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Claviculectomy for exposure and redo repair of expanding, recurrent right subclavian aneurysm

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ABSTRACT

Subclavian artery aneurysms (SAAs) are rare, and their repair can be technically complex. We have reported the redo repair of a large, expanding, right SAA after primary repair consisting of total aortic arch replacement with bilateral subclavian artery ligation and bypass. The redo repair used claviculectomy to facilitate exposure, ligation of the right deep cervical and internal thoracic arteries from within the aneurysm sac, and revision of the previous axillary artery bypass that had thrombosed owing to the mass effect of the expanding SAA. Claviculectomy can facilitate repair of large SAAs that are poorly suited to more routine exposure approaches, with acceptable risk and functional outcomes. (J Vasc Surg Cases Innov Tech 2021;7:694-7.)

Keywords: Aneurysm; Claviculectomy; Connective tissue disorder; Subclavian artery aneurysm; Surgical technique

Subclavian artery aneurysms (SAAs) are uncommon, and surgical repair is usually performed using median sternotomy, posterolateral thoracotomy, or supraclavicular exposure.[1-3] We report a redo repair of a right SAA that had expanded to a diameter of 5.1 cm after primary repair, which consisted of total aortic arch replacement with bilateral subclavian artery ligation and bypass. For the redo repair, claviculectomy was used to facilitate exposure, branch ligation was performed from within the sac, and the previous ipsilateral bypass graft, which had thrombosed from the mass effect from the underlying SAA, was revised. The patient provided written informed consent for the report of his CASE.

CASE REPORT

A 50-year-old man had presented for outpatient evaluation of brachiocephalic and bilateral subclavian artery aneurysms. He had previously undergone emergency repair of an acute type A aortic dissection with aortic root replacement and mechanical aortic valve in another country. At that time, the bilateral SAAs had been identified but not repaired. In addition to bilateral SAAs, follow-up computed tomography angiography (CTA) also demonstrated chronic dissection with aneurysmal degeneration of the brachiocephalic artery, chronic bilateral common carotid artery dissections, chronic bilateral subclavian artery dissections, and chronic dissection of the descending thoracic aorta (Fig 1, *A*). The SAAs were visible and palpable on physical examination, and both measured 3.6 cm in diameter. He underwent total aortic arch replacement, brachiocephalic artery resection, bilateral carotid and subclavian artery bypass grafting, and transposition of the right carotid and bilateral vertebral arteries. Both subclavian arteries were ligated superiorly and inferiorly to the clavicle, and bilateral axillary artery bypass grafts were tunneled posteriorly to the clavicles.

At 3 months of follow-up, the patient reported right arm fatigue and right hand paresthesia during repetitive motion tasks, such as brushing his teeth, that resolved with rest. Repeat CTA demonstrated thrombosis of the right arch—axillary bypass graft and expansion of the previously ligated right SAA to a diameter of 3.8 cm. The ligated right SAA appeared to have ongoing pressurization through the deep cervical artery in a location that was not easily accessible for ligation. An arteriogram was performed with plans to attempt embolization but flow within the SAA was not identified nor was an opportunity for embolization through transfemoral or brachial access found. Interval CTA 1 month later demonstrated further expansion of the SAA to 5.1 cm (Fig 1, *B*).

Because of the ongoing risk of right SAA rupture, open surgical repair was recommended. Right claviculectomy was performed for exposure (Fig 2, *A*). An incision was made overlying the right clavicle, starting at the manubrium and extending toward the lateral aspect of the clavicle. Electrocautery was then used to divide the overlying platysma and its insertions, exposing the clavicle. Circumferential dissection in the body of the clavicle provided exposure and allowed for elevation. The clavicular—manubrial joint space was then exposed. Using electrocautery and sharp dissection with a periosteal elevator, the

