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## International Journal of Surgery Case Reports

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## Treatment of subclavian artery stenosis: A case series



Reem Salman, Jane Hornsby\*, Lucie J. Wright, Tarek Elsaid, Grace Timmons, Ahmed Mudawi, Vish Bhattacharya

Queen Elizabeth Hospital, Queen Elizabeth Avenue, Gateshead NE9 6SX, UK

## ARTICLE INFO

## Article history:

Received 9 September 2015

Received in revised form

11 December 2015

Accepted 12 December 2015

Available online 17 December 2015

## Keywords:

Subclavian artery stenosis

Subclavian steal syndrome

## ABSTRACT

**INTRODUCTION:** In this case series, different modalities of treatment for patients with ischaemic symptoms of subclavian stenosis are described, including the different operative strategies that can be adopted in more challenging cases. This is the first case series describing these four management options.

**PRESENTATION:** *Case 1:* A seventy-one year-old female presented with acute on chronic ischaemia of her left arm following a fall and developed dry gangrene of her left thumb. This was initially managed with a heparin infusion followed by stenting of the subclavian artery which relieved her symptoms. *Case 2:* A fifty-nine year-old male presented with chronic ischemia of the left arm secondary to an occlusion of the left subclavian artery. This was managed by transposition of the left subclavian artery onto the left common carotid artery. *Case 3:* A sixty-four year-old female presented with left subclavian steal syndrome secondary to subclavian artery stenosis. She underwent carotid subclavian artery bypass. *Case 4:* A fifty-six year-old female presented with acute left upper limb ischaemia secondary to acutely thrombosed subclavian artery on a CT-angiography. She underwent a carotid to axillary bypass.

**DISCUSSION AND CONCLUSION:** This case series demonstrates the treatment options available to vascular surgeons when managing symptomatic subclavian artery disease. Symptomatic subclavian artery occlusive disease should be treated with endovascular stenting and angioplasty as first line management. If it is not successful then open surgery should be considered. Bypassing the carotid to the subclavian or to the axillary artery are both good treatment modalities.

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## 1. Introduction

Patients with atherosclerotic occlusive plaques in the subclavian artery are usually asymptomatic. Intervention is warranted in the symptomatic patient [1,2]. Hemodynamically significant stenosis of the subclavian artery usually presents with symptoms of upper limb ischemia on the ipsilateral side as the lesion. It may also present as subclavian steal syndrome with symptoms of vertebro-basilar insufficiency as a result of retrograde flow in the ipsilateral vertebral artery [3]. The most common cause of subclavian artery stenosis is atherosclerosis but other causes include congenital abnormalities such as arteria lusoria (aberrant subclavian artery) or right sided aortic arch that can cause compression

of the right subclavian artery leading to congenital subclavian steal syndrome [4–6].

There are several methods of treating symptomatic occlusive lesions of the proximal subclavian artery. An endovascular approach is attempted before proceeding to open subclavian artery revascularization as it is a less invasive procedure [7]. Surgical revascularization is attempted either via transposition of subclavian to carotid artery, carotid – subclavian bypass using a synthetic graft or by subclavian – axillary bypass if the carotid is not feasible [8].

Angioplasty and stenting are first line interventions for symptomatic subclavian occlusive disease. A retrospective study on the long-term outcome of this endovascular intervention concluded that there was high primary success with satisfactory outcomes beyond 10 years [9].

The study conducted by Stone et al. compared endovascular treatment and open surgery in subclavian occlusive disease [10]. The study concluded that endoluminal therapy for subclavian disease is effective and safe; however, open surgery still carries a better long-term durability and should be the preferred approach in low-risk patients. Symptomatic patients who failed endovascular treatment or subsequent loss of patency by stent occlusion should be considered for surgical revascularization.

**Abbreviations:** PTFE, Polytetrafluoroethylene; MRA, Magnetic resonance angiogram using philips ingenia 1.5T.

\* Corresponding author.

