EJVES Vascular Forum (2024) 61, 27–30

CASE REPORT

Hybrid Repair of Left Subclavian Artery Pseudoaneurysm With Vertebral Artery Revascularisation: A Solution for a Complex Case

José I. Chiriboga Granja [*], **Vicente Sala Almonacil, Marta Zaplana Córdoba, Rosario Jímenez Palmer, Mario Altable García**

Servicio de Angiología y Cirugía Vascular, Hospital Clínico Universitario de Valencia, Valencia, Spain

Introduction: Pseudoaneurysms of the subclavian artery are a rare complication. Surgical treatment is necessary to prevent potentially lethal complications. This needs adequate planning in cases that require vertebral artery revascularisation.

Report: A 56 year old man with multiple systemic comorbidities underwent endovascular treatment using a balloon expandable bare metal stent for symptomatic subclavian Steal syndrome. During follow up, computed tomography angiography (CTA) revealed a pseudoaneurysm in the proximal segment of the left subclavian artery. The patient had criteria warranting left vertebral artery revascularisation. The patient underwent scheduled hybrid surgical treatment involving transposition of the vertebral artery to the common carotid artery, endarterectomy of the internal carotid artery, and endovascular therapy for pseudoaneurysm exclusion; all were performed on the left side. The post-operative period was without incident. After 12 months the patient remains asymptomatic, with adequate exclusion of the pseudoaneurysm, and patency of the procedures.

Discussion: Hybrid surgery could offer a secure, feasible, and less invasive option for treating subclavian artery pseudoaneurysms that require vertebral artery revascularisation.

Article history: Received 19 September 2023, Revised 10 November 2023, Accepted 8 December 2023,

Keywords: Cerebral Revascularisation, Pseudoaneurysm, Vascular surgery

INTRODUCTION

Subclavian artery pseudoaneurysms can be particularly challenging, and a hybrid approach may offer advantages for surgical treatment. Open surgical repair is complicated due to the deep cervical and intrathoracic location of the subclavian artery, while endovascular treatment is conditioned by the vertebrobasilar circulation. A case of hybrid surgical repair of a pseudoaneurysm of the left subclavian artery and ipsilateral vertebral revascularisation is presented. This approach combines the benefits of both open surgical repair and endovascular treatment, making it an option for treating subclavian artery pseudoaneurysms.

CASE REPORT

A 56 year old male patient was transferred after undergoing endovascular therapy by another medical team. He had a past medical history of smoking, arterial hypertension, dyslipidaemia, type II diabetes mellitus, and ischaemic heart disease. The patient was treated for symptomatic left subclavian steal syndrome, characterised by vertigo and peri-oral numbness during exertion. A bare metal balloon expandable stent 9 × 57 mm (Bentley, BeSmooth) was implanted through distal radial access in the pre-vertebral subclavian artery. Post-procedure, the patient regained antegrade flow in the vertebral artery and recovered the radial pulse.

At six months follow up, the patient remained asymptomatic. However, CTA revealed a 2 cm pseudoaneurysm in the pre-vertebral segment of the left subclavian artery (Fig. 1). Additionally, there was a proximal right subclavian artery occlusion and a significant internal carotid artery stenosis (Fig. 2). The patient presented with elements that influenced the need for revascularisation of the ipsilateral vertebral axis. These factors included a history of previous revascularisation due to symptomatic subclavian steal syndrome, contralateral vertebral axis occlusion, and the termination of the vertebral artery in the posterior inferior cerebellar artery (PICA). The patient underwent scheduled surgical treatment under general anaesthesia and continuous cerebral oximetry monitoring with INVOS technology. The vertebral artery was dissected and identified in its V1 segment through a left lateral cervical approach. The common carotid artery and its bifurcation were dissected, and a clamp test was performed. Since there was no significant decrease in cerebral oximetry, a shunt was not used. Subsequently, a vertebral artery to the common carotid artery

* Corresponding author. Servicio de Angiología y Cirugía Vascular, Hospital Clínico Universitario de Valencia, Av. Blasco Ibañez, 17, 46010, Valencia, Spain.

