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Supra-Aortic Trunk Atherosclerosis Presenting as Bilateral Upper Extremity Numbness and Falls

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Background	Traditional surgical therapy for supra-aortic trunk vessel stenosis is through open surgical transthoracic repair, and endovascular therapy is limited by stent fracture and re-stenosis.
Summary	A woman in her midfifties presented with bilateral upper extremity numbness and vertebrobasilar insufficiency manifested by frequent drop attacks. She was found to have extensive supra-aortic trunk vessel and aortic arch atherosclerosis. She was treated with an ascending aorta to right subclavian and right common carotid artery bypass, right carotid to left carotid artery bypass, and concomitant coronary artery bypass grafting. At a later date, she also underwent a staged left carotid to subclavian bypass. She enjoys full resolution of her symptoms.
Conclusion	Atherosclerosis is the leading cause of death and disability in the United States. Since there are many manifestations of atherosclerosis, best medical therapy is with risk factor optimization and operative adaptations. We discuss surgical supra-aortic trunk revascularization and the strategy of providing cerebral and upper extremity reperfusion through this case report
Keywords	Supra-aortic trunk, ischemia, revascularization, carotid, subclavian, atherosclerosis

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Case Description

Atherosclerosis is the leading cause of death and disability in the United States and is most commonly implicated in coronary artery disease and cerebral infarction.[1] However, other manifestations of atherosclerosis include arterial aneurysms and peripheral artery occlusive disease with symptoms of ischemia related to any affected vascular bed. Best medical therapy is with risk factor optimization and treatment with statin and antiplatelet medications. Current surgical therapy includes balloon angioplasty and stenting, endarterectomy, and surgical bypass grafting.

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A woman in her midfifties presented to the vascular surgery clinic with several months of bilateral upper extremity numbness and weakness with activity. She also experienced frequent drop attacks consistent with vertebrobasilar insufficiency and had a heavy smoking history. She had no neck pain, no neck stiffness, and no laboratory signs of systemic inflammation. Her medical history was significant for coronary artery disease requiring two prior coronary stents, atrial fibrillation, and hypertension. Physical examination revealed cool hands, bilateral upper extremity hypotension, and the absence of upper extremity arterial pulses without evidence of ischemic tissue loss or neurological deficits. There were no abnormalities on laboratory examination. Carotid duplex ultrasound revealed no visible plaque and no evidence of intimal flap or dissection. At this point, the differential diagnosis included thromboangiitis obliterans, atherosclerosis of the supra-aortic trunks, giant cell arteritis, and cervical degenerative disk disease. Computed tomography angiogram revealed high grade stenosis of the brachiocephalic artery, bilateral proximal common carotid arteries, and proximal and distal left subclavian artery; a large dominant left vertebral artery; and an occluded right vertebral artery. Subsequent catheter-based angiography confirmed these findings and revealed significant coronary artery disease as well (figure 1). At the time of catheter based angiography, central blood pressure measured in the thoracic aorta was 168/58.

Given the patient's history as a middle-aged woman with a history of smoking with upper extremity exercise-induced fatigue, vertebrobasilar symptoms, and absent upper extremity arterial pulses, she was diagnosed with atherosclerosis of the coronary arteries and supra-aortic trunk vessels resulting in chronic upper extremity ischemia and cerebrovascular malperfusion resulting in vertebrobasilar insufficiency.

Despite smoking cessation, risk factor modification, and best medical therapy with statin and antiplatelet medication, our patient had persistent symptoms. She underwent an ascending aorta to right subclavian and right common carotid artery bypass with a 16 x 8 mm bifurcated Dacron graft, and right common carotid artery graft to left common carotid artery bypass through a median sternotomy. Concurrently, she underwent a two-vessel coronary artery bypass grafting with saphenous vein grafts, and a CryoMaze procedure for treatment of her concomitant coronary artery disease and atrial fibrillation, respectively (figure 2).

Perfusion to the brain during the cerebrovascular reconstruction was achieved with retrograde cannulation of the left axillary artery to provide flow to the dominant patent left vertebral artery. Postoperatively, while in cardiac rehabilitation, the patient experienced repeated vertebrobasilar symptoms, likely due to her residual left subclavian artery stenosis proximal to her dominant left vertebral artery resulting in posterior cerebral circulation ischemia. The patient returned several weeks later for a planned supraclavicular approach left carotid to subclavian artery bypass grafting with an 8 mm PTFE graft after her cardiac rehabilitation was completed. She currently enjoys full resolution of her symptoms, her atrial fibrillation is treated, and she no longer requires anticoagulation for thromboembolism prophylaxis.

