Editorial Comment

Laser Angioplasty: A Plea for Modesty in the Search for a Real Beginning

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Since the early demonstration of the laser to ablate or vaporize coronary atherosclerotic plaque obstruction,1 several clinical studies have been performed with different lasers both in diseased peripheral and coronary arteries.2-7 In addition, a variety of fiber-optic catheters delivering laser energy to the obstruction have been tried, usually under fluoroscopic imaging. Clinical experiences with argon energy transmitted through bare optical fiber2 or sapphire lens3 or delivered to heat a thick capped fiber4 have resulted, not infrequently, in mechanical and laser perforation or dissection of the vascular wall. This is not surprising because tissue studies have shown that the pathway of recanalization by either the bare fiber5 or the laser-heated metal cap6 may facilitate the creation of a false intraluminal channel.

Angioscopy may provide another method of guiding laser delivery with some precision onto the arterial plaque obstruction.10-12 However, angioscopy cannot determine the intraluminal thickness of the atherosclerotic plaque, and momentary cessation of blood flow or displacement of blood by constant flushing of saline are necessary for visualization of the target site. Indeed, despite angioscopic guidance, clinical studies have been disappointing, with a high frequency of wall perforation in peripheral atherosclerotic arteries.13 Current angioscopic catheters are still relatively large with limited flexibility and lack angulation at the tip. Stiffer angioscopic catheters may result in intraluminal wall injury in small or tortuous arteries.14

The use of a leading soft wire to guide the fiber-optic laser catheter under radiographic imaging has helped reduce the perforation rate. However, it does not guarantee that the wire will not partially deviate into a false channel. Moreover, even when the wire is passed into the true lumen of an eccentric plaque obstruction, it may not prevent laser injury to the thin vessel wall opposite the thick mass of the plaque. In clinical studies using the free beam excimer laser, despite the use of an over-the-wire circumferentially oriented multifiber catheter system, a high frequency of coronary dissections has been observed5,6 apparently related, in part, to dead space between peripheral fiber optics and the control guide wire.

The recent introduction of the soft hydrophilic-coated guide wire followed by balloon angioplasty alone has greatly improved the successful recanalization of long obstructions and occlusions. In some patients with coronary occlusion in which difficulty was encountered while passing standard steerable guide wires for balloon angioplasty, the hydrophilic wire was successful in recanalizing seven of eight coronary occlusions, thus facilitating angioplasty.15 The hydrophilic-coated wire has also been implemented to guide a thin laser cap with short-burst energy from a compact portable neodymium:yttrium-aluminum garnet laser with some success in occluded peripheral arteries.16 However, its use does not abrogate the laser procedure of arterial wall dissections especially in small diseased coronary arteries.

The present paper by Geschwind et al in this issue of Circulation17 describes yet another technique to guide and direct laser ablation without the use of a guide wire. While the fiber-optic catheter tip is directed at the target obstruction, the helium-cadmium laser (325 nm), which serves as the diagnostic laser, is transmitted through the optical fiber to excite fluorophores and induce fluorescence of the target tissue. The fluorescent light pattern is then transmitted back through the same optical fiber and is analyzed by a computer system to determine whether the obstruction is atherosclerotic or nonatherosclerotic material. If it is determined to be atherosclerotic tissue, the pulsed dye laser (480 nm), which serves as the treatment laser, is then emitted to ablate and remove the tissue.

This study provides early clinical demonstration that spectroscopic guidance of the laser is useful in producing a channel into the occlusive artery. The pilot hole was small, about the size of the 200-μm fiber, and subsequent balloon dilatation was necessary to produce a larger channel. The application of balloon angioplasty after laser recanalization does

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cloud the issue as to whether the laser really has a role in reducing the restenosis rate. Like balloon angioplasty alone, more than one third of arteries treated by the combined procedure had closed, and only 64% of arteries were patent at follow-up (mean, 18 months). However, it could be argued that without the laser treatment, none of the arteries would be patent because lack of the pilot hole would have precluded the use of the balloon catheter.

The concept of fluorescence-guided laser ablation of atherosclerotic plaque is, however, not new. During the past decade, investigators have shown that atherosclerotic and normal arteries can be distinguished from one another by fluorescence spectroscopy, and that the fluorescence feedback system can guide laser angioplasty by “turning on” or “turning off” the treatment laser based on a spectral pattern. Although it may apparently be a simple concept, its implementation in the clinical setting requires highly sophisticated technology. Complex algorithms are necessary for the system to distinguish the many variable spectroscopic patterns of different types of atheroma and vascular wall tissue. Blood may interfere with the feedback system as well as the laser treatment itself. There may be the lack of an adequate and reliable fluorescence pattern to trigger the treatment laser, thereby prolonging the procedure. Furthermore, each laser firing can alter the spectroscopic pattern.

Despite the sophisticated algorithms in the system to distinguish between plaque and normal tissue, eight arterial perforations occurred in this series, and it took 90 minutes to create a tiny hole through an average 8-cm occlusion. An additional drawback of this system is that it cannot distinguish intimal atherosclerotic plaque that has invaded into the medial wall. It cannot predict the location of the thick mass of the plaque so as to direct higher laser energy to the lesion and expedite the process of plaque ablation and to create a larger lumen. The future implementation of intravascular ultrasound imaging to guide laser ablation may help in this regard.

At the present time, neither this system nor any fiberoptic laser delivery catheter system under investigation can prevent perforation and ablate heavily calcified obstructions. There are no laser systems that have been demonstrated to be more effective with fewer adverse effects and less potential for chronic restenosis when compared with balloon angioplasty alone. It is unfortunate that too rapidly many different laser systems have been introduced clinically as the best system without rigorous preclinical evaluation, only to ultimately succumb to dissatisfaction, leading to skepticism about laser angioplasty in general. Nonetheless, the study by Geschwind et al does illustrate that in patients with moderately long peripheral arterial occlusion that could not be crossed by a guide wire, spectroscopic-guided laser recanalization can be effective in creating a tiny passageway. As with any new technology, much research remains to be done to improve this and other prototype systems. The process of finding the ideal laser and catheter and improving these systems so that they are safe and effective remain long and arduous tasks.

References
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