, with CT imaging showing bilateral occipital ischemic lesions in the posterior cerebral artery territories. The patient fully recovered within two weeks, with no residual neurological deficits.

Figure 3. Intraoperative digital subtraction angiography

On the left, pre-deployment; on the right, completion angiography.
BCT – brachiocephalic trunk; **RSA** – right subclavian artery; **LCCA** – left common carotid artery; **LSA** – left subclavian artery).

Follow-up imaging at six months showed patency of the endografts with complete exclusion of the aneurysm and no evidence of endoleaks, [Figure 4](#). The patient remained asymptomatic, with no further vascular or neurological events.

Figure 4. Six-month follow-up computed tomography angiography – 3D reconstruction, showing successful aneurysm exclusion, absence of endoleaks and patency of endografts.

DISCUSSION

This case highlights the importance of preoperative imaging, meticulous procedural planning and device selection. The presence of a short brachiocephalic trunk led to the need for adjunctive debranching procedures prior to the deployment of a branched endograft. Also, an endoconduit was necessary due to the coexistence of narrow iliac arteries, unfavourable for subsequent B-TEVAR.

This case-report is in line with the existing literature on custom-made devices: the aneurysm was successfully excluded, with optimal sealing, no endoleaks and target vessel patency on imaging follow-up. However, the rate of neurological events remains a matter of concern.⁽⁴⁻⁸⁾ In this context, the postoperative occurrence of a minor stroke also underscores the importance of minimizing wire and manipulation of the supra-aortic trunks during arch procedures.

In conclusion, a patient-tailored approach, combining advanced imaging, customized device design and staged hybrid approach, was a major contribution to the success of the procedure in a patient with hostile anatomy.

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