Excimer Laser as an Adjunct for Popliteal Aneurysms

A case report demonstrating the use of this novel technique.

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Popliteal artery aneurysms (PAAs) exhibit a natural history of chronic insidious embolization, which can eventually thrombose distal runoff vessels and cause limb loss when natural collaterals in the limb can no longer compensate. Amputation rates are 25% to 50% in emergent cases, despite exclusion and bypass, due to compromised runoff.[1,2] Forty percent of PAA patients have popliteal thrombosis at presentation, and up to a quarter of these have evidence of distal emboli.[2,3] In comparison, elective repair of PAAs with at least two-vessel runoff has <1% associated limb loss.[4]

The importance of optimizing the distal runoff before repairing the aneurysm typically requires the use of catheter-directed thrombolytic (CDT) infusion into the distal arterial circulation. This allows the opening of additional outflow vessels to improve patency and durability of the repair.[5,6] However, there are limitations to thrombolysis, including the age and amount of thrombus, degree of acute ischemia, and the ability of the patient to tolerate additional intervention before revascularization.[5] CDT is accompanied by significant risks,[7] can take 24 to 48 hours to perform, requires multiple fluoroscopic assessments and repositioning of the catheter, and increases costs due to a longer length of stay and the requisite higher level of care.

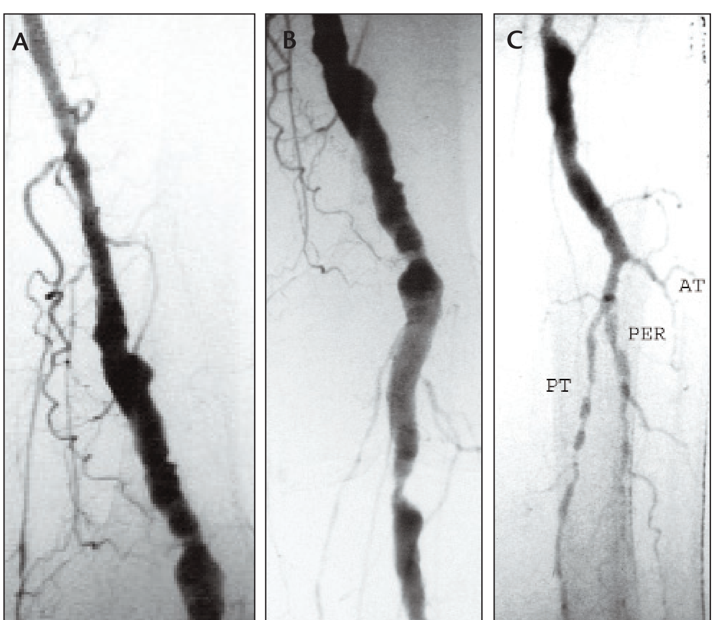

Figure 1. Pretreatment arteriogram of the left femoral and popliteal arteries (A), popliteal aneurysm (B), and runoff (C). Note the attenuated and highly diseased runoff vessels: posterior tibial, peroneal, and anterior tibial.

The CVX-300 excimer laser (Spectranetics Corporation, Colorado Springs, CO) may be a useful alternative to CDT and may facilitate a shorter hospital course. Several recent reports have demonstrated its thrombolytic properties in various vascular territories.[8-12] We present a case demonstrating successful thrombolysis of the tibial outflow vessels utilizing the excimer laser. Elective endovascular repair of a PAA was accomplished, including angiography and thrombus ablation of multiple sites in the tibial and peroneal vessels, requiring fewer than 3 hours of procedure time.

CASE REVIEW

An 86-year-old man with a history of hypertension and pacemaker insertion and no history of smoking had emergency surgical exclusion bypass with a reversed saphenous vein graft of a right PAA in 2004 with good results.

In March 2006, he presented with a left PAA. Physical exam revealed no foot wounds, ulcers, or evidence of infection, embolization, or infarction. Duplex ultrasound showed a left PAA that measured 2.1 cm in diameter and a patent exclusion bypass graft of the right leg. The patient was brought to the operating room electively. Diagnostic aortography, bilateral iliofemoral runoff, and left-leg runoff showed patent aortoiliac segments bilaterally. Left-leg runoff revealed a patent superficial femoral artery and profunda femoris and an enlarged popliteal artery from the adductor canal to the tibioperoneal trunk with two areas of stenosis and several areas of thrombus. The anterior tibial and peroneal arteries were occluded near their origins. The anterior tibial artery reconstituted for a short distance at the midcalf but was not continuous to the foot. The posterior tibial artery was highly diseased but open to the ankle, despite multiple tandem stenoses (Figure 1).

