Subclavian and Vertebral Occlusive Disease

An overview of the clinical syndromes and therapeutic strategies.

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With few exceptions, most of the occlusive disease involving the great vessels off of the aortic arch is no longer considered a surgical disease. For example, both the right and left subclavian arteries, left common carotid origin, the innominate origin, and the proximal divisions of the right and left vertebral arteries are all quite amenable to endovascular stenting. There are, however, a few exceptions. Occasionally, aneurysmal disease and certain occlusions cannot be recanalized and are best managed by surgical reconstruction.

CLINICAL SYNDROMES

Subclavian stenosis can be responsible for vertebrobasilar insufficiency. The symptoms are quite variable, but may include ataxia, diplopia, syncope, vertigo, and dizziness. Occasionally, upper-extremity ischemia may exist (Figure 1), especially if a pressure gradient across the target lesion stenotic site is greater than 20 mm Hg. Ischemic changes also may occur from atheroembolic events occurring secondary to the subclavian occlusive disease. An additional syndrome associated with proximal left subclavian artery stenosis may exist in patients who have had aortocoronary bypass procedures, which may include the left internal mammary artery graft to the left anterior descending coronary artery. In these situations, flow reversal may occur from the native coronary artery to the internal mammary conduit and re-establish flow in the left subclavian. This obviously results in a shunt from the coronary circulation with visible reversible ischemic changes noted during the radionuclide stress examination.

After correction of the subclavian stenosis and re-establishment of antegrade flow in the left inferior mesenteric artery (LIMA), the radionuclide stress examination returns to normal distribution. One additional indication for subclavian artery endovascular stenting is in patients with functioning hemodialysis grafts that have impaired flow resulting from subclavian artery occlusive disease. Consequently, vertebrobasilar insufficiency, upper-extremity ischemia, coronary artery steal syndrome, and stenosis proximal to the hemodialysis graft are all firm indications for endovascular intervention.

TECHNIQUES

Although subclavian stenosis is quite common, in 6,534 patients evaluated in the joint study for extracranial occlusive disease by Perler and Williams,[1] only 17% were noted to have a stenosis ≥30%. Of those same patients, only 24% had clinical and angiographic evidence of subclavian steal.[1]

Access to the subclavian artery for interventional methods can be from either a femoral or a brachial artery approach. Total occlusions frequently are best managed

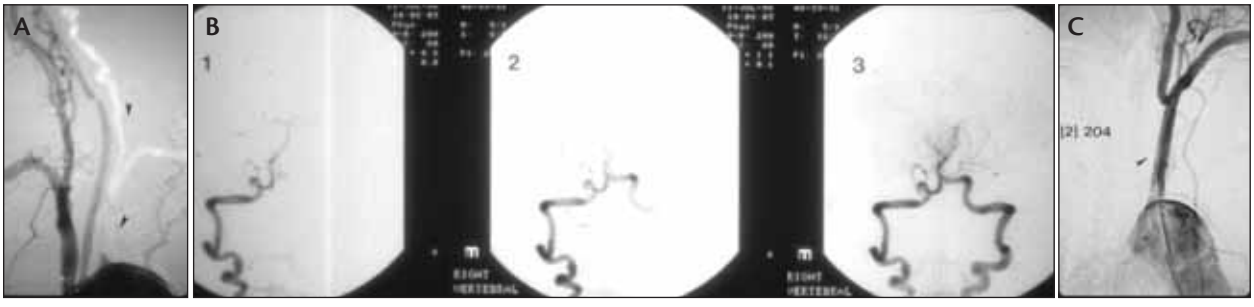

Figure 1. Total occlusion of the left subclavian artery with visible retrograde flow from the left vertebral to reconstitute the subclavian (A). Dynamic study showing the shunt reversal from the right vertebral to the left vertebral (B). Re-establishment of antegrade flow in the vertebral and the subclavian after effective stenting of the totally occluded segment (C).