E-mail address: josechiriboga89@gmail.com (José I. Chiriboga Granja).

https://doi.org/10.1016/j.ejvsvf.2023.12.001

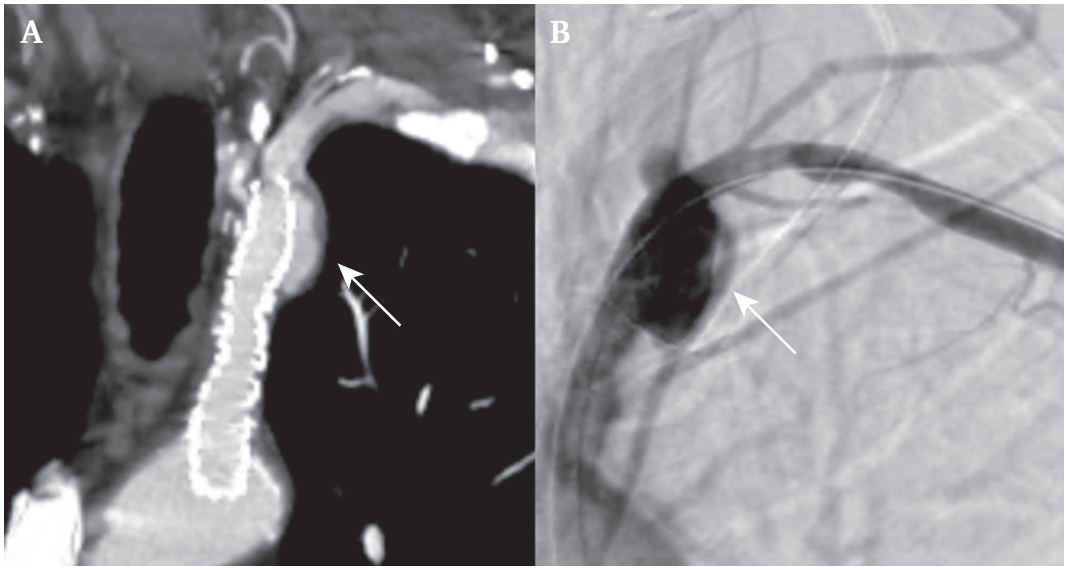

Figure 1. A. CTA supra-aortic trunks in coronal section and B. Selective angiography of pseudoaneurysm at the origin of the left subclavian artery (white arrow).