Figure 2. Distal arteriogram of the posterior tibial artery and plantar arteries showing good patency without intraluminal defects.

The patient was readmitted for elective intervention of the left PAA. Through a left groin antegrade approach, selective left leg arteriography was performed, confirming the previous findings. A 55 cm, 6-F sheath was exchanged for the diagnostic sheath, and a .014-inch guidewire was inserted through a Quick-Cross support catheter (Spectranetics Corporation) into the posterior tibial artery and advanced down to the level of the malleolus. Distal arteriography of the foot revealed excellent flow (Figure 2).

A 0.9-mm Turbo Elite excimer laser catheter (Spectranetics Corporation) was directed into the posterior tibial artery, energized, and passed to the level of the ankle. A 1.7-mm Turbo Elite catheter further increased luminal diameter and restored excellent flow (Figure 3A). Percutaneous balloon angioplasty (PTA) was then performed with a 3-mm X 40-mm balloon to increase the lumen size in an isolated section of the proximal posterior tibial artery (Figure 3B). A second .014-inch buddy guidewire and guide catheter were then advanced into the peroneal artery, where thrombus ablation and PTA were then performed, and brisk flow was noted beyond the midcalf (Figure 4). An attempt to open the anterior tibial artery was unsuccessful due to calcification.

The PAA was then excluded with two 8-mm X 15-cm overlapping Viabahn endoprostheses (Gore & Associates, Flagstaff, AZ) from the distal superficial femoral artery to the distal popliteal artery through a 9-F sheath (Figure 5A). Poststent dilation was performed with an 8-mm X 4-cm balloon within the prostheses and a native distal popliteal artery stenosis (Figure 5B). Completion angiography revealed excellent flow through the stent grafts and throughout the runoff.

The patient returned home within 24 hours without complications. Duplex ultrasound follow-up at 1, 4, and 12 months revealed a widely patent left popliteal stent graft, a patent left posterior tibial artery, and a normal ankle brachial index, indicating a durable repair. The patient's left foot remained healthy without evidence of embolization or ischemia.

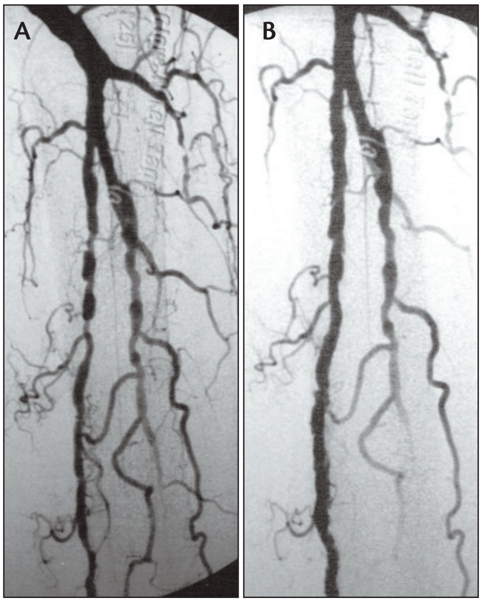

Figure 3. Sequential arteriograms of the tibial arteries after laser (A), and subsequent PTA treatment (B).

DISCUSSION

PAAs are generally found in patients during their sixth and seventh decades of life and are approximately 10 times more common in men than in women.[13] Historical estimates vary regarding the number of PAAs diagnosed each year. Reported cases have increased recently due to newer diagnostic modalities. PAAs are bilateral in 50% to 70% of cases and are associated with abdominal aortic aneurysms in 40% to 50% of patients.[7,14] At the initial diagnosis, approximately 45% of patients with PAAs are asymptomatic and are either followed with serial ultrasounds until the PAA is ≥2 cm or are repaired when thrombus is present in the sac.[3] However, small PAAs (1.2 cm to 2 cm) have a high rate of thromboembolism, which is a compelling indication for early treatment.[15] The goal of treatment remains limb preservation and prevention of the sequelae that define the condition's natural history: local thrombosis and distal embolization leading to tissue or limb loss[13] or, rarely, rupture.[16]

