

A Look at Proximal Subclavian Artery Occlusive Disease

A review of treatment options.

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Proximal subclavian artery occlusive disease is a fairly common, usually asymptomatic, phenomenon.¹ When patients become symptomatic, they can present with subclavian steal syndrome, or after coronary artery bypass grafting (CABG), coronary subclavian steal syndrome. Both syndromes share similar pathophysiology, diagnostic criteria, and management. The presentation of subclavian steal versus coronary subclavian steal varies noticeably. In classic subclavian steal, patients can exhibit symptoms of posterior cerebral ischemia, such as syncope, ataxia, vertigo, and/or dizziness.²⁻⁵ Patients may also present with signs and symptoms of upper extremity ischemia including claudication, rest pain, or tissue loss.^{3,5} Patients experiencing coronary subclavian steal might present with symptoms of cardiac ischemia such as chest pain or demonstrate ischemic changes during stress testing in the region of the heart supplied by the internal mammary artery (IMA).⁶ These patients may also demonstrate the symptoms of upper extremity ischemia that were previously mentioned.

CASE REPORT

An 87-year-old woman initially presented to the hospital with symptoms of nausea and left shoulder pain. The patient's medical history was significant for hypertension, hyperlipidemia, peripheral arterial disease (PAD), and insulin-dependent diabetes mellitus. The patient was found to have a non-ST elevated myocardial infarction. Upon further workup, cardiac catheterization demonstrated significant triple-vessel disease (Figures 1 and 2). The patient underwent CABG surgery with a left IMA to left anterior descending artery, a saphenous vein to first obtuse marginal artery, and a saphenous vein to posterior descending artery anastomoses. The patient had a fairly uncomplicated postoperative course.

One year after surgery, the patient presented to the hospital after a witnessed syncopal episode. The syncope workup included a carotid duplex ultrasound, which showed 60% to 79% stenosis of the right common carotid artery, 80% to 89% stenosis of the left common

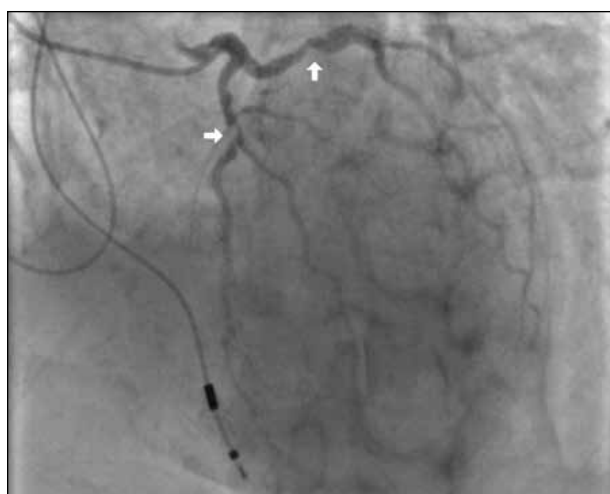


Figure 1. Stenoses of the left anterior descending (left arrow) and circumflex (right arrow) arteries.



Figure 2. Stenosis of the right coronary artery.



Figure 3. Patent left IMA graft with reversal of flow.

carotid artery, and reversal of flow in the left vertebral artery. The patient was scheduled for a carotid endarterectomy. In order to gain cardiac clearance for surgery, the patient underwent a persantine thallium stress test that was positive for reversible, anterolateral myocardial ischemia. This finding led to further investigation with cardiac catheterization. The left IMA graft was patent, but there was reversal of flow (Figure 3). There was 90% to 95% stenosis of the ostium and proximal portion of the left subclavian artery (Figure 4).

The subclavian artery stenosis was addressed with balloon angioplasty, placement of a 9- X 19-mm balloon-expandable stent in the proximal left subclavian artery, and placement of an 8- X 18-mm stent distally, overlapping the first stent (Figure 5). A repeat carotid duplex revealed antegrade flow in the left vertebral artery. Four days later, the left carotid artery was stented with an 8- X 10-mm X 40-mm self-expanding stent.