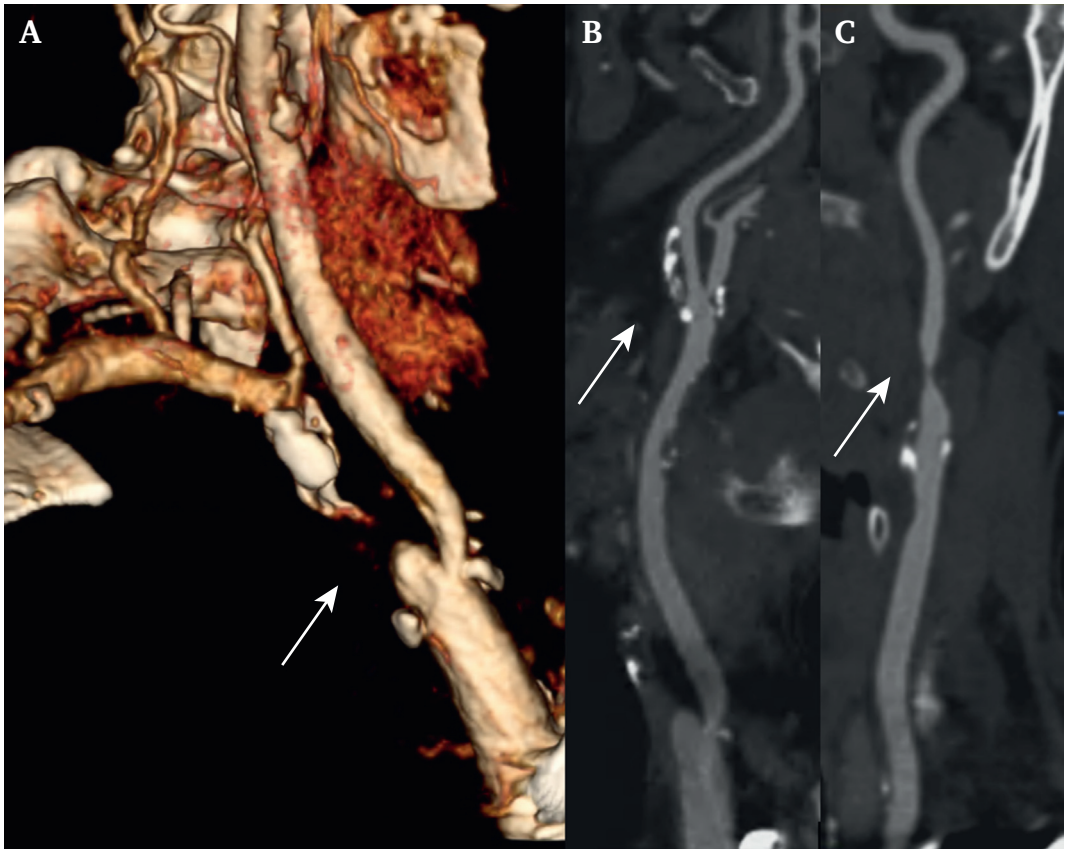

Figure 2. A. 3D Reconstruction — Right subclavian artery. B. CTA supra-aortic trunks 1. Right carotid bifurcation. 2. Left carotid bifurcation.

transposition (Fig. 3A), and a carotid endarterectomy employing a 1 × 10 mm polyester urethane patch (Fig. 3B; Braun Surgical S.A.) were conducted. Finally, the left subclavian artery and ascending aorta catheterisation were achieved through left humeral access. A pre-dilatation of the previous stent by 7 × 40 mm balloon angioplasty was performed through an 8F × 55 mm introducer. Following this, an 8 × 59 mm balloon expandable covered stent (Gore VBX) was implanted at the origin of the subclavian artery, followed by the placement of a 7 × 50 mm self expanding covered stent (Gore Viabahn) (Fig. 3B). Control arteriography revealed successful exclusion of the left subclavian