There has recently been an evolution in the management of PAAs from open surgical bypass and exclusion toward an endovascular approach, which uses adjunctive thrombolysis to improve runoff and stent grafts for aneurysm exclusion.[17] However, surgery requires acceptable recipient vessels for graft anastomotic sites; both surgical reconstructions and endovascular stent grafts require acceptable runoff to prevent thrombosis. This may not be available if the distal vessels have become filled with embolic debris. There is a direct relationship between long-term graft patency rates and preoperative findings. A single vessel or absent runoff negatively affects early patency and limb salvagability.[2,5,6] One study concluded that limb salvage success rates are directly dependent on the number of distal runoff vessels, whereas lytic failure was an indication for amputation.[5] Five-year bypass graft patency rates for asymptomatic patients undergoing elective surgical repair are 82% to 97%, but patency drops for symptomatic patients to 39% to 70%.[1-4] In another recent study of endovascular stent-graft exclusion of a PAA, in the absence of acute limb ischemia, the technical success rate was 100%, with 83% of the patients having at least two-vessel tibial artery runoff. The 1-year primary and secondary patency rates were 93% and 100%, respectively.[17]

Preoperative thrombolytic therapy with CDT has improved graft patency in surgical PAA repairs by improving the distal outflow, producing greater limb salvage rates.[2,5,6] However, the duration of thrombosis, volume of thrombus burden, severity of ischemia, and the ability of the patient to undergo hours of CDT before revascularization can preclude effective preoperative lytic therapy in emergent cases. Coexisting atherosclerotic disease can compound obstructive thrombosis and require an additional intervention, such as PTA, to provide adequate runoff. Furthermore, the attendant risks of thrombolytics are well known and include intracranial hemorrhage, major bleeding, proximal thrombosis from the indwelling infusion catheter, distal embolization, and death.[7] The frequency of serious events varies widely, based on the specific lytic agent and technique used for local delivery, as well as the patient's age and comorbid conditions.[5-7]

Excimer laser thrombolysis has been shown to be effective in various vascular beds, including native coronary arteries, saphenous vein grafts in acute myocardial infarction,[8,9] peripheral arterial disease,[10] and acute and subacute thrombotic hemodialysis shunt occlusions.[11] It has recently shown efficacy in mixed-chronicity deep vein thrombosis of the truncal veins.[12] Thrombus avidly absorbs the 308-nm ultraviolet light of this laser, and platelet function is also decreased after exposure to the laser's 308-nm ultraviolet wavelength.[18] Thrombus ablation occurs through photomechanical (acoustic) effects, photochemical (molecular dissociation), and photothermal (energy transfer) mechanisms, causing vaporization of atheromatous plaque, thrombus, and calcium.[19]

Figure 4. Note the reopened distal posterior tibial and peroneal arteries after excimer laser treatment.

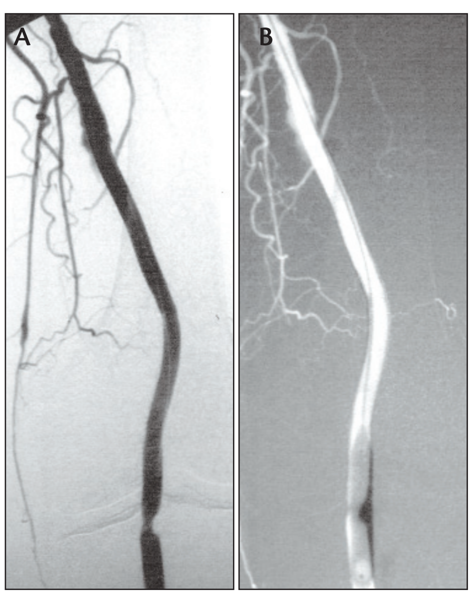

Figure 5. Arteriograms after stent graft deployment (A) and poststent balloon dilatation (B). Final angiographic result showed a widely patent stent graft and minimal residual stenosis.

CONCLUSION

In this case, excimer laser thrombolysis recanalized thrombus-laden tibial runoff vessels within minutes, leading to overall decreased procedure time. Improved outflow of tibial vessels potentially reduced ischemia and limb loss. Unlike CDT therapy to prepare runoff, during which the endovascular exclusion of the aneurysm may need to be performed more than 24 hours after the initiation of thrombolytic treatment, excimer laser thrombolysis can be performed sequentially during the same procedure as aneurysm repair. Overall, the general risks associated with the infusion of thrombolytics are eliminated, and system costs, such as ICU resources and hospital length of stay, may be decreased. Additional experience with this technique will be necessary to establish its role in PAA treatment. ■

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