**E-mail addresses:** [reem.salman@ghnt.nhs.uk](mailto:reem.salman@ghnt.nhs.uk) (R. Salman), [j.hornsby@doctors.org.uk](mailto:j.hornsby@doctors.org.uk) (J. Hornsby), [luciejwright@doctors.org.uk](mailto:luciejwright@doctors.org.uk) (L.J. Wright), [tarek.elsaid@ghnt.nhs.uk](mailto:tarek.elsaid@ghnt.nhs.uk) (T. Elsaid), [grace.timmons@ghnt.nhs.uk](mailto:grace.timmons@ghnt.nhs.uk) (G. Timmons), [ahmed.mudawi@ghnt.nhs.uk](mailto:ahmed.mudawi@ghnt.nhs.uk) (A. Mudawi), [vish.bhattacharya@ghnt.nhs.uk](mailto:vish.bhattacharya@ghnt.nhs.uk) (V. Bhattacharya).

<http://dx.doi.org/10.1016/j.ijscr.2015.12.011>

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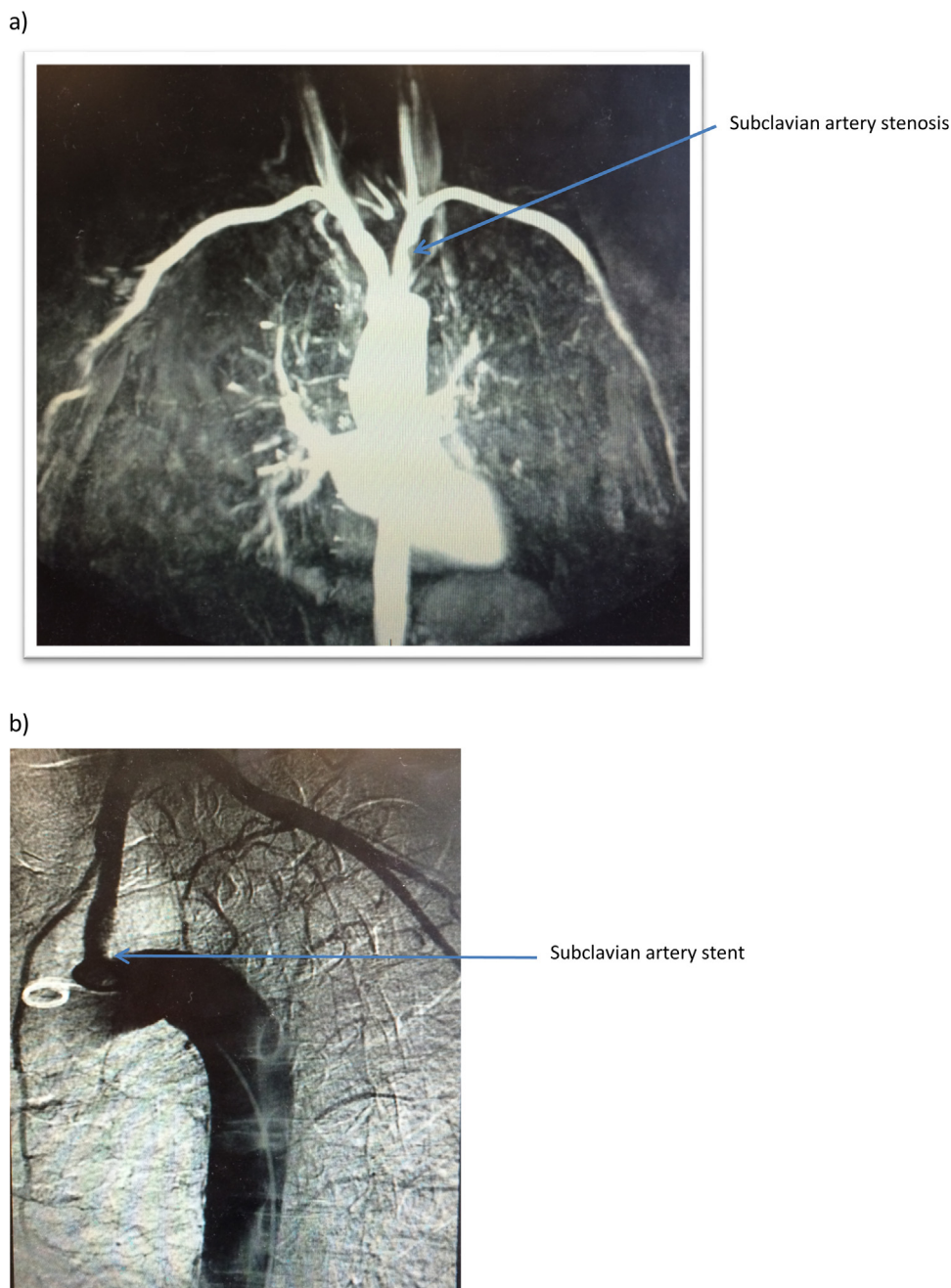
The carotid subclavian bypass is a safe and commonly used surgical procedure when endovascular intervention has failed [11]. A retrospective study analysing outcomes of common carotid-subclavian artery bypass versus transposition of subclavian artery on the common carotid artery concluded that the latter should be considered the first line surgical management of proximal subclavian artery lesions. The study showed the six-year patency rate was one hundred percent for transposition of subclavian artery on the common carotid artery and sixty-six percent for carotid subclavian bypass [12].