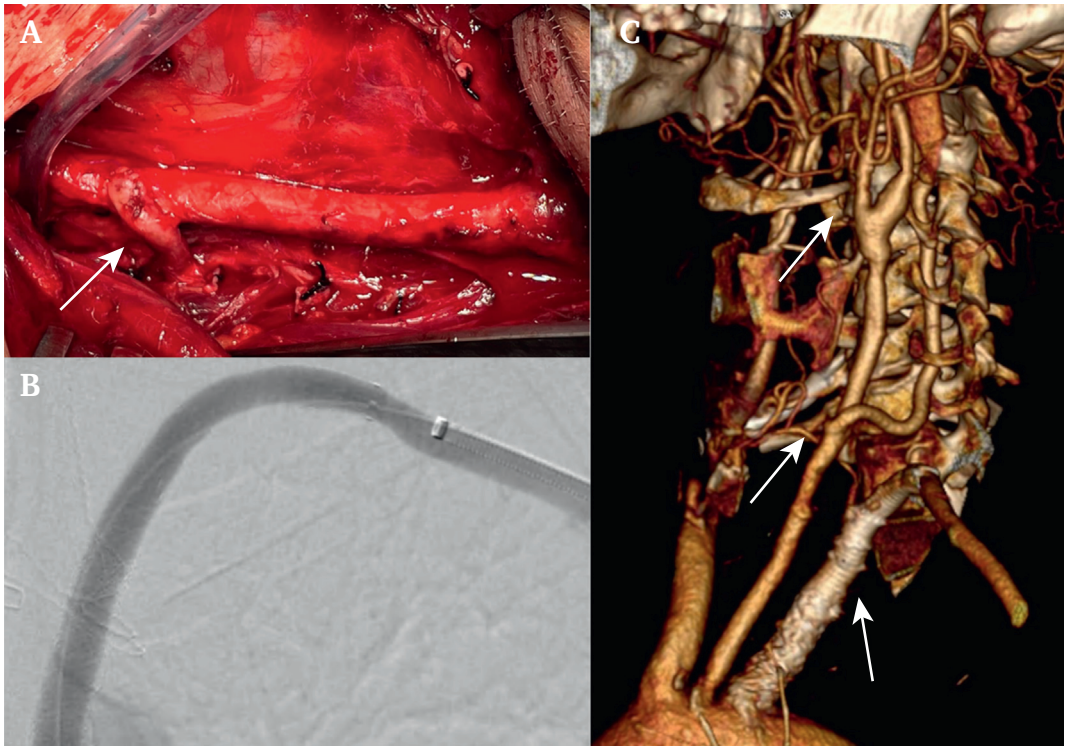

Figure 3. A. Surgical Image — vertebral artery transposition to the left common carotid artery. B. Selective control angiography after treatment. C. 3D reconstruction post-operative control.

artery pseudoaneurysm and patency of the vertebral artery transposition and left carotid endarterectomy.

The post-operative period proceeded without complication, leading to the patient's discharge after a five day hospital stay (including 24 hours in the Resuscitation Unit). On discharge, the patient received a six month regimen of dual antiplatelet therapy (acetylsalicylic acid 100 mg and clopidogrel 75 mg, both daily) and thereafter, an indefinite regimen of single antiplatelet therapy (acetylsalicylic acid 100 mg daily). During follow up assessments, which have now extended to one year, the patient exhibited no abnormalities on Doppler ultrasound or CTA, with patency of the procedures (Fig. 3C).

DISCUSSION

A subclavian artery pseudoaneurysm can be particularly challenging when it is accompanied by severe atherosclerosis in the supra-aortic trunks. Subclavian artery pseudoaneurysms have a relatively low incidence, ranging from 1% to 2%, with their primary causes being iatrogenic injuries resulting from the improper placement of central venous catheters or penetrating trauma.[1–3] Treatment is imperative to mitigate the risk of potentially catastrophic complications, which may include rupture, embolisation, and gradual compression of the airway or neurovascular structures.[1–5] Various techniques including open surgery and endovascular procedures have been detailed to address this condition.[1–5] Open surgery is associated with significant morbidity and mortality as it typically involves revascularisation via sternotomy or thoracotomy.[4] On the other hand, endovascular treatment can be complex, especially in the proximal segment where coverage of the vertebral artery origin may be necessary. A hybrid approach may offer advantages by avoiding the need for sternotomy or thoracotomy, thus providing a less invasive treatment option and enabling revascularisation of the vertebral artery.

An exceptional case of a pseudoaneurysm of the subclavian artery that emerged due to previous endovascular treatment is reported. This condition was further complicated by severe atherosclerotic disease of the supra-aortic trunks, which increased the complexity of its treatment. The initial endovascular intervention for this patient was performed externally, and it is believed that employing bare metal balloon expandable stents at the origin of the supra-aortic trunks may not have been the most appropriate choice. This viewpoint aligns with the research of Wei et al., which highlights the superior primary patency rates associated with balloon expandable covered stents compared with bare metal balloon expandable stents in cases of subclavian artery occlusive pathology.[5] Furthermore, it has been substantiated that in atherosclerotic pathology affecting other regions, covered stents exhibit enhanced tolerance in areas exposed to higher shear stress, consequently reducing the risk of arterial rupture and pseudoaneurysm formation.[6] In this particular case, covered stents were chosen, beginning with a balloon expandable stent at the origin and following up with a self expandable stent at the curvature of the subclavian artery. This approach yielded excellent results in effectively excluding the pseudoaneurysm.

The patient's condition included specific factors that necessitated the revascularisation of the ipsilateral vertebral axis.[7] Given these circumstances, anatomical revascularisation

methods that would require invasive procedures such as thoracotomy or sternotomy were avoided. Furthermore, endovascular treatment was not relied on exclusively due to the specific requirement for vertebral revascularisation. As a result, a less invasive procedure was chosen, specifically transposition of the vertebral artery to the common carotid artery. This technique has demonstrated excellent primary patency rates ranging from 95% to 100% but with a non-negligible 21.4% complication rate that includes Horner syndrome (7.1%), vocal cord paralysis (3.6%), and embolism of subclavian artery stenosis (3.6%).[8] Considering the significant left internal carotid artery stenosis observed in the patient, a carotid endarterectomy was carried out, thereby avoiding the need for a cervical re-intervention. This choice aligns with the findings of Gu et al., whose study concluded that the combination of revascularisation of the V1 segment of the vertebral artery and carotid endarterectomy is a safe approach.[9]

