

The Evolution of Laser Technology for Retinal Applications

A new laser system offers advanced technology with the potential for improved outcomes.

By Roger Novack, MD, PhD, FACS

The theory of turning light into a coherent, tight beam goes back to Albert Einstein. In 1917, he proposed stimulated emission of radiation.

Light photocoagulation for the retina was first demonstrated in the 1940s by German ophthalmologist Gerd Meyer-Schwickerath, MD, who experimented with focusing natural sunlight into the eye using a heliostat. The invention of photocoagulation represented a major advancement in how retinal pathology could be addressed. Shortly thereafter, Dr. Meyer-Schwickerath began using a carbon arc lamp, and then a xenon photocoagulator.

In 1954, Charles Hard Townes and colleagues from Columbia University in New York developed the stimulated emission of microwave radiation, or maser.

EARLY LASER SYSTEMS

Theodore Maiman, PhD, at the Hughes Research Laboratory in Malibu, CA built the first working laser (Light Amplification by the Stimulated Emission of Radiation) in 1960. Dr. Maiman wrapped a high-powered flash lamp around a ruby rod lined with silver flashing on each end of the rod to stimulate the emission of coherent light. The lamp pulsed light into the rod, which then reflected back and forth and became more and more coherent. Because the flashing on one end of the rod was less than on the other, eventually the light was emitted through that end as a coherent beam of light. Leon Goldman, MD, then pioneered the study of lasers on biologic systems and performed the first studies of the effects of laser on human tissue. In

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1964, he developed a CO₂ laser that emitted light at 10,600 nm and that successfully coagulated tissue. It was applied in ENT and gynecologic surgery. That same year, both the Neodymium:Yttrium Aluminum Garnet (Nd:YAG) laser and the continuous wave 488 nm blue-green argon lasers were developed.

The Nd:YAG laser is commonly used to make an opening in the posterior capsule for treatment of opacification following cataract surgery. The argon laser produces a light frequency that penetrates the tissues appropriately for retina procedures.

The earlier lasers were large, bulky, difficult to use, and required a water-cooling mechanism. During the 1960s, however, innovation in laser technology continued and dye lasers, which became available in 1969, allowed for a variable wavelength.

VALIDATION OF LASERS FOR RETINAL APPLICATIONS

In 1975, the excimer laser was introduced and opened up the field of refractive eye surgery, and by 1980 a new generation of smaller, yet more powerful, lasers became available. In particular, the diode laser,

which was used in retinal surgery, was portable enough so that it could be carried to the hospital or office setting to treat patients. First developed in 1979 by Steve Charles, MD, the introduction of endophotocoagulation was a significant advance in vitreoretinal surgery.¹ In his original system, Dr. Charles used a fiber optic probe attached to a portable xenon arc photocoagulator. Several years later, Gholam Peyman, MD, developed an argon laser probe that enabled more rapid firing, had a more comfortable and safe working distance, and didn't generate as much heat.² The argon green and diode lasers were then used most frequently. Carmen Puliafito, MD, utilized semiconductor based laser technology to decrease instrument size, increase portability and improve stability.

Since then, there have been many lasers developed for use in the retinal OR. In vitreoretinal surgery, lasers are most commonly used to treat retinal detachments, retinal tears, or neovascularization.

The findings of the landmark Diabetic Retinopathy Vitrectomy Study (DRVS), which was performed in the 1970 and 80s, were the first to indicate that lasers were effective in retinal applications. The visual acuity results were mixed in DRVS,³⁻⁵ but it was concluded that this was partly due to the fact that in the early phases of this study, lasers were not used in the OR during vitrectomy. After panretinal photocoagulation was used during vitrectomy, the results began improving and subsequent data showed more stability.^{6,7}

Alcon Laboratories, Inc. (Fort Worth, TX) first entered the laser market with the EYELITE 532 nm Photocoagulator. Long-term experience using the EYELITE laser is that it is stable and holds up well with heavy use. Alcon, however, has developed a new laser photocoagulation system, the PUREPOINT Laser, which represents an improvement in multiple areas and offers other clinical advantages and efficiencies.

TECHNOLOGICAL ADVANCES IN LASER PHOTOCOAGULATION

The PUREPOINT Laser is a 532 nm, green, frequency-doubled Nd:Crystal laser. Like the EYELITE Photocoagulator, the PUREPOINT (Figure 1) Laser can be used with an endolaser probe during a vitrectomy procedure and also has a laser indirect ophthalmoscope (LIO) attach-



Figure 1. The PUREPOINT Laser console.



Figure 2. The multifunction footpedal on the PUREPOINT Laser allows for surgeon control of standby to ready, power settings, and features customizable side switches. These combined features free the OR staff for other duties to improve productivity.

ment. The firing rate of the PUREPOINT Laser is 25 Hz, vs 9 Hz on the EYELITE—a significant improvement in speed that allows completion of laser treatment much more rapidly. Additionally, the maximum power on the PUREPOINT Laser is higher than on the EYELITE Photocoagulator. This is helpful in situations such as where there is a significant amount of haze, hemorrhage or edema that requires extra power. The engine on the PUREPOINT is designed to be reliable and the unit is smaller and lighter than the EYELITE.