DISCUSSION

The pathophysiology of subclavian steal syndrome is severe stenosis or occlusion of the proximal subclavian artery, leading to retrograde flow through the vertebral artery.² Coronary subclavian steal syndrome is a similar phenomenon occurring in patients after CABG, utilizing an in situ left or right IMA.⁶ Patients may have unrecognized, severe, proximal subclavian artery stenosis or occlusion before CABG. This results in reversal of blood flow through the IMA graft.

Screening

Patients can be screened for proximal subclavian artery occlusive disease by comparing the systolic blood pressures of both upper extremities. A pressure differ-

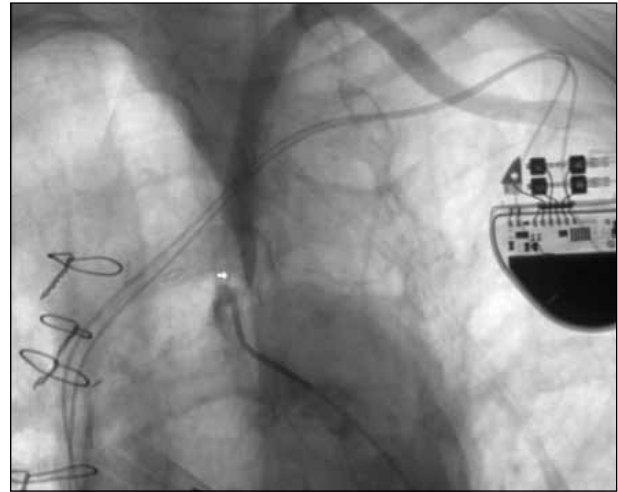


Figure 4. Stenosis of the ostium and proximal left subclavian artery.

ence of > 20 mm Hg supports subclavian occlusive disease.^{1,2} Duplex ultrasound or arteriography of the vertebral artery help establish the diagnosis by showing reversal of flow.¹⁻³ CTA and MRA can also be useful in demonstrating subclavian stenosis or occlusion.

In an attempt to prevent coronary subclavian steal, some interventionists have proposed more invasive testing for diagnosing subclavian stenosis or occlusion. A review conducted by Tackach et al⁶ found that several institutions screen the proximal subclavian artery in all patients undergoing angiography of the coronary arteries. This has led to the identification of several patients with great vessel disease before elective CABG. Rogers and colleagues³ point out arguments against routine screening, because selective angiography of the subclavian artery is not entirely benign. Complications such as transient ischemic attack and upper extremity embolism can occur with an incidence of 0% to 1.7%.³

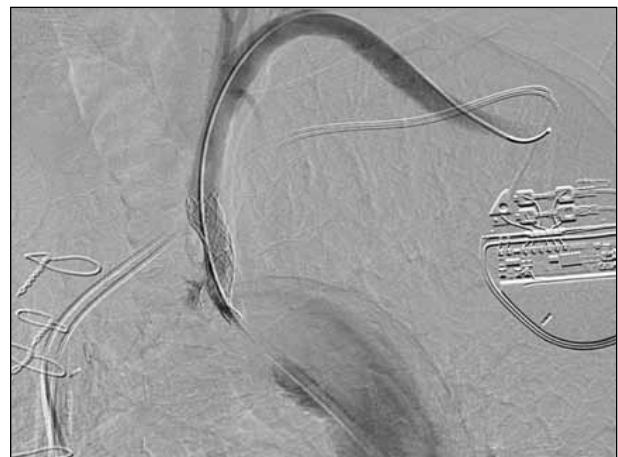


Figure 5. The left subclavian artery after placement of a balloon-expandable stent.