In this case series, we describe different modalities of intervention in four patients presenting with ischaemic symptoms of subclavian stenosis. This work has been reported in line with the CARE criteria [13].

## 2. Case presentations and discussion

### 2.1. Case 1

A 71 year old female presented as an emergency with a ten day history of a cold left arm following a fall onto her left side. On examination, her left upper limb was cold, pale and pulseless. Duplex ultrasonography showed low velocity flow and dampened waveform in the left subclavian artery. Intravenous heparin was commenced. Symptoms initially improved but she had ongoing pain in her left upper limb and developed dry gangrene of her left thumb. She underwent stenting of the subclavian artery which restored luminal patency and relieved her symptoms. Fig. 1 shows MRA images of the subclavian artery before treatment (Fig. 1a) and after stent insertion (Fig. 1b).

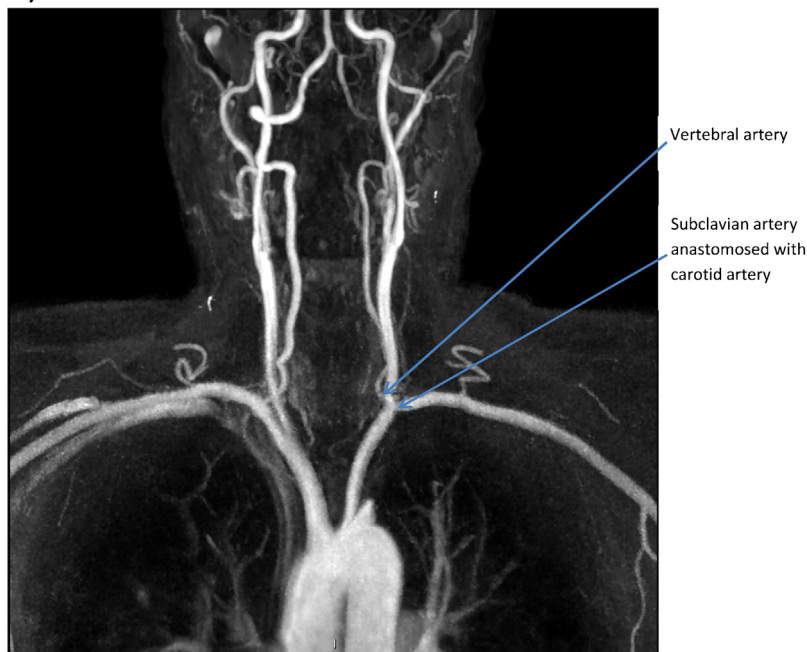


**Fig. 1.** (a) Pre-op MRA showing subclavian artery stenosis. (b) Post stent insertion.

a)



b)