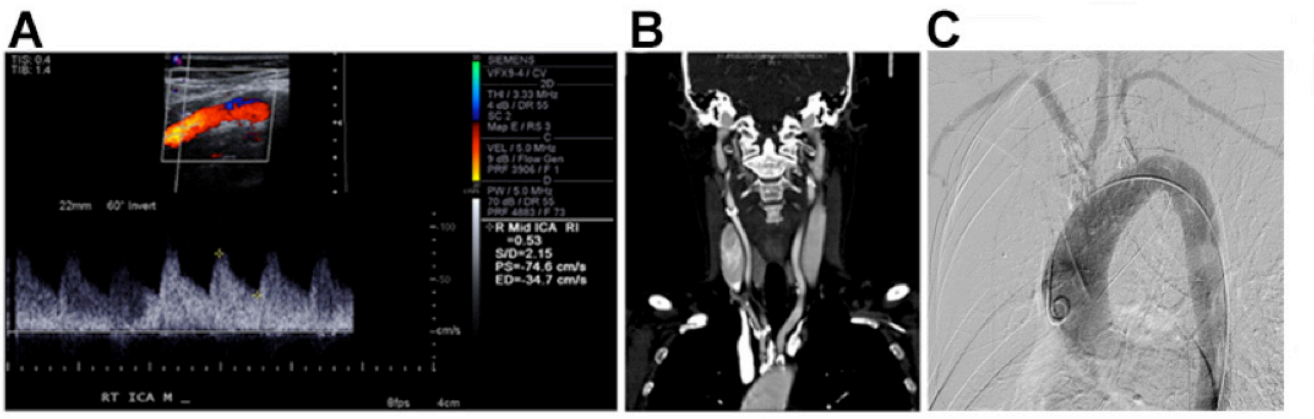

Figure 1. This patient's carotid artery duplex ultrasound (A) showing normal carotid artery waveforms and velocities, (B) computed tomography angiogram showing supra-aortic trunk vessel lesions, and (C) aortic arch angiography with heavy atherosclerotic burden in the supra-aortic trunk vessels.

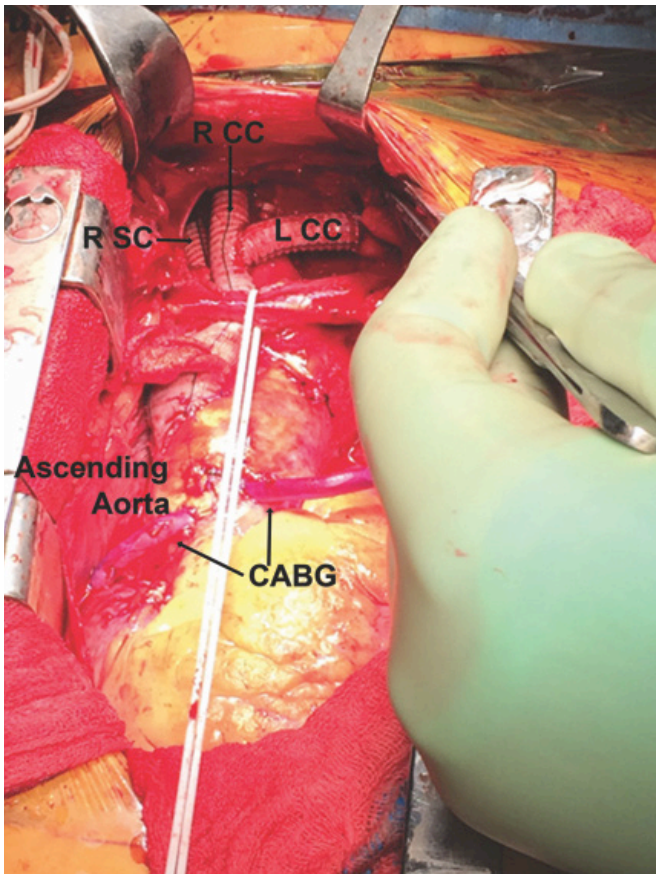

Figure 2. Intraoperative image of a bifurcated ascending aorta to right subclavian and right common carotid artery bypass (under the preserved innominate vein retracted and marked by white vessel loop), right to left common carotid artery bypass, and two ascending aorta-coronary artery saphenous vein grafts. R SC: right subclavian artery graft, R CC: right common carotid artery graft, L CC: left common carotid artery graft, CABG: saphenous vein coronary artery bypass grafts.

