Tibial Recanalization with Excimer Laser Angioplasty

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ABSTRACT

We report a case of chronic critical limb ischemia (CLI) due to occlusive tibial artery disease that we treated with an excimer laser with good clinical results. The current status of laser technology in the treatment of infrainguinal arterial disease is reviewed, and our approach to the use of this device in these challenging patients is presented. Data that indicate the value of this modality in the treatment of patients with CLI are discussed.

KEYWORDS: Laser-assisted angioplasty, critical limb ischemia, tibial occlusion

Objectives: Upon completion of this article, the reader should understand the characteristics that differentiate the current excimer laser from older technology, understand its current clinical use, and identify the necessary technical factors for its safe application.

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Chronic critical limb ischemia (CLI) is a devastating condition with a poor prognosis characterized by rest pain, ischemic ulceration, and nonhealing wounds. Patients with CLI have a short life expectancy and a high rate of major limb amputation.¹ There has been extensive investigation into various interventional options for these patients because surgery is often not possible.² Laser-assisted angioplasty has shown promise in successfully recanalizing the infrainguinal occlusions that are typically seen in these patients.

CASE REPORT

A 72-year-old man presented with severe ischemic rest pain in his right foot. His past medical history included severe coronary artery disease, diabetes, and hypertension. The patient, a longtime smoker, had undergone prior coronary artery bypass grafting and carotid endarterectomy.

On physical examination, a palpable right femoral pulse and weak Doppler signals in the right foot were noted. Ankle-brachial indexes could not be obtained due to noncompressible vessels, but the right toe pressure was 26 mm Hg. An angiogram performed at another institution demonstrated occlusion of the popliteal artery with reconstitution of the posterior tibial artery (PTA) and peroneal arteries. Interventional consultation was obtained after the patient was found to be a very poor surgical candidate because of his medical comorbidities.

Ipsilateral antegrade arterial access was obtained, angiography was performed, and the popliteal occlusion was probed with a 0.018 guidewire and catheter (Fig. 1). The wire and catheter were then negotiated across the occlusion into the PTA, and a gentle injection of contrast was made to confirm intraluminal positioning of the catheter (Fig. 2). The patient was heparinized, and several passes were made with a 2.0-mm excimer laser catheter

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Figure 1 Crossing popliteal occlusion. (A) Angiography shows catheter and wire being advanced through popliteal occlusion. (B) Angiogram shows reconstitution of posterior tibial artery and peroneal artery.

(CLiRpath; Spectranetics, Colorado Springs, CO). Angiography demonstrated a patent PTA with brisk flow to the foot (Fig. 3). Upon completion of the procedure, a palpable PTA pulse was noted. The patient reported that his symptoms resolved, and on follow-up examination 4 months later he continued to be free of rest pain.

DISCUSSION

Early experience with laser recanalization in the peripheral vascular system was unsatisfactory due to a high rate of complications, including early and late vascular occlusion, as well as distal embolization and perforation. This technique is being looked at again because of

Figure 2 Contrast injection confirms intraluminal location of catheter after crossing posterior tibial artery occlusion.

advances in laser technology and recent refinements in the technique of laser atherectomy resulting from a better understanding of the mechanism of this treatment modality. Outcomes from recent trials indicate improved results of laser-assisted angioplasty when compared with the technology that was used in the last decade. These results are exciting because laser atherectomy appears to be useful in treating complicated infrainguinal disease typical of patients with CLI. In particular, encouraging results have been obtained in patients who are very poor surgical candidates for various reasons, including inadequate target vessels, lack of suitable bypass conduit, or severe concurrent medical disease. These patients have traditionally had limited options and a high limb amputation rate.¹

Lasers are systems that contain a material whose molecules are induced into a higher energy state by the input of electromagnetic or electrical energy and then allowed to relax back to the original lower state. Upon relaxation, the system produces monochromatic coherent light emitted in a collimated fashion and, depending on the design of the system, is discharged in a continuous or pulsed manner. Older technology made use of continuous lasers that emitted light at wavelengths that caused local tissue heating, resulting in thermal injury to the vascular endothelium.³ As a result, there was a high rate of early occlusion, vessel perforation, and distal embolization, as well as a high restenosis rate. In addition, because the older lasers were not ablating tissue efficiently, they were essentially “dottering” the vessel as they were being advanced. Current excimer lasers emit light with a wavelength in the ultraviolet range, which directly breaks chemical bonds in atheromatous tissue as well in acute and organized thrombus and penetrates tissue to a very shallow depth.³ These lasers discharge their energy in very short pulses that do not allow enough time for significant tissue heating. These “cold” lasers effectively vaporize very thin layers of tissue into particles < 10 micrometers with each pulse.³ Knowledge of the basic physics and biological effects of these lasers is important in understanding the modifications in lasing technique that have been made, which, as we discuss later, further reduce the rate of complications.