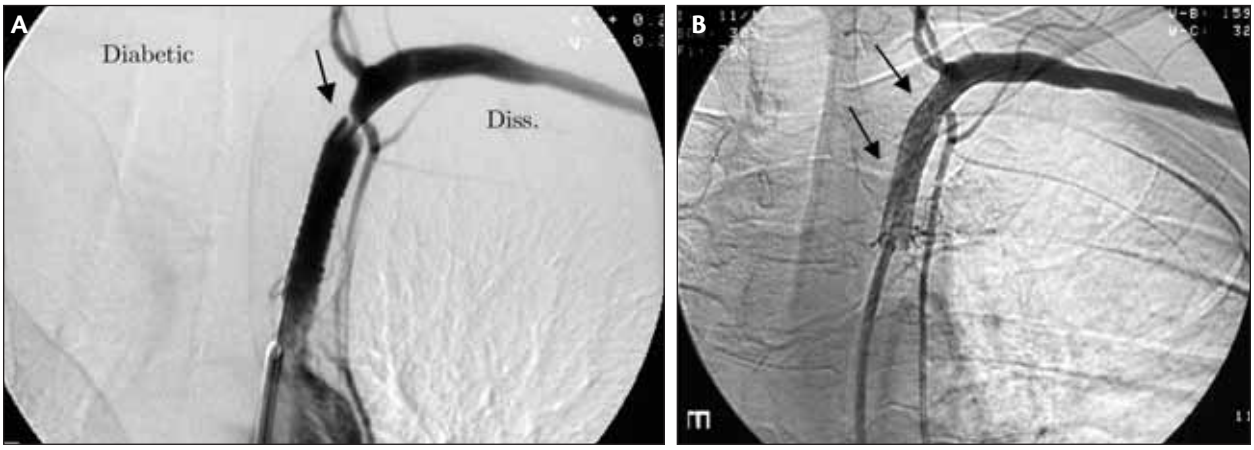

Figure 2. Subclavian stenosis with stenting in a diabetic patient that resulted in edge dissection just proximal to the origin of the internal mammary (A). Precise positioning of a stent at the dissection site resulted in improved flow with correction of the dissection. Note: the internal mammary is preserved along with the left vertebral artery (B).

from the brachial approach because the linear force and direction of the catheter and wires are more easily accomplished from the brachial versus the femoral approach. For simple stenotic lesions, however, the femoral approach is quite satisfactory and is acceptable in most indications. The technique presently used for achieving access from the femoral approach is selective catheterization of the subclavian artery with a 5-F diagnostic catheter ordinarily passed over a steerable .035-inch wire. The catheter is subsequently removed, and an 8-F guide or 6-F sheath is positioned at the ostium, which is followed by predilatation ordinarily done with a 6-mm to 7-mm angioplasty balloon, and then positioning of a balloon-expandable stent at the target lesion site.

For most subclavian lesions involving the first and second portions of the subclavian artery, balloon-expandable stents are the appropriate choice. However, the third portion of the subclavian, however, and the axillary may be best managed with a self-expanding stent because these stents are exposed to external pressure. Ostial lesions, however, are best managed with balloon-expandable stents because the positioning is more precise than with self-expanding stents.

Endovascular management of the aortic arch vessels requires careful manipulation of the catheters in the arch because the atherosclerotic arch has the potential for embolic events to occur when there is excessive manipulation. The aortic arch is its own independent stroke risk factor. Again, a .035-inch steerable wire is utilized at the origin of the great vessels because kinking of the guide catheter or sheath can occur when there is an acute angulation at the origin of the innominate or left common carotid. Frequently, the left common carotid has an almost horizontal origin in a bovine configuration that results in a complex curve as the guiding catheter or sheath approaches the entrance site.

After positioning the guide or sheath at the ostium, the predilatation balloon is positioned at the target lesion site and expanded for 30 seconds. The stent is then positioned under fluoroscopic guidance and expanded to 8 mm or 10 mm in diameter. More recently, with the introduction of distal protection devices, we have been utilizing a protection filter positioned in the internal carotid during common carotid artery procedures. In stenting the subclavian, caution is recommended to avoid unnecessary covering of either the vertebral or internal mammary artery by the stent. In managing ostial vertebral lesions, balloon-mounted stents are also the stent of choice. These stents are ordinarily expanded to 4 mm or 5 mm in diameter and are 1 cm to 1.5 cm in length. If the occlusive disease extends to the axillary, or certainly to the brachial artery, a self-expanding stent would be preferable.

