

Improvements in Endolaser Technology

Flexible tip curved laser probe enhances reliability, precision, and reproducibility.

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Among medical fields, ophthalmology has perhaps the richest history with regard to the widespread application of laser technologies.^{1,2}

During vitrectomy procedures, the endolaser is most commonly used to create a laser barricade around retinal tears, surround retinectomy edges or giant retinal tear margins, and deliver scatter panretinal photocoagulation. For retinal tears, the goal is to achieve 360° of laser encircling the tear. To achieve an effective laser burn, subretinal fluid under the hole must be fully aspirated or the retinal pigment epithelium will not effectively absorb the laser energy. For retinectomies and giant retinal tears, laser spots are generally placed adjacent to the margin of detached retina or to wall off the area of prior detachment such as in cases of proliferative vitreoretinopathy or viral retinitis. Reattached retina is typically lasered overlying a scleral buckle—often a silicone band placed around the outside of the eye to maintain the reattached position of the retina. Endolaser can be performed through perfluorocarbon liquids or intraocular gas if either is being used to hold the retina in position. Afterward, perfluorocarbons are exchanged with air, gas, or silicone oil to achieve long-term stabilization.

For panretinal endolaser photocoagulation, the goal is similar to panretinal photocoagulation performed using slit-lamp or indirect ophthalmoscopic systems. The endolaser typically enables easier access to more peripheral retina than the nonoperative systems, particularly if wide-angle intraoperative viewing systems are used.

Finally, endophotocoagulation can be applied to neovascu-



Figure 1. Photograph of rabbit retina 3 days after laser application. Burns of different sizes can be visualized.

lar tissues prior to removal or to retina prior to a retinectomy to minimize bleeding. The argon green 532 nm laser is generally used for this purpose because it is best absorbed by blood.

STANDARD TECHNIQUES AND SHORTCOMINGS

Endolaser probes are available in several forms including: straight or curved, blunt or tapered, simple or aspirating,³ or illuminating.⁴ The straight probe with a blunt or tapered tip has been used most commonly.

The curved tip is useful for applying laser to the difficult-to-reach anterior superior retina or peripheral retina near the surgeon's dominant hand.

Aspirating tips can be used to drain subretinal fluid or blood from the edge of retinal holes while lasering. Illuminating probes, which have become more popular recently, free the opposite hand for use of another instrument, although the range of illumination has been limited.

More recently, with the increase of microincisional surgical techniques, endolaser probes have been developed to include 23-gauge and 25-gauge instruments. These probes can be used in smaller transconjunctival cannulated sclerotomy incisions enabling a sutureless closure at the end of the surgery and enhancing postoperative comfort for the patient. Twenty-three-gauge laser probes function virtually identically to existing 20-gauge technology. Many surgeons have found, as they have with other small-gauge instruments, that the main limitation of 25-gauge laser probe technology is the lack of rigidity and their inability to enable easy maneuvering of the globe position during surgery.

