

Glaucoma Lasers of Today and How They Differ

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In recent years, the glaucoma treatment marketplace has been inundated with new laser technologies, which have excited physicians and surgeons as they have completely reinvented and invigorated the glaucoma treatment paradigm.

Today, glaucoma is on the rise and continues to be one of the leading causes of blindness and vision loss worldwide. According to the AAO, the number of people with glaucoma around the world will increase to 112 million by 2040, disproportionately affecting people residing in Asia and Africa.¹

New glaucoma laser designs were subtle but meaningful. Some focused more on the type of laser (wavelength), while others went further to focus on which tissue was targeted (iris, ciliary body, trabecular meshwork [TM], sclera). Some lasers were developed as non-invasive for use in an outpatient setting, and others were considered incisional requiring traditional surgery. One of the more critical variables was how the targeted tissue was affected and are categorized as causing thermal coagulation or no tissue destruction, the latter allowing for future, repeatable treatments. With new laser options hitting the market, laser treatment is now being considered as a first-line level of intervention within the glaucoma treatment decision tree. It is crucial at this point to take a good look at which lasers are most effective toward patient safety and outcome.

THE TARGET TISSUE

As mentioned, lasers were developed for its effects on target tissues. The Nd: YAG laser peripheral iridotomy and the Argon laser peripheral iridoplasty were effective on the iris. For targeting the sclera, laser-assisted filtration surgery, such as non-penetrating deep sclerectomy and trabeculectomy (excimer, erbium, CO₂), were available but not widely used.

For the most part, lasers were designed to target the TM or ciliary body. The argon laser trabeculoplasty (ALT), pattern laser trabeculoplasty (PLT), micropulse laser trabeculoplasty (MLT), and the selective laser trabeculoplasty (SLT) all target the TM. Subthreshold SLT is widely used today targeting TM. The other targeted tissue of interest with newer lasers is the ciliary body. Endoscopic cyclophotocoagulation and transscleral diode laser are well-known laser methods targeting the ciliary body. A more modern method is SubLiminal cyclophotocoagulation (SubCyclo).

EVOLUTION OF LASER TRABECULOPLASTY

Laser trabeculoplasty has evolved since the 1970s and has varied in laser types and wavelengths with critical differences. The significant difference is the tissue effect and whether the laser energy destroys, stimulates, or preserves the targeted tissue. The effective outcomes are based on spot size, impact

energy, total energy, inflammation caused, and if you can repeat similar procedures in the future. What we've learned in laser trabeculoplasty is that the older methods do not offer the flexibility needed for today's glaucoma patient. Inflammation has shown to be clinically significant in both ALT and PLT methods and is not repeatable. The newer SLT has demonstrated no inflammation and offers repeatability by utilizing larger spot size with less impact and total energy.

COLLATERAL THERMAL EFFECTS

One of the most critical elements that affect the tissue during any laser treatment is impact duration. Impact duration is directly responsible for the heat accumulation zone, which is the area around the target treatment spot and how much the thermal effect spreads through the surrounding tissue. Of the methods available today, SLT is the only method that produces a very limited thermal

accumulation zone, 1 μm , which is extremely important for the health of the tissue and the possibility of treatment repetitions. Comparatively, PLT produces a thermal accumulation of 50 μm , and ALT produces at 220 μm , which covers the entire TM (Figure 1). The wider the heating zone, the more severe the thermal effect in surrounding tissue which is an unwanted result.

SLT: A SAFE, NON-INVASIVE AND REPEATABLE PROCEDURE

SLT is based on the principle of selective photothermolysis, which relies on selective absorption of a short laser pulse to generate and spatially confine heat to pigmented targets. SLT mechanism causes minimal thermal diffusion and no collateral tissue destruction. Furthermore, it induces cytokine release and macrophages activation, which causes the cleaning of extracellular debris. One of the most important effects of SLT is the stimulation of cell division, increasing and rejuvenating TM and Schlemm's canal porosity. All these factors contribute to increased trabecular outflow and a hypotensive effect. Since its introduction, SLT superseded the other laser trabeculoplasty techniques with fewer adverse events, greater ease of use, and improved repeatability.² These indicators lead us to believe that SLT should be considered as an initial treatment for primary open-angle glaucoma, ocular hypertension, and pigmentary glaucoma.³

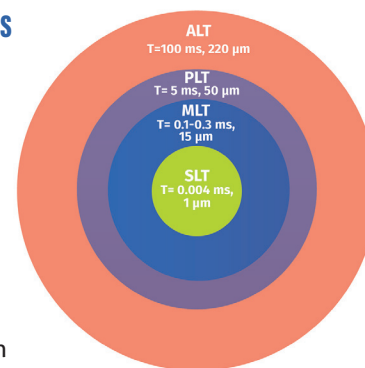


Figure 1. Laser trabeculoplasty: heat cumulation zone.