Although the patient tolerated simultaneous carotid and vertebral clamping well, options were discussed if this had not been the case. If a decline in cerebral perfusion had been observed during the test clamping, the course of action would have been to initially carry out revascularisation of the carotid axis. This would then have been followed by vertebral artery transposition under partial carotid clamping. For follow up of the case, CTA was chosen. This technique provides a comprehensive view of the supra-aortic trunks, including both their intrathoracic origins and their extension to cervical level. Furthermore, CTA enabled the successful endovascular exclusion of the subclavian pseudoaneurysm to be verified.

The recently published 2023 ESVS Clinical Practice Guidelines on the Management of Atherosclerotic Carotid and Vertebral Artery Disease mentions the usefulness of hybrid treatment in tandem carotid lesions. Where treatment is recommended for symptomatic patients with a proximal common carotid artery or innominate stenoses, open retrograde angioplasty and stenting should be considered.[10] This case exemplifies the practicality and viability of hybrid treatment in cases with disease at the origin of the supra-aortic trunks that present with criteria for vertebral revascularisation.

Conclusion

Hybrid surgery integrates the benefits of open surgery with endovascular techniques and emerges as an alternative for managing subclavian artery pseudoaneurysms. This strategy is especially advantageous when revascularisation of the vertebral artery is necessary, providing a safer, more practical, and minimally invasive solution.

CONFLICT OF INTEREST

None.

FUNDING

None.

REFERENCES

1 van der Weijde E, Vos JA, Heijmen RH. Hybrid repair of a large pseudoaneurysm of the proximal right subclavian artery in a Marfan patient. *J Vasc Surg Cases Innov Tech* 2017;**3**:215—7.
2 Al-Thani H, Hussein A, Sadek A, Barah A, El-Menyar A. Balloon-assisted percutaneous thrombin injection for treatment of iatrogenic left subclavian artery pseudoaneurysm in a critically ill COVID-19 patient. *Case Rep Vasc Med* 2021;**2021**:1—6.
3 Yamashita Y, Kimura S, Kurisu K, Ueno Y. Successful treatment of iatrogenic subclavian artery pseudoaneurysm by ultrasound-guided thrombin injection. *Ann Vasc Dis* 2016;**9**:108—10.
4 Sobnach S, Nicol AJ, Nathire H, Edu S, Kahn D, Navsaria PH. An analysis of 50 surgically managed penetrating subclavian artery injuries. *Eur J Vasc Endovasc Surg* 2010;**39**:155—9.
5 Wei L, Gao X, Tong Z, Cui S, Guo L, Gu Y. Outcomes of covered stents versus bare-metal stents for subclavian artery occlusive disease. *Front Cardiovasc Med* 2023;**10**:1—6.
6 Squizzato F, Piazza M, Pulli R, et al. Covered versus bare metal kissing stents for reconstruction of the aortic bifurcation in the ILIACS registry. *J Vasc Surg* 2021;**73**:1980—90.
7 Berguer R, Flynn LM, Kline RA, Caplan L. Surgical reconstruction of the extracranial vertebral artery: management and outcome. *J Vasc Surg* 2000;**31**:9—18.
8 Duran M, Schelzig H, Petrov A, et al. Reconstruction for symptomatic vertebral artery lesion using vertebral artery to carotid artery transposition: a retrospective study. *Ann Vasc Surg* 2022;**84**:148—54.
9 Gu Y, Zhou Z, Qin Y, et al. Is revascularization of V1 segment of vertebral artery combined with ipsilateral carotid endarterectomy Safe? *Ann Vasc Surg* 2023;**88**:218—27.
10 Naylor R, Rantner B, Ancetti S, et al. Editor's Choice — European Society for Vascular Surgery (ESVS) 2023 clinical practice guidelines on the management of atherosclerotic carotid and vertebral artery disease. *Eur J Vasc Endovasc Surge* 2023;**65**:7—111.