Excimer Laser-Assisted Angioplasty

Physical modifications and new tools to allow directional control of laser photoablative therapy and creation of larger lumens have become available since the LACI trial.

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The LACI (laser-assisted angioplasty in critical limb ischemia) trial[1] demonstrated that with the use of an excimer laser (ClirPath, Spectranetics Corporation, Colorado Springs, CO), there were high rates of technical success in crossing and treating arterial obstructions in patients with critical limb ischemia. Six-month limb salvage rates of 93% were achieved. Excimer-laser energy appears to ablate thrombus and plaque-employing photochemical, photothermal, and photomechanical mechanisms.[2] The photochemical effect fractures billions of tissue bonds within 100 µm of the catheter tip with each pulse of energy lasting 125 nanoseconds. The photothermal effect is caused by molecular vibration with energy transfer leading to vaporization of plaque. The photomechanical effect is a result of the vapor bubble expanding and collapsing. The power delivered is the mathematical product of the number of pulses delivered per second (frequency), and the energy per pulse is measured in mJ/mm^2 (fluence). In an effort to achieve more effective excimer laser therapy, catheter modifications, changes in energy delivery, and new catheters allowing directional control have been developed.

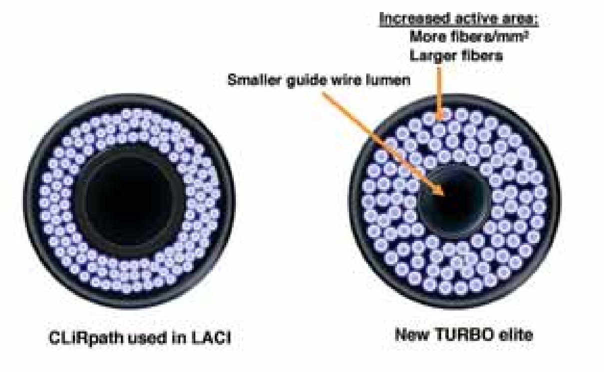

Figure 1. Laser catheter comparison.

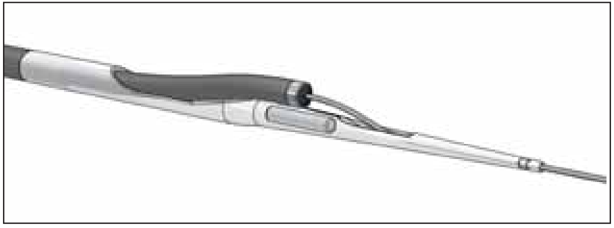

Figure 2. Diagram of the Turbo-Booster.

CATHETER MODIFICATIONS

Catheter modifications since LACI include the placement of more energy delivery fibers per catheter to lessen dead space and improve delivered laser energy to the catheter tip and hydrophilic catheter coatings to lessen drag along the catheter shaft. Catheter diameters include .9 mm, 1.4 mm, 1.7 mm, 2 mm, 2.3 mm, and 2.5 mm (Figure 1).

ENERGY DELIVERY

Changes in energy delivery since LACI include the ability to deliver frequency rates of up to 80 pulses per second in all catheter sizes and higher fluency in most of the ranges of catheter sizes. During the LACI study, the laser energy was delivered over either 5-second or 10-second increments, after which the energy was automatically terminated. As the physician advancing the

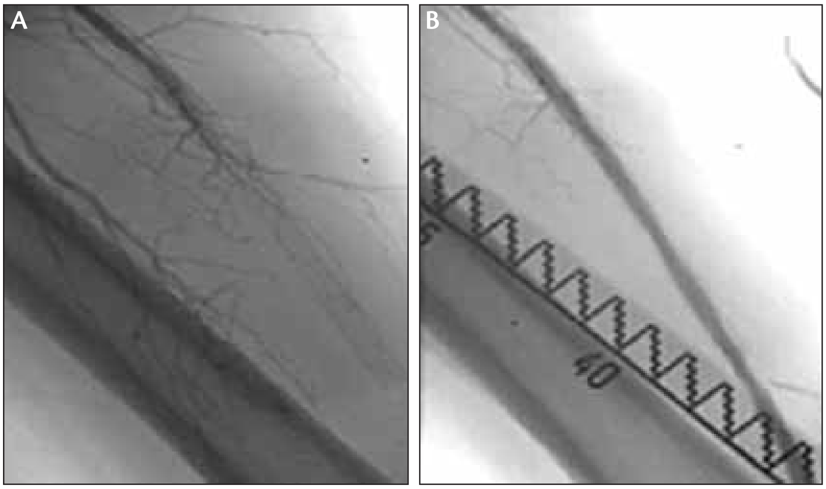

Figure 3. Total occlusion of previously placed distal superficial femoral stent (A). Result after laser ablation with the Turbo-Booster (B).

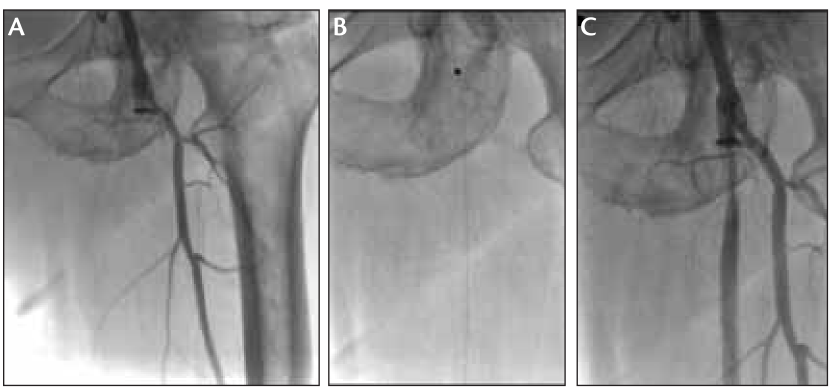

Figure 4. Total occlusion of a femoral-to-popliteal bypass graft (A). One single pass made with a 2-mm Turbo elite at 60 fluence and a rate of 80 pulses per second (B). Postangiography demonstrated complete thrombus resolution and identification of the "culprit" stenosis (C).

laser catheter had no control of this, inadvertent advancement of the catheter while the energy was off resulted in areas of "dottering" rather than photoablation. The "constant on" function of present laser catheters results in the laser energy remaining on until the physician chooses to stop it to avoid inadvertent advancement.

DIRECTIONAL CONTROL

A new tool, the Turbo-Booster (Figure 2), has recently been approved by the FDA for use with laser catheters to treat infrainguinal stenoses and occlusions. The Turbo-booster is effective for the directional ablation of concentric and eccentric lesions, creating lumens up to 6-mm. A pilot channel is created using either a 1.7-mm or 2-mm laser catheter. The laser catheter is then removed from the patient and loaded inside the Turbo-Booster, which serves as a ramp, eccentrically displacing the laser catheter. The entire system is then reintroduced into the patient. With the catheter displaced away from the initial lumen, multiple eccentric laser treatments can be delivered by simply rotating the catheter after each run. Markers on the catheter and the laser probe allow the operator to control the direction of laser ablation.

CONCLUSION

Lasers have been shown to ablate thrombus effectively (Figures 3 and 4).[3-7] New studies are being initiated to evaluate the effect of laser ablation on neointimal hyperplasia (in-stent restenosis), stent wall apposition, and thrombus. ■

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