Currently, no strong data support the use of laser atherectomy as the primary method of treatment for patients with CLI. Most patients with CLI have femoropopliteal and tibial artery occlusions, often longer than 3 to 5 cm, which have traditionally been considered surgical lesions.¹ Laser atherectomy appears to have a good initial success rate in recanalizing these occlusions. In our practice, therefore, we offer percutaneous treatment with the use of laser-assisted angioplasty to these patients when they have been evaluated by a vascular surgeon and no surgical options are available. An adequate pedal vessel must be present to act as “runoff.” In

Figure 3 (A) and (B) Final angiogram shows patent posterior tibial artery to foot.

the setting of limb salvage where the clinical goal is healing a wound or ulcer and long-term patency is not needed, the apparently good technical success rate of laser-assisted angioplasty makes this an appealing treatment modality.

Meticulous attention to technique improves the outcome of laser angioplasty and reduces the rate of complication. Crossing an occluded vessel can be challenging and is the key step in the procedure. Ideally, intraluminal passage of a guidewire is desirable, but in attempting to negotiate the occlusion the wire may create a subintimal pathway. Subintimal wire passage does not preclude a successful angioplasty, but the wire must return to the lumen close to the distal aspect of the occlusion to preserve the outflow vessel. One strategy for maintaining an intraluminal passage is to buckle the wire on itself as it is passed through the occlusion. A

wireless technique for crossing occlusions using the laser catheter itself has been described. This step-by-step technique involves alternatively advancing the activated laser catheter a short distance ahead of the wire into the occlusion and then probing with the wire to be followed again by the laser.⁴ The distal 1 to 2 cm of the occlusion should be crossed with the wire to avoid injury to the outflow vessel. Experience with catheters and wires is the most important tool in crossing occlusions, and the feel of the wire and its fluoroscopic appearance often indicate whether the wire has passed subintimally or remains intraluminal. Confirmation of intraluminal positioning of the catheter distal to the occlusion with a gentle injection of contrast is essential before proceeding.

The technique of laser angioplasty has undergone improvement in recent years. The laser can be used as the

sole method of recanalization or can be used to debulk the lesion so complex lesions can be converted to lesions that can be dilated with simple balloon angioplasty. The laser creates a lumen slightly larger than the diameter of the catheter. A general rule of thumb is to use a catheter that is two thirds the size of the vessel. The sheath and laser catheter must be thoroughly flushed with a heparinized saline solution prior to and during activation of the laser. No contrast material can be present because the activated laser creates microbubbles in iodinated contrast that can explode and cause vascular injury and dissection. We use a solution of nitroglycerin and a calcium channel blocker in heparinized saline to help prevent vessel spasm. Standard laser safety precautions must be used, including the use of appropriate safety eyewear for everyone in the procedure room, including the patient. The laser ablates atheroma and thrombus in contact with the tip of the laser catheter to a depth of 50 micrometers. The activated laser fiber must be advanced slowly (no more than 0.5 to 1.0 mm per second); otherwise, the catheter itself will physically "dotter" the lesion, and dissection or embolization can result. Because of the requirement to advance the catheter slowly, careful attention to radiation safety practices is necessary. Adequate shielding and the intermittent use of pulsed fluoroscopy are vital. Identifying the endpoint of treatment in the tibial vessels is also an important issue. The desired final result is patency of the vessel with brisk forward flow. An optimal "angiographic" result is not necessarily sought because there is a higher risk of dissection and occlusion in the tibial vessels, and long-term patency is not necessarily the goal. This goal can be achieved with the laser alone, but often adjunctive angioplasty is required. In general, low-profile balloons should be used in the tibial vessels and the vessel should not be oversized. In the superficial femoral artery, stenting may also be necessary. The response of a lesion to balloon angioplasty may be different after it is debulked with the laser than the response of a so-called native lesion. Even if an adequate result is not obtained with the laser alone, there may be less risk of dissection and distal embolization with subsequent angioplasty.

Recent trials looking at the use of the excimer laser in the peripheral vascular system, and specifically in the setting of CLI, have shown promising results. Laird et al published the results of a multicenter trial looking at results of laser atherectomy plus PTA and optional stenting for lesions in 155 critically ischemic limbs in 145 patients with CLI (Rutherford categories 4 through 6).⁵ In this trial the lesions (occlusions as well as stenoses) were successfully crossed in 99% of patients using either the guidewire alone or using the

step-by-step technique. Axial patency with < 50% residual stenosis was achieved in 85% of the patients treated. Complications such as dissection, perforation, and distal embolization occurred in 12% of treated limbs, most of which required some form of secondary intervention. These investigators reported a 93% limb salvage rate at 6 months. Another group using similar enrollment criteria and treating with laser, PTA, and optional stenting reported a procedural success rate of 95.4%, including 9% of their patients who required the step-by-step technique to cross the lesion.⁶ Interestingly, no major complications were reported. In their series, 16.6% of patients required a secondary intervention, but the overall limb salvage rate was 90.9% at 6 months and 85.7% at 1 year. These studies, as well as others, have shown promising results for limb salvage in patients with CLI.

CONCLUSION

The excimer laser appears to have a role in treating appropriately selected patients with infrainguinal disease if meticulous technique is employed. The laser alone can often recanalize long occlusions. In many cases PTA may still be required, but the effect of debulking the lesion with the laser appears to result in better responses to balloon angioplasty and possibly lowers the risk of distal embolization. This modality is very exciting because it may be useful in preventing amputations in patients with CLI when no other options exist.

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