DATA REVIEW

In a review of subclavian interventions prior to 1989, most of the procedures were done with primary angioplasty. The technical success rate varied from 88% to 100%. However, restenosis rates with primary angioplasty alone were quite high and, in our own personal experience, approach 12%, with a 4% procedural complication event rate.[2] The overall evaluation of 423 patients in a review of four centers demonstrated a technical success rate of 92%, with a relatively high restenosis rate of 19% and a complication rate of 5%.[3] In a review of seven centers for procedures done after 1989, the technical success rate was 93% to 100%, with restenosis rates in the 5% to 8% range and with complications described in only 2%. In a series of 113 patients with subclavian artery stenosis and occlusions followed by Henry et al,[4] a primary and secondary assisted patency of 69% and

75%, respectively, was described for angioplasty alone, whereas primary and secondary assisted patency of stenting was 87% and 94%, respectively. The technical success for stenting for stenotic lesions was 96%, with complications described in 2.6% and a restenosis rate at 4 years of 8%. However, the technical success in total occlusions was only 57%.[5]

In the multicenter registry of 258 patients in six centers described by Silva et al,[5] overall technical success was 97%, with 89% success in total occlusions and 98% success in stenotic lesions. Eighty-two percent of the lesions did represent stenosis, whereas only 18% represented total occlusions. The overall complication rate was 3.1%. Peripheral emboli occurred in 1.1%, with transient ischemic attacks (TIAs) in .4% and brachial artery thrombosis in .4%. In the series described by Jain et al,[3] which included the left subclavian, the right subclavian, and the innominate arteries, 86% of the lesions occurred in the left subclavian artery. In a series of 484 patients with subclavian artery and great vessel occlusive disease described by Jaeger et al,[6] a .6% incidence of TIA was described and probably was provoked by aortic manipulations. Generally, the risk of embolic events from the great vessels has been quite low.

DISCUSSION

Subclavian artery total occlusions, obviously from the data being presented, have a much lower technical success rate than stenotic lesions. A review of the literature demonstrates success rates varying from 53% to 76%. Rodriquez-Lopez et al[7] from the Arizona Heart Institute described a series of 17 patients with occluded subclavians and a 94% technical success. Our experiences at the Pittsburgh Vascular Institute with total occlusions describe a technical success rate of approximately 75%.[2]

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When dissection occurs during stent deployment, it may require an additional overlapping stent. If possible, it is best not to cover either the vertebral or internal mammary artery. If this is necessary, it is fortunate that the stent cell size allows adequate flow and rarely results in junctional occlusion (Figure 2A,B). Frequently, with a high-grade lesion in the subclavian artery, we will protect the vertebral artery with an embolic protection device. At present, the only available distal embolic protection devices are the PercuSurge balloon (guidewire) (Medtronic, Santa Rosa, CA), the Boston Scientific EPI filter wire (Natick, MA), and the Guidant Accunet (Indianapolis, IN). All are off-label indications for those applications.

For subclavian lesions, there is the concept that distal embolic events are unlikely to occur after stenting because retrograde flow in the vertebral persists for at least 1 minute before antegrade flow is established, which may account for the less-than-1% rate of distal embolic events. Eccentric