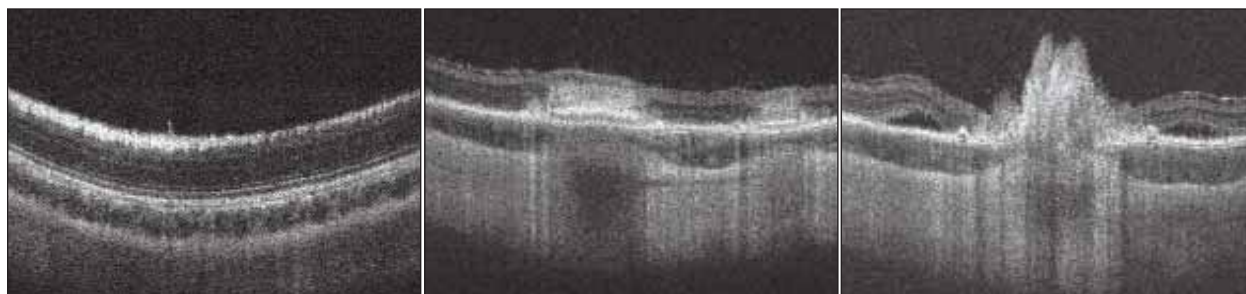


Figure 2. Optical coherence tomography imaging of rabbit eye after use of PUREPOINT laser technology. (A) Normal rabbit retina in control eye. All retinal layers as well as the inner choroid are effectively visualized. (B) Two laser burns. The burn on the left is from application of 750 mW of power; the burn on the right is from a 500 mW burn. Note the smaller width of the chorioretinal scar on the right. (C) Dense chorioretinal scar with adjacent pigment epithelial detachments.

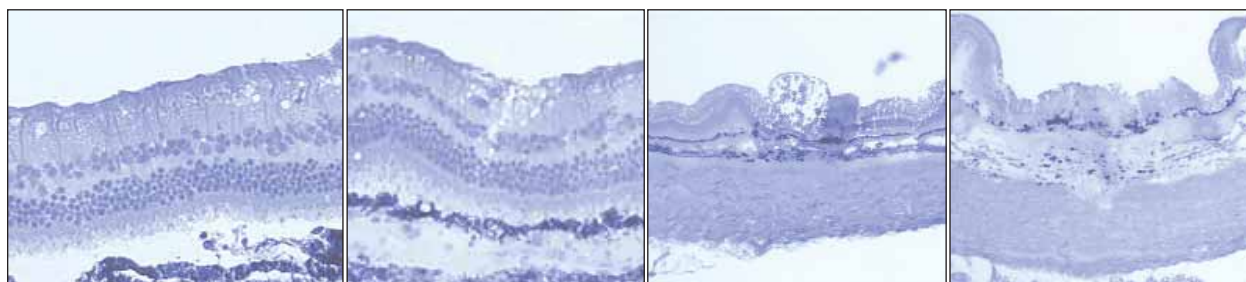


Figure 3. Histopathology of rabbit eye after use of PUREPOINT laser technology. (A) Normal rabbit retina in control eye (hematoxylin-eosin (H&E) staining, 200x magnification). (B) Histopathology of 300 mW burn (H&E, 200x magnification). Note mild retinal necrosis, most pronounced in inner retinal layers. (C) Histopathology of 500 mW burn (H&E, 40x magnification). Note more involved retinal necrosis and inner retinal edema involving all retinal layers. (D) Histopathology of 750 mW burn (H&E, 40x magnification). Note severe retinal necrosis and inner retinal edema involving all retinal layers and encompassing a wider area of retina than the 500 mW burn.

ENDOLASER PROBES

Endolaser probes for use with the PUREPOINT 532 nm thin disc laser system (Alcon Laboratories, Inc., Fort Worth, TX) are available in 20-, 23-, and 25-gauge platforms. Current radio frequency identification (RFID) probe technology includes straight, curved, and illuminated platforms. The RFID feature has been designed to offer faster set-up time and allow preset surgeon parameters for endo-probe usage. This feature also enables the voice confirmation when using the multifunction footpedal to adjust power as well as transition the laser from standby to ready.

A flexible tip curved laser probe (Alcon Laboratories, Inc.) is available for use in 23-gauge or 25-gauge cases. This probe has a shorter tip extension and a smaller bend radius (6 mm) than previous probes. This modification allows for greater access to the periphery and less risk of contacting the lens when lasering on the opposite side of the eye from the location of the entry trocar. It also enables avoiding retina on the crest of a high buckle when placing laser posterior to the buckle. The 23-gauge probe has a 26% thicker cannula construction compared

to existing 23-gauge probes and the 25-gauge probe has up to a 44% thicker cannula construction. The thicker-walled cannula and shorter tip extension on the flexible tip curved laser probe have been designed to enable more robust manipulation of the eye than previous probes. In addition to the flexible tip curved laser probe, straight laser probes are available in 20, 23, and 25 gauge with RFID connectors.