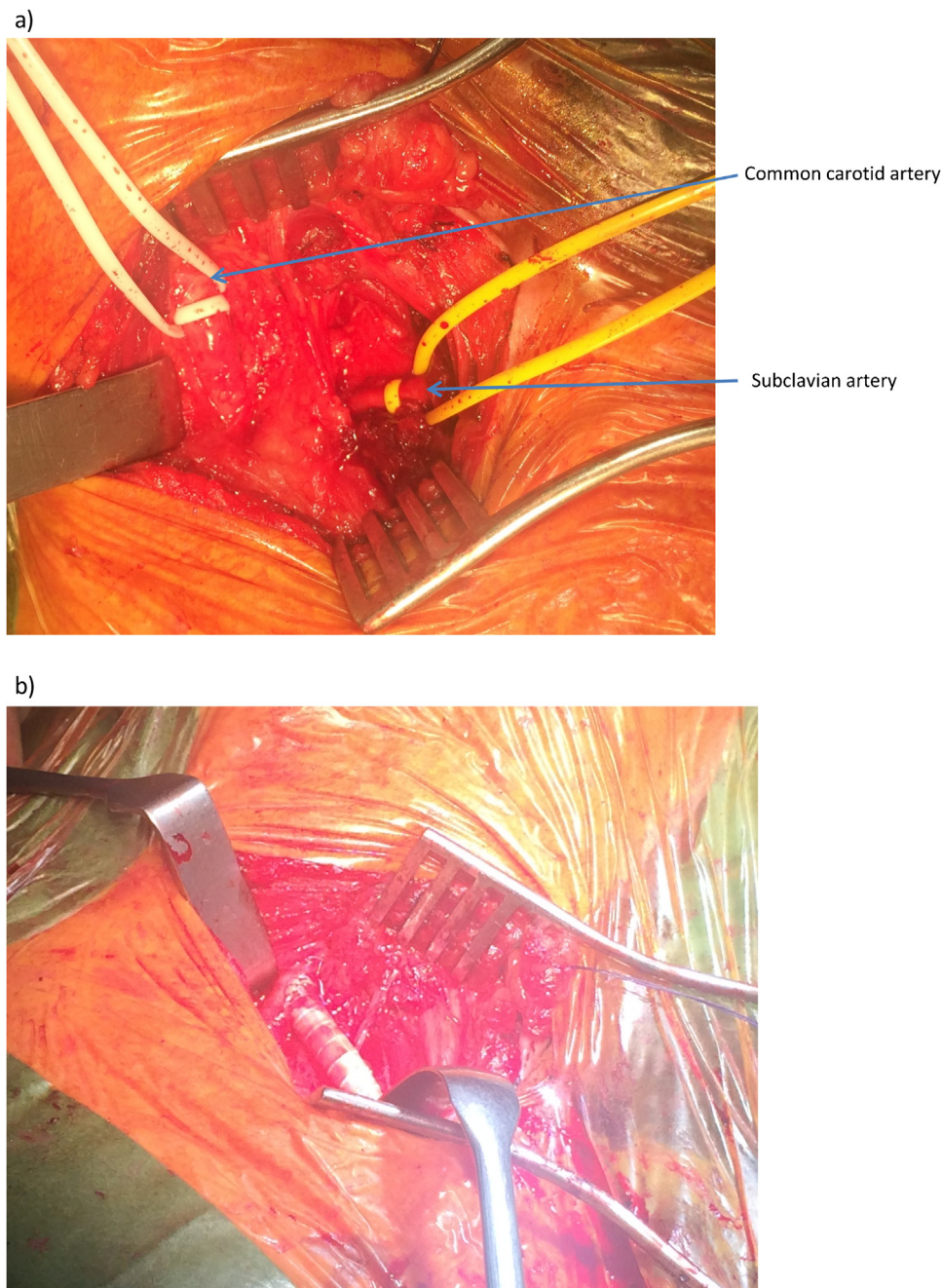
**Fig. 2.** (a) Pre-operative MRA showing an occlusion of the proximal left subclavian artery extending to the origin of the left vertebral artery. (b) MRA after transposition of the left subclavian artery to the left common carotid artery.

Where appropriate, angioplasty and stenting is the first line treatment for subclavian artery stenosis. The following cases demonstrate surgical options when angioplasty and stenting is not possible.

## 2.2. Case 2

A 59 year old male smoker was referred to vascular outpatient clinic with a history of a cold left upper limb over the last few

years. Duplex ultrasonography of his left upper limb showed high velocity flow distally. MRA showed an occlusion of the proximal left subclavian artery extending to the origin of the left vertebral artery (Fig. 2a). Angioplasty and stenting was attempted on two occasions but the procedures were terminated because it was not possible to cross the occlusion. Following multidisciplinary team discussion, it was decided to offer a carotid subclavian bypass with transposition of the subclavian artery onto the common carotid artery.