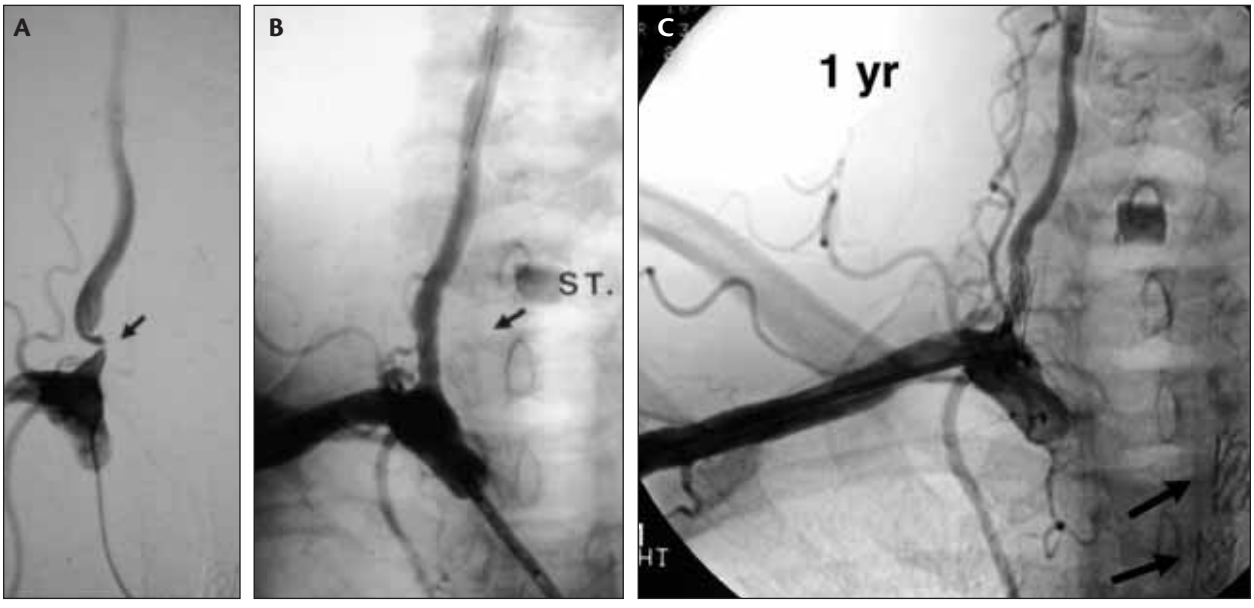

Figure 3. High-grade stenosis at the origin of the dominant right vertebral (A). A 1-cm X 4-mm balloon-expandable stent was positioned, with improved antegrade flow and no residual stenosis (B). One-year follow-up demonstrated 40% restenosis at the ostium (C).

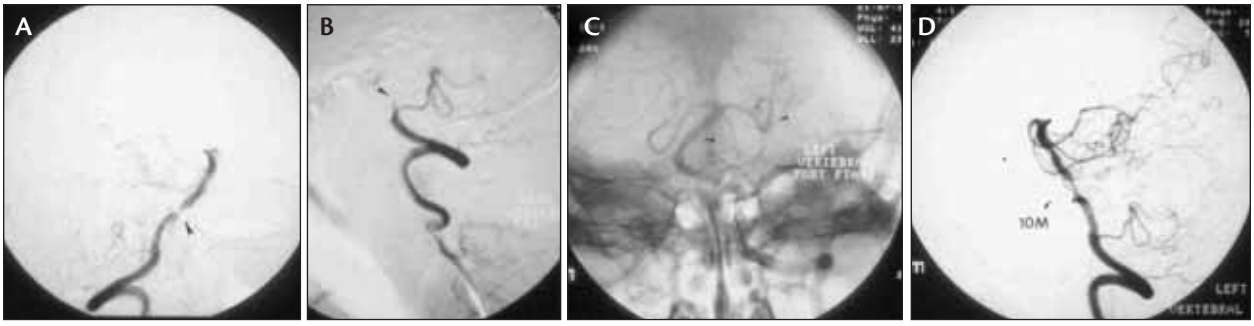

Figure 4. High-grade stenosis in the basilar artery in a patient managed with long-term anticoagulants (A). The patient was admitted with ataxia, coma, and NIH stroke scale >20. The patient was transferred 10 hours after onset to a tertiary center. Angiography demonstrated total basilar artery occlusion (B). After primary angioplasty at the occlusion site, flow was re-established in the basilar artery, with satisfactory filling of the posterior cerebral arteries and the left superior cerebellar artery. There was marked clinical improvement after re-establishment of flow. There were no thrombolytics initiated because of the 10-hour delay prior to admission (C). At a follow-up examination for coronary artery disease 10 months later, the basilar artery was re-evaluated and demonstrated continued patency with mild restenosis. The patient had returned to full employment (D).