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Fig 1. Computed tomography angiography (CTA) images before and after primary repair. Preoperative CTA three-dimensional reconstruction **(A)** and coronal maximum intensity projection image **(B)** demonstrating bilateral subclavian artery aneurysms (*asterisk*), in addition to aortic, innominate, and carotid artery dissections. **C,** Axial image from 1-year postoperative study showing thrombosed axillary artery bypass graft (*arrow*) anterior to the right subclavian artery aneurysm (*asterisk*) that had increased in diameter despite proximal and distal ligation.

joint space was exposed. The head of the clavicle was then circumferentially mobilized away from the manubrium. The underlying soft tissue and muscular attachments were mobilized, with electrocautery performed out to the lateral aspect of the clavicle. The clavicle was then divided laterally using an oscillating saw. Some bone wax was placed to minimize marrow bleeding. Hemostasis was then confirmed within the clavicular bed. After claviculectomy, the thrombosed bypass graft was exposed posterior to the resected clavicle, clamped proximally and distally, and resected to expose the underlying SAA, which had a palpable pulse. The distal right axillary artery and proximal right brachial artery were exposed through a separate longitudinal incision lateral to the right pectoralis major. A tunnel was then created from the brachial artery exposure to the claviculectomy wound. The ectatic deep cervical artery supplying retrograde flow to the aneurysm was identified and clamped. However, the SAA remained pulsatile, and no additional branches were visible externally owing to the size and mass effect of the aneurysm. Because the proximal right subclavian and innominate arteries had been divided and ligated at the previous arch replacement, and a more medial exposure would have required a redo (third) sternotomy, the aneurysm sac was opened without control of the internal thoracic artery. Pulsatile back bleeding was present from the right internal thoracic artery, and the branches were suture ligated from within the lumen. A Fogarty arterial embolectomy catheter (Edwards Life Sciences, Irvine, Calif) was used to perform successful thrombectomy of the thrombosed proximal bypass stump originating from the aortic arch graft. The previously tunneled Hemashield jump graft was then created from the proximal arch graft to the right brachial artery distally (Fig 2, *B*). The ipsilateral brachial, radial, and ulnar pulses were palpable after clamp removal.

Anticoagulation therapy was resumed on postoperative day 1, and the patient underwent elective claviculectomy wound reexploration on postoperative day 5 because of concerns for possible hematoma or seroma. However, no fluid collection was identified. His postoperative course was otherwise unremarkable, and he was discharged after a 7-day hospital stay.

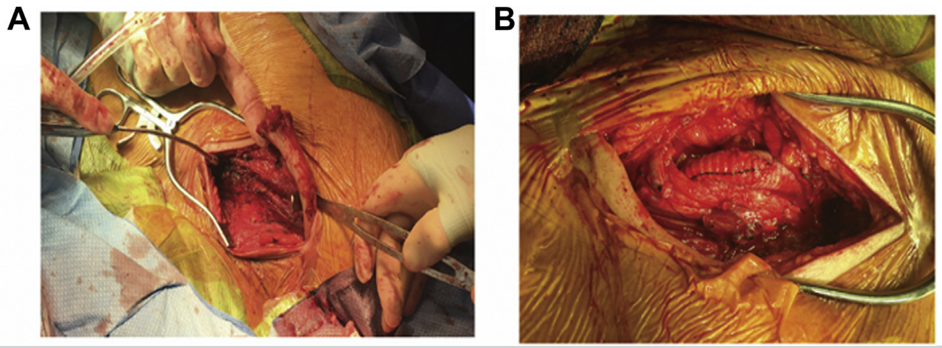

Fig 2. Claviculectomy performed via transverse incision overlying and parallel to the right clavicle. **A,** Patient's head is to the right of the image. **B,** After aneurysmectomy and graft revision, the revised graft was visible within wound before closure. The clavicle was neither replaced nor repaired.

At 1 month of follow-up, he reported complete resolution of his upper extremity symptoms and was cleared for unrestricted physical therapy. At that time, he had symmetric brachial artery blood pressures, normal pulses, and normal upper extremity arterial Doppler ultrasound findings.