**Fig. 3.** (a) Intraoperative dissection during carotid-subclavian bypass. (b) Intraoperative image showing PTFE graft in situ between left carotid and axillary arteries.

Via a transverse supraclavicular incision, the left subclavian artery, left thyrocervical trunk and left vertebral arteries were dissected and controlled. The left subclavian artery was clamped just distal to the occlusion, proximal to the origin of the left vertebral artery, and transected. The subclavian artery stump was closed. The left common carotid artery was dissected and controlled. A longitudinal arteriotomy was made in the left common carotid artery and an end-to-side anastomosis was performed between the left subclavian artery and left common carotid artery.

After 6 months a MRA showed that the transposition of the left subclavian artery to the left common carotid artery was successful, with slight narrowing at the origin of the subclavian artery. The left vertebral artery was patent and the origin of the left subclavian artery is now a small blind ending trunk (Fig. 2b).

The transposition of the subclavian onto the carotid artery technique was possible because the lesion was proximal to the origin of the vertebral artery and the carotid artery was not diseased. It has the benefit that there is no graft in situ. Transposition of the subclavian artery to the carotid artery is most commonly performed in preparation for stenting of aneurysms of the thoracic aorta.

### 2.3. Case 3 (Fig. 3a and b)

A 64 year old female smoker with severe chronic obstructive pulmonary disease and peripheral vascular disease requiring lower limb vascular stents was found to be complaining of left upper limb claudication at a vascular outpatient review appointment. She also complained of dizziness when moving her arm. Duplex ultra-

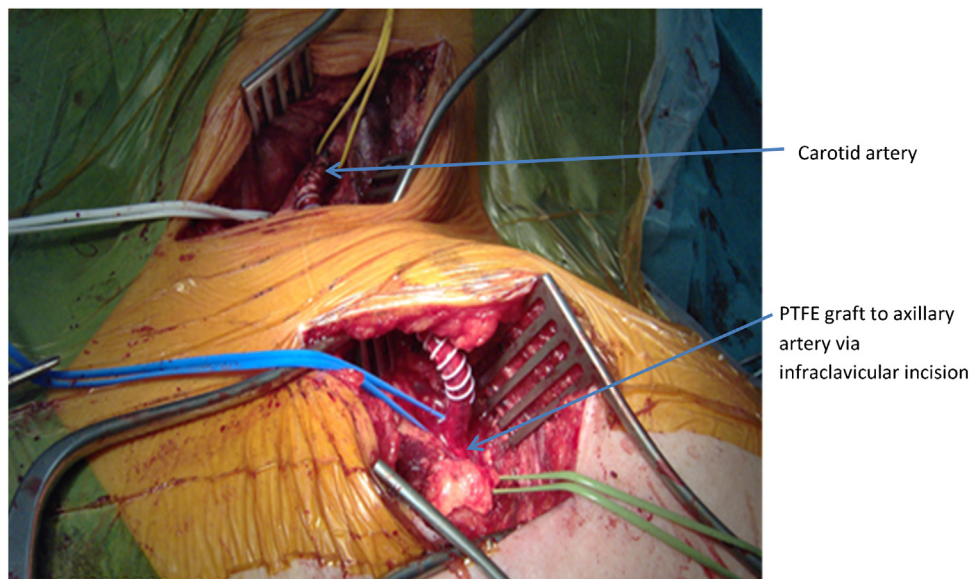


Fig. 4. Intraoperative image for carotid-axillary bypass.<sup>1</sup>

sonography showed stenosis in the mid left subclavian artery with reversed flow in the left vertebral artery, in keeping with subclavian steal. MRA confirmed occlusion of the left subclavian artery. Angioplasty was attempted but terminated because it was not possible to cross the lesion. Multidisciplinary team advice was to offer carotid subclavian artery bypass.

Via a transverse left supraclavicular incision the left common carotid artery was dissected. Scalenius anterior muscle was divided to provide access to the left subclavian artery. The subclavian artery, thyrocervical trunk and internal mammary arteries were identified and dissected. Proximal and distal control of the common carotid artery and the subclavian artery was gained. A six millimetre unsupported PTFE graft was anastomosed to the carotid and subclavian artery.