plaque and/or a question of residual clot at the target lesion site is occasionally a predictor of distal embolic events; in these situations, lysis prior to proceeding, or certainly the use of a distal embolic protection device, is recommended. Caution is also recommended in the initial dilatation of those patients with total occlusion. Frequently, the rigid dystrophic calcification results in excessive dissection and, occasionally, a false aneurysm. For these reasons, in total occlusions, it is best to initially underdilate after establishing a minimal lumen and subsequently positioning a balloon-expandable stent. In the event a false aneurysm does develop, it may then be necessary to position a covered stent at that site. The proximal vertebral vessels are also considered a part of the brachial cephalic group, and, in fact, the anomalous origin of the left vertebral from the aortic arch occurs in 5% to 10% of the patient population (Figure 3).

In the vertebral multicenter registry reported by Jain et al,[3] 54 patients were evaluated with a technical success rate of 98% and a restenosis rate of 5.5% at 1 year. The predominant stent utilized in those patients was the balloon-expandable Palmaz stent (Cordis Endovascular, a Johnson & Johnson company, Miami, FL). Chastain et al[8] reported 98% technical success in 55 vertebral arteries in 50 patients, with no procedure-related complications. A 25-month follow-up did demonstrate two patients with recurrence of vertebrobasilar artery insufficiency and a 6-month angiographic restenosis rate of 10%. Albuquerque et al[9] reported a 1% incidence of vertebroembolic events with 5% overall complications, and a 13% restenosis rate at 2 years when angioplasty alone was utilized.

At present, most vertebral artery stenotic lesions are managed with balloon-expandable stents because the stent does eliminate the potential for dissection, in addition to eliminating the elastic recoil that frequently follows the angioplasty procedure. In those patients evaluated for vertebrobasilar insufficiency, an MRA study to include both extra- and intracranial circulation is a satisfactory screening procedure. When endovascular intervention is necessary, however, a detailed selective vertebral arteriogram to evaluate the entire vasculature in the posterior fossa is necessary. Occasionally, in patients with multivessel occlusive disease, the segmental atherosclerotic change also present in the cerebellar circulation can clearly be demonstrated.

Selective examination of the vertebral artery may demonstrate basilar artery stenotic lesions. Unfortunately, endovascular management of the basilar artery is attendant with a relatively high complication rate, which can be as variable as 15% to 20%. Medical management of patients with symptomatic disease also has limitations because recurrent stroke will occur in 14%, and the mortality at 15 months has been described as high as 21%.[10] Basilar artery complications that might occur during vertebral interventions are predicated on the treatment being initiated as expeditiously as possible. Outcome predictors include duration of occlusion >6 hours, quadriplegia, coma, or an NIH stroke scale on admission >20 (Figure 4). Failed medical management, however, may necessitate angioplasty or stenting. Unfortunately, the complications of stroke and death in this situation can be as high as 28%.[11]

CONCLUSIONS

With few exceptions, endovascular stenting of the great vessels off of the aortic arch is associated with fewer periprocedural complications and more favorable outcomes than conventional surgical reconstruction. Restenosis of these vessels, excluding the vertebral artery, has not been an issue, with

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long-term patency reported as high as 95% at 1 year. Embolic complications are also being further reduced since the introduction of embolic protection devices. Surprisingly, however, even without embolic protection, the embolic event rate was less than 1%. Prophylactic stenting of subclavian stenosis in the asymptomatic patient remains an unanswered issue. It would appear, however, that with the long-term patency of the internal mammary as a conduit graft during coronary artery bypass surgery, preserving the patency of the subclavian artery has become even more significant. Careful patient selection and operator experience are the two most essential fundamentals in minimizing periprocedural events and managing occlusive disease involving the aortic arch vessels. ■

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