Discussion

Traditional surgical therapy for supra-aortic trunk vessel stenosis involves open surgical transthoracic repair, traditionally through median sternotomy.[2-4] Methods include endarterectomy and aorta to innominate/common carotid/subclavian artery bypass.[5] Indications for revascularization are atherosclerotic occlusive disease and inflammatory arteritides. Median sternotomy provides easy access to the brachiocephalic artery, right subclavian artery, and bilateral common carotid arteries. Configuration of direct repair depends on the diseased vessel(s) involved. Through a median sternotomy, the right subclavian and bilateral common carotid arteries can be revascularized. Left subclavian artery access can be gained by left anterior thoracotomy. To reduce morbidity and mortality associated with transthoracic repair, extra-anatomic revascularization such as carotid-subclavian bypass, carotid-subclavian transposition, and carotid-carotid bypass were later championed with improved results.[6,7] Combined patency of supra-aortic trunk endarterectomy and anatomic or extra-anatomic bypass surgery has been reported as high as 91% at 10 years, and 89% at 15 years.[8]

Endovascular therapy for atherosclerotic supra-aortic trunk disease was initially met with enthusiasm due to significantly decreased mortality compared to open surgery.[9,10] Although endovascular recanalization of chronically occluded great vessels is possible, it requires significant endovascular expertise. Some authors advocate for multiple arterial access points for use of distal embolic protection devices. Due to the degree of calcification in occlusive lesions, the initial failure rate of endovascular therapy for occlusive lesions has been reported as high as 50%—80%.[11, 12] Furthermore, compared to extra-anatomic bypass, angioplasty and stenting has poorer long-term patency (97% at five years vs. 82% at four years).[13] In a contemporary series of 114 patients, van de Weijer and colleagues[14] reported treating symptomatic patients with aortic arch branch disease. While they reported over 90% technical success and survival after two years, they also reported 19 patients who developed symptoms of restenosis at the target vessel and eight patients who developed contralateral stenosis who required re-intervention. Direct comparison by Takach and colleagues of surgical vs. endovascular revascularization of single brachiocephalic vessel disease corroborated these results. In 391 patients at five years postprocedure, freedom from failure rate was 92.7% in the surgical group and 83.9% in the endovascular group.[15] Finally, there is evidence of mid- to long-term restenosis attributed to stent fatigue and fracture, particularly in the presence of significant calcification of the atherosclerotic plaque.[16] Therefore, in spite of the initial appeal of minimally invasive catheter-based therapy, endovascular supra-aortic trunk repair with balloon angioplasty and stenting has fallen out of favor.

There are no consensus guidelines pertaining to endovascular vs. open repair of the supra-aortic trunk vessels. Although long-term patency is superior for surgical revascularization, endovascular therapy minimizes perioperative morbidity related to sternotomy and expedites postprocedural recovery. Therefore, supra-aortic trunk revascularization must be tailored to individual patients' circumstances, operator skill and preference, and institutional capabilities. While planning for open repair, multidisciplinary collaboration maximizes treatment potential. In this case, supra-aortic trunk revascularization, coronary revascularization, and CryoMaze for atrial fibrillation were

all accomplished expeditiously through a single median sternotomy. Since the patient's stroke risk was mitigated from the first procedure, left arm revascularization was staged to minimize operative time and expedite cardiac recovery. When cardiac rehabilitation was completed and the patient had recovered from her initial operation, she returned for left carotid-subclavian bypass through a standard supraclavicular approach. She now enjoys full resolution of her symptoms.

Conclusion

Atherosclerosis is the leading cause of death and disability in the United States. Since there are many manifestations of atherosclerosis, the best medical therapy is with risk factor optimization and operative adaptations.

Lessons Learned

Although long-term patency is superior for surgical revascularization, endovascular therapy minimizes perioperative morbidity related to sternotomy and expedites postprocedural recovery. Supra-aortic trunk revascularization must be tailored to individual patients' circumstances, operator skill and preference, and institutional capabilities.

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