#### 2.4. Case 4 [14] (Fig. 4)

A 56 year old female smoker presented acutely with left arm numbness and pain. There were no palpable pulses. She underwent urgent computed tomography, which showed an acutely thrombosed left subclavian artery.

Initial angiograms obtained through the femoral artery in the groin showed a tight stenosis at the origin of the subclavian artery. She underwent angioplasty and stenting of the subclavian artery stenosis.

She continued to smoke and was re-admitted with recurrent symptoms. The duplex repeat angiogram confirmed an occlusion of the left subclavian stent and she underwent further angioplasty and insertion of a stent. Unfortunately, the stent blocked again for the second time, and a decision made to carry out a bypass rather than perform repeat radiological re-intervention. She therefore underwent a carotid to axillary bypass.

Via a longitudinal incision along the medial aspect of the left sternocleidomastoid muscle, the common carotid artery was dissected and controlled. The left axillary artery was exposed through an infraclavicular incision parallel to the clavicle. A six millimetre

supported PTFE graft was tunneled under the sternocleidomastoid muscle and over the clavicle and anastomosed.

In cases where previous stenting of the subclavian artery complicates any anastomosis involving the subclavian artery, carotid-axillary bypass is a good alternative.

### 3. Discussion and conclusion

Haemodynamically significant stenosis of the subclavian artery may present with symptoms of upper limb ischemia, subclavian steal syndrome or, more rarely, coronary steal syndrome. We have described four methods of restoring blood flow to the upper limb in cases of symptomatic subclavian artery stenosis. It is widely accepted that endovascular stenting of the subclavian artery should be first line treatment for this condition. Angioplasty can however, can cause intraluminal hyperplasia and the re-stenosis rates are higher than for extrathoracic surgical revascularisation [15]. Extrathoracic surgical revascularisation becomes necessary when endoluminal measures fail, or when anatomical variations make it more technically difficult.

Transposition of the subclavian artery onto the carotid artery is suitable if there is proximal stenosis of the subclavian artery, allowing for mobilisation of the subclavian artery distal to the stenosis. In the management of proximal subclavian artery stenosis it is safe and re-occlusion rates are low [16]. Re-occlusion rates are lower than those for carotid-subclavian artery bypass using a graft [17]. This technique has been used to treat subclavian steal due to a congenital aberrant right subclavian artery [18]. Another common reason for doing this operation is in preparation for stenting of thoracic aortic aneurysms, to reduce the risk of cerebral ischemia [19,20].

Carotid-subclavian artery bypass using a prosthetic graft is considered as a safe surgical intervention with mortality rates of 0–3% and stroke risk of 0–5% [21]. These rates are comparable with those for transposition of the subclavian artery onto the carotid artery [22]. A wide range of grafts may be used, including Dacron, autologous vein and PTFE. Takach et al. [23] have demonstrated the safety and effectiveness of carotid-subclavian bypass in their analysis of 287 patients treated for subclavian artery stenosis in this way. Carotid-subclavian bypass has also been used in repair of aberrant right subclavian artery aneurysm following endoluminal aortic stent graft exclusion [24].

<sup>1</sup> T.I. Barakat, L. Kenny, H. Khout, G. Timmons, V. Bhattacharya. Carotid axillary bypass in a patient with blocked subclavian stents: a case report. J. Med. Case Rep. 5 (June) (2011) 237.

Carotid-axillary bypass is less widely used than the other techniques. It has the advantage of avoiding the area of stenosis in cases where the subclavian artery has extensive disease and damage from previous angioplasty and stenting. It can be performed even with more distal disease in the subclavian artery.

It is important to consider the options available when considering surgical management of subclavian artery stenosis. In addition to atherosclerosis and damage from previous endovascular treatments, anatomical variations such as arteria lusoria may complicate surgical decisions. It is important for the surgeon to have a thorough understanding of the anatomy and aetiology while considering surgical options. This original case series demonstrates some of the treatment options available to vascular surgeons when managing symptomatic subclavian artery disease.

#### Conflicts of interest

None.

#### Funding

None.

#### Ethical approval

Not required.

#### Consent

All patients have provided written consent to be included in this article.

#### Author contribution

RS, JH and LJW collected data, performed a literature review and wrote the paper. TES, GT, AMM and VB performed the procedures. All authors reviewed final submission.

#### Guarantor

Vish Bhattacharya.

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