DISCUSSION

SAAs are uncommon, accounting for 0.13% to 0.5% of aneurysms overall.[4,5] Because evidence is inadequate to support a diameter cutpoint for SAA observation vs repair, the repair of any SAA has generally been recommended for suitable risk patients.[3,4] The median reported SAA diameter at presentation has been ∼4 cm. Larger aneurysms >5 cm are rare, with evidence to support their management limited to a few CASE reports.[3-6] Associated etiologies include trauma, atherosclerosis, thoracic outlet syndrome, iatrogenic, and infections, including syphilis and human immunodeficiency virus.[3] Less common causes include Ehlers-Danlos syndrome, Marfan syndrome, and Turner syndrome.[5,7] Although most SAAs will be identified as incidental imaging findings, local compression can also cause symptoms,[3,8] including brachial plexopathy, Horner syndrome, hoarseness, dysphagia, hemoptysis, chest pain, effort fatigue, and thrombosis or embolization.[5,9,10] The diameter does not correlate with the risk of SAA rupture, and ruptures of proximal and middle segment SAAs have been most commonly reported.[2,3,10,11] Emergent repair has been associated with a 13% mortality rate compared with 3% for elective repair. Given this difference and the potential for both rupture and thromboembolism, elective repair should be recommended for suitable risk candidates.[3,11]

Open, endovascular, and hybrid approaches to treat SAA have had similar reported morbidity and mortality rates.[1,3,12,13] In one review of 381 SAA repairs, the overall complication rates were 27% for open repair, 25% for endovascular repair, and 20% for hybrid repair. The most frequently observed complications were postoperative thrombosis and cardiopulmonary events.[3] Exposure for surgical SAA repair depends on the laterality and the intra-vs extrathoracic extent.[1] On the right, intrathoracic exposure will usually be achieved through median sternotomy.[1] In contrast, on the left, posterolateral thoracotomy will usually be the approach.[2,9,10]

Extrathoracic and middle segment SAAs can be repaired using a supraclavicular incision, with or without infraclavicular exposure.[1,3,10] Claviculectomy has seldom been used for vascular reconstruction; however, it is a well-described treatment of sternoclavicular joint conditions, including osteomyelitis, tumors, arthritis, fractures, and dislocations. No absolute contraindications exist for claviculectomy, and most patients will maintain a full range of motion without a significant loss of strength and will have acceptable cosmetic outcomes.[14,15] The risk of shoulder instability from claviculectomy is low if the superior acromioclavicular ligament, trapezoid coracoclavicular ligament, and the deltotrapezial fascia are respected with careful surgical technique. However, instability can occur and could restrict a patient's weight-bearing ability. Although clavicle reconstruction with an autograft tendon, an allograft tendon, and prostheses can theoretically provide more shoulder stability and better cosmesis, reconstruction has remained controversial with recent evidence supporting no differences in functional outcomes, including global limb function, mobility, and patient satisfaction.[14,16,17] Claviculectomy for vascular exposure has been previously reported for trauma,[15] venous thrombosis,[14] and venous stenosis,[18] with almost all patients returning to their preoperative functional levels. To the best of our knowledge, only one other CASE report has described the use of claviculectomy for elective SAA repair. Singh et al[6] combined claviculectomy with trapdoor thoracotomy for a SAA that was >8 cm in diameter.

The SAA described in the present report measured 5.1 cm and involved the middle segment of the subclavian artery. This location is often the site of SAAs associated with connective tissue disorders, which, in turn, increases the risk of rupture.[3,10] Although a connective tissue disorder was suspected in our patient, genetic testing did not identify any mutations known to be associated with aneurysmal or connective tissue disease.

CONCLUSIONS

SAAs are uncommon and can result from a variety of etiologies. Claviculectomy can facilitate the repair of large SAAs poorly suited to more routine exposure approaches, with acceptable risk and functional outcomes.

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