Certain patient populations are at increased risk for subclavian artery stenosis or occlusion and may benefit from screening of the proximal subclavian artery. Patients with a history of PAD are especially at risk for coronary subclavian steal syndrome. Gutierrez et al⁷ found that patients with clinical evidence of PAD have higher rates of subclavian artery stenosis, ranging from 11.8% to 18.7%. Another study found that the risk factor profile for symptomatic subclavian occlusive disease is similar to patients with general atherosclerotic disease. These factors include history of tobacco abuse, hypertension, diabetes mellitus, hyperlipidemia, and metabolic syndrome.⁵

Treatment Options

Several treatment options are available for symptomatic proximal subclavian artery disease. The most commonly performed procedures include percutaneous transluminal angioplasty (PTA) with or without stenting of the subclavian artery, carotid subclavian artery bypass graft, subclavian carotid artery transposition, and axillo-axillary artery bypass graft placement.

PTA. PTA with or without stenting of the subclavian artery has become the treatment of choice for symptomatic subclavian artery occlusive disease. The technique described by Rodriguez-Lopez et al⁸ involves placing the patient under general or local anesthesia. A femoral or brachial artery approach is then used to gain access to the subclavian artery. A 6- or 7-F sheath is placed, and fluoroscopic guidance is used to visualize the passage of wires toward the subclavian artery. The subclavian lesion is eventually crossed with an angled hydrophilic wire. The lesion is then dilated with an angioplasty balloon. In some cases, this is followed by deployment of a balloon-expandable stent.

A study conducted by Palchik et al⁵ found that the number of endoluminal interventions performed for symptomatic subclavian stenosis has increased in the last 9 years, especially interventions for a cardiac indication. The initial technical or procedural success rates range between 93% to 96%.⁸⁻¹¹ Short-term patency rates range between 92% to 96%.^{8,9} The intermediate to long-term patency rates range between 80% to 90%.^{5,10,11} Advantages of PTA include less invasiveness and fewer procedural complications resulting in less morbidity and mortality in comparison to open surgical methods. The primary concern of this procedure is restenosis, with reported rates of 6% to 21%.^{3,9,11} Occlusive lesions that cannot be crossed with a guidewire are another concern. These lesions may require treatment with an open surgical procedure. Interestingly, de Vries et al¹¹ found that occlusive disease is not associated with an increase in restenosis rates. Their study looking at the long-term results of

PTA for obstructive lesions of the proximal subclavian artery found that none of the patients with successfully recanalized occlusions restenosed. Other reported complications of PTA include major and minor stroke, amaurosis fugax, inguinal hematoma, and upper limb artery occlusion.^{10,11}

Carotid subclavian artery bypass graft. For patients who are not amenable to endoluminal intervention, placement of a carotid subclavian artery bypass graft is the procedure of choice. Paty et al¹² describe an anterior supraclavicular incision, which provides exposure to the common carotid and subclavian arteries. Occasionally, division of the clavicular head of the sternocleidomastoid (SCM) muscle is necessary to provide sufficient exposure of the common carotid artery. The anterior scalene muscle is divided at the inferior aspect. The subclavian artery is identified, usually distal to the IMA and medial to the brachial plexus. The common carotid artery is dissected out through the same incision upon entry into the carotid sheath. Patients with concomitant significant carotid disease may require additional cephalad exposure of the common carotid artery for carotid endarterectomy. In these cases, the incision is extended superiorly along the lateral border of the SCM. After exposure of the arteries and a bolus dose of heparin, a prosthetic graft is sewn to the carotid or subclavian artery and passed underneath the SCM, posterior to the internal jugular vein. The final step is creation of the remaining anastomosis.