Multifunction foot pedal. The PUREPOINT Laser addresses time and efficiency with a multifunction foot pedal (Figure 2) that allows the surgeon to have more control over the laser. The surgeon can control standby-to-ready and power settings and can also customize side switches on the pedal to suit surgical technique. The OR staff benefits from this technology in that they are free to perform other duties, improving productivity.

Voice confirmation technology. Voice confirmation is important because many surgeons are set up without direct visual access to the laser and would have to physically turn to check that the power setting is correct. The PUREPOINT Laser's voice recognition feature, however, states what settings have been activated. The surgeon does not have to take his eyes away from the operating microscope and again, has a higher level of control over the laser. Voice confirmation occurs for parameter changes, verification of laser accessories, and insertions including endoprobes, LIO, slit lamp, and protection filters.

Radiofrequency identification technology (RFID). The PUREPOINT laser is equipped with ENGAUGE RFID

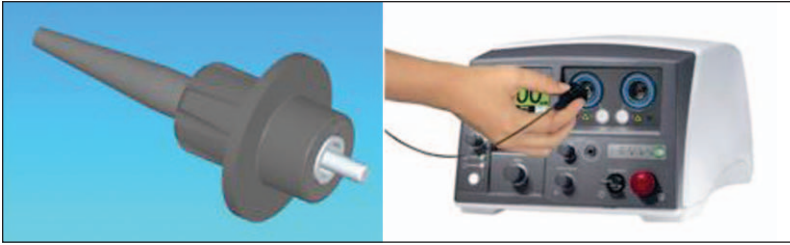


Figure 3. ENGAUGE RFID automatically recognizes the type of device being connected. Laser settings can be preset and automatically loaded when the type of delivery device is identified.



Figure 4. Dual ports allow multiple device connections, which reduces switching time and allows switching between the endoprobe and LIO with a single button (push).

technology (Alcon Laboratories, Inc.; Figure 3), which automatically recognizes Alcon devices equipped with this technology when connected to the laser. The laser settings can be preset and automatically loaded as the type of delivery device is detected and inserted into the laser. For example, if a surgeon connects an Alcon RFID equipped probe into the laser, the machine identifies the device and adjusts the settings appropriately. The manufacturer presets some of this information, but the surgeon can program his own settings. Each programmed set is color coded and easily recognizable for both the surgeon and the staff.

Dual laser attachment ports. The PUREPOINT Laser has dual laser attachment ports (Figure 4). This is a convenient and efficient feature because it takes away the step of unplugging and replugging the endolaser probe when switching to a laser indirect ophthalmoscope (LIO). Every time an endolaser probe is unplugged, it is

flexed and there is an increased risk of breaking it. Additionally, it takes time to switch back and forth. The PUREPOINT has dual ports and with the touch of a button, the surgeon can switch from endoprobe to LIO.

SUMMARY

The PUREPOINT Laser is a newly designed next generation laser for use in the operating room and the office with advanced technology that

increases surgeon control. The coherence and power of the laser beam on this system is excellent and enables an effective, efficient procedure. The repeat rate is fast and speeds up placement of the laser pattern. The improvements to the PUREPOINT Laser result in a laser photocoagulation system that provides increased surgeon control and increased efficiencies while reducing dependence on OR staff during the laser procedure. ■

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1. Charles S. Endophotocoagulation. *Retina*. 1981;1:117-120.
2. Peyman GA, Grisolano JM, Palacio MN. Intraocular photocoagulation with the argon krypton laser. *Arch Ophthalmol*. 1980;98:2062-2064.
3. Diabetic Retinopathy Vitrectomy Study Group. Two-year course of visual acuity in severe proliferative diabetic retinopathy with conventional management. Diabetic Retinopathy Vitrectomy Study (DRVS) report #1. *Ophthalmology*. 1985;92(4):492-502.
4. Diabetic Retinopathy Vitrectomy Study Group. Early vitrectomy for severe vitreous hemorrhage in diabetic retinopathy. Two-year results of a randomized trial. Diabetic Retinopathy Vitrectomy Study report 2. The Diabetic Retinopathy Vitrectomy Study Research Group. *Arch Ophthalmol*. 1985;103(11):1644-1652.
5. Diabetic Retinopathy Vitrectomy Study Group. Early vitrectomy for severe proliferative diabetic retinopathy in eyes with useful vision. Results of a randomized trial—Diabetic Retinopathy Vitrectomy Study Report 3. The Diabetic Retinopathy Vitrectomy Study Research Group. *Ophthalmology*. 1988;95(10):1307-1320.
7. Diabetic Retinopathy Vitrectomy Study Group. Early vitrectomy for severe proliferative diabetic retinopathy in eyes with useful vision. Clinical application of results of a randomized trial—Diabetic Retinopathy Vitrectomy Study Report 5. The Diabetic Retinopathy Vitrectomy Study Research Group. *Ophthalmology*. 1988;95(10):1321-1334.
7. Diabetic Retinopathy Vitrectomy Study Group. Early vitrectomy for severe vitreous hemorrhage in diabetic retinopathy. Four-year results of a randomized trial: Diabetic Retinopathy Vitrectomy Study Report 5. *Arch Ophthalmol*. 1990;108(7):958-964.