In 20 gauge, straight and curved illuminated endolaser probes with RFID connectors uniquely combine illumination and laser in a single probe, which frees the surgeon's second hand and enables scleral depression while lasering.

ANIMAL MODELING: METHODS

In order to investigate the anatomic effects of the PUREPOINT laser technology, we performed panretinal photocoagulation using a range of laser power settings in the left eye of a Dutch-belted rabbit with a moderately pigmented fundus. The right eye served as a control. The rabbit was anesthetized with intramuscular injections of ketamine hydrochloride (25 mg/kg), xylazine hydrochloride

(5 mg/kg), and azepromazine (0.75 mg/kg) prior to all treatments. Euthanasia was performed with intravenous injections of pentobarbital sodium (390 mg/ml). After the rabbit was euthanized, both eyes were enucleated, placed in OCT, snap frozen in liquid nitrogen, and sectioned (10 μ m sections). Twenty-four sections taken at even intervals to representatively sample the whole globe were stained with Masson trichome.

LASER

The rabbit eye was dilated with standard ophthalmic dilating drops and the eye was prepped with povidone-iodine solution. The 60 D Rabbit lens (Volk Optics Inc., Mentor, OH) was used to visualize the fundus through the operating microscope. A 23-gauge trocar was placed through the conjunctiva 2-mm posterior to the surgical limbus. Care was taken to insert the trocar at a very steep angle to avoid a cataract, as the rabbit lens is much larger anatomically relative to the globe volume than the human lens. A 23-gauge flexible tip curved laser probe was inserted through the trocar. Laser burns were created at five different power settings, from 200 mW to 1000 mW and at five different pulse durations, from 0.1 ms to 0.8 ms. A grid was created for each power setting in an identifiable pattern on the retina so that the laser burns could be identified later for imaging and histopathology. The corresponding retinal color change was observed while lasering, the color change was noted to increase linearly as the power setting was increased. At power settings greater than 750 mW, breaks in Bruch's membrane were observed.

FUNDUS AND SPECTRAL DOMAIN OCT IMAGING

Three days after performing laser, fundus photographs and optical coherence tomography (OCT) images were taken of the fundus using the SDOCT system (Bioptigen, Research Triangle Park, NC). The SDOCT imaging system is designed for 3D retinal imaging of small animals and has been described previously.³ Images of normal rabbit retina provide detail of all retinal layers, the retinal pigment epithelium, and the inner choroid.

Fundus photographs demonstrated full thickness retinal burns with surrounding retinal pigment epithelium atrophy (Figure 1). OCT demonstrated full-thickness retinal atrophy and scarring (Figures 2A-C). The width of the chorioretinal scars varied based on the power setting at



Figure 4. The Flexible Tip Curved Laser Probe.

which the laser was set; high-powered burns produced wider scars. Some pigment epithelial detachments were noted adjacent to retinal burns.

HISTOPATHOLOGY

After the rabbit was sacrificed, eyes were harvested as explained above. Masson trichome sections are demonstrated in Figures 3A-D. Compared with the normal retinal architecture, there is progressive retinal necrosis and edema with increasing amounts of laser power used. As with OCT imaging, the width of the retinal damage was greater with higher powered burns.

CONCLUSIONS

The endolaser is a highly critical component of vitreo-retinal surgery. As smaller gauge systems have recently been developed, the number of available probes and configurations has increased, enabling greater choice and versatility for the surgeon. The PUREPOINT 532 nm thin disc laser system by Alcon Laboratories, Inc., is extremely surgeon-friendly, improving versatility and ease of use and decreasing reliance on operating room staff. Our work in the laboratory indicates that the laser produces effective thermal burns that are stabilized within 3 days of application. The PUREPOINT laser system and flexible tip curved laser probe (Figure 4) enable reliable, precise, and reproducible laser delivery to intraocular structures during complex vitreoretinal surgery, greatly improving surgical success rates. ■

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