EVOLUTION OF TRANSCLERAL CYCLOPHOTOCOAGULATION: SUBCYCLO

Transscleral cyclophotocoagulation (TSCPC) was invented in the early 1970s with the Xe, ruby, and diode lasers. The technology at the time was extraordinarily innovative and succeeded in alleviating pain in the blind or visually impaired eye; it was used after multiple surgical failures or when surgery wasn't possible. TSCPC was effective in lowering IOP but caused numerous side effects and severe complications, including pain, uveitis, hypotony, permanent decrease in visual acuity, and phthisis bulbi.⁴ The procedure was not repeatable due to the thermal tissue destruction and was generally considered as a last resort treatment option.

SubCyclo is the latest technology available, featuring a non-destructive laser procedure that is based on traditional TSCPC. SubCyclo is a non-destructive 810-nm laser used to treat open-angle, angle-closure, and even neovascular glaucoma. The technology is specifically designed to reduce the production of aqueous humour, selectively destroying the pigmented ciliary body and resulting in minimal coagulative necrosis. Another benefit of the technology is that it undertakes uveoscleral remodeling which increases outflow through the unconventional pathway. Although SubCyclo is based on TSCPC principles, the differences are significant. The most crucial difference is the tissue effect the laser produces. Unlike traditional TSCPC, SubCyclo is based on pulse technology that delivers a continuous wave of repetitive short pulses with cooling breaks which controls levels of thermal elevation and preserves the structures of the ciliary body. The presence of "cool-off" periods between treating pulses (*Duty Cycle*), eliminates the risk of overheating (leading to tissue thermal destruction) and minimalizes the likelihood of inflammation and other serious adverse effects (Figure 2). The preservation of the ciliary body allows future glaucoma procedures to be repeated.

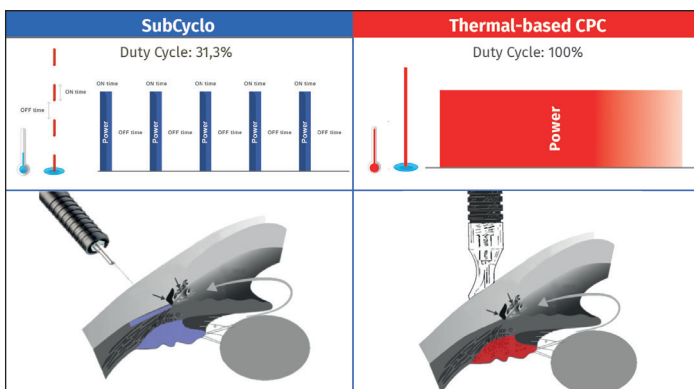


Figure 2. SubCyclo and thermal-based CPC.

RE-THINKING THE THERAPEUTIC ALGORITHM IN GLAUCOMA

Previously, the first line of treatment for glaucoma involved prescribed prostaglandin analogues (eye drops) in reducing and maintaining IOP. This treatment therapy could last for years until the patient reached critical mass and required surgery, which was

thermal TSCPC. That algorithm changed as more lasers were introduced into the field and several MIGS methods were developed. With the introduction of new laser trabeculoplasty technologies, the therapeutic algorithm changed once again. In a randomized controlled study testing SLT versus eye drops for the first line of treatment of ocular hypertension and glaucoma (LIGHT trial), it was concluded that SLT should be considered as a first line of treatment for open-angle glaucoma and ocular hypertension.⁵ We can now consider specific methods of laser trabeculoplasty, such as SLT and SubCyclo, in the same category as eye drops when considering first- and second-line treatment options (Figure 3).

We can offer our patients SLT treatment parallel to drops or make a shift to laser from medications anytime, but we should consider the fact that SLT may work more efficiently in treatment-naïve subjects. Further analysis of LIGHT trial data shows that patients treated first with medications were more prone to undergo rapid visual field progression than those treated first with SLT.

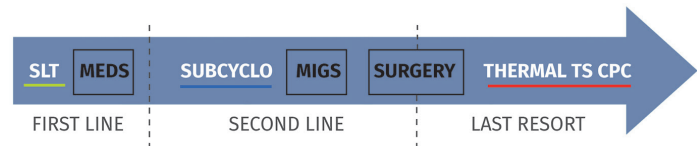


Figure 3. Glaucoma treatment: laser algorithm.

CONCLUSION

As you move through the decision tree of options for glaucoma patients, there are more than enough options to consider, especially in laser treatment, for primary open-angle glaucoma or ocular hypertension, and in some secondary glaucoma pathologies laser trabeculoplasty can be considered as a first and second line of treatment. This includes SLT and SubCyclo. For angle-closure glaucoma, you can choose iridotomy and iridoplasty, and despite having new technology that surpasses in efficacy and outcomes, you can still select thermal TSCPC. How you proceed and the options presented to patients rely on your experience, comfort levels with new technologies, and, ultimately, what is best for your patient. ■

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