This surgery was the procedure of choice for treating patients with symptomatic proximal subclavian artery disease until the advent of percutaneous intervention. Some interventionists argue that a carotid subclavian bypass is superior to percutaneous intervention and should continue to be the procedure of choice for symptomatic proximal subclavian stenosis or occlusion because of significantly decreased restenosis rates and considerably low perioperative complications.⁴ AbuRahma et al⁴ report 100%, 98%, 96%, and 92% primary patency rates for carotid subclavian bypass at 1, 3, 5, and 10 years, respectively. Having two anastomoses, which may result in decreased graft patency rates, is a disadvantage of the procedure. Also, the surgery is technically difficult with a risk of damaging critical structures such as the phrenic nerve and thoracic duct. Cranial nerve injury is another observed complication of this surgery.⁵

Carotid axillary bypass. Carotid axillary bypass is an interesting modification of the carotid subclavian bypass, which was proposed by Criado et al.¹³ The procedure is similar to the carotid subclavian bypass, but the axillary artery is anastomosed instead. The benefit of this procedure is an infraclavicular incision to expose the axillary artery, thus avoiding critical structures such

as the phrenic nerve and lymphatics that overlay the proximal subclavian artery. The carotid artery is exposed with another incision anterior to the SCM. The operation is thought to be more technically feasible than the traditional carotid subclavian bypass. This procedure also has two anastomoses and similar patency rates to the carotid subclavian bypass surgery.

Subclavian-to-carotid artery transposition. Subclavian-to-carotid artery transposition is another option for when percutaneous treatment is not possible. Cina et al¹⁴ describe the procedure as first making a transverse supraclavicular incision, then mobilizing and isolating the phrenic nerve, followed by transecting the anterior scalene muscle. The subclavian artery and its branches are dissected, followed by identification and division of the thoracic duct on the left and the lymphatic trunk on the right. This helps with mobilization and retraction of the jugular vein. The subclavian artery is then transected as proximal as possible. The proximal stump is oversewn with running sutures, then horizontal mattress sutures reinforced with pledgets. Subsequently, the subclavian artery is anastomosed to the carotid artery in an end-side fashion.

The procedure has the greatest long-term durability of all the treatments for proximal subclavian artery occlusive disease. Other advantages include exclusion of the diseased subclavian artery and no need for the use of a prosthetic graft, avoiding its associated complications. The disadvantage of this procedure is the technical difficulty compared to other surgical procedures for symptomatic proximal subclavian disease.^{12,14} Incidentally, the rates of nerve injuries, hematomas, and lymphatic leaks have been found to be similar for subclavian to carotid artery transposition and carotid subclavian bypass graft surgery.¹⁴

Axillo-axillary artery bypass surgery. Axillo-axillary artery bypass surgery is another option for treating patients with symptomatic proximal subclavian artery occlusive disease. Chang et al¹⁵ make transverse bilateral supraclavicular incisions, splitting the fibers of the pectoralis major muscle and then laterally retract the pectoralis minor muscle to expose the axillary arteries. A prosthetic graft is tunneled over the sternum from axillary artery to axillary artery. Anastomoses between the graft and the arteries are usually fashioned in an end-to-side fashion.

This procedure is associated with the lowest patency rates, ranging from 88% to 89%.¹⁵ It also prevents future CABG, as the graft runs over the sternum. The graft would need to be ligated before performing any surgery requiring a sternotomy. This procedure can be performed under local anesthesia, so it is mainly indicated for patients with coexisting severe disease who cannot tolerate general anesthesia. The procedure is also indicated for patients with severe carotid artery disease in

which manipulation of the carotid artery may lead to a thromboembolic event.¹⁵

CONCLUSION

Proximal subclavian artery occlusive disease can be easily diagnosed in a noninvasive manner. Screening is proposed for certain patient populations in which subclavian artery stenosis or occlusion may increase morbidity, primarily patients with PAD who will undergo CABG. There are several management options for those with symptomatic subclavian artery disease. Endoluminal intervention has quickly become the mainstay treatment. The advantages of PTA with or without stenting include being least invasive, decreased hospital stay, and high initial patency rates. The disadvantages are higher restenosis rates compared to open surgical repair and occasionally an inability to access a completely occluded proximal subclavian artery. In these cases, open procedures, such as carotid subclavian artery bypass, subclavian-to-carotid artery transposition, and axillo-axillary artery bypass, are great alternatives, promising high patency rates and low perioperative complications when performed by experienced operators. ■

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