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Selective Laser Trabeculoplasty Updates and Tips

How Best to Use Selective Laser Trabeculoplasty in Your Practice

BY MARK LATINA, MD

The glaucoma surgical landscape is bombarded with a variety of new microinvasive glaucoma surgery (MIGS) procedures daily. These new procedures are altering the paradigm and treatment concepts of glaucoma surgery and are accelerating the importance of earlier surgical intervention aimed at reducing morbidity of progression, reducing the need for more aggressive surgical options (while preserving those options), and reducing the burden of medication along with patient-compliance issues, which is one of the most prevalent problems in glaucoma treatment today.

THE CONCEPT OF SUBTHRESHOLD TREATMENT

To Reduce IOP, Is It Necessary to Photocoagulate the TM?

It is widely accepted that argon laser trabeculoplasty (ALT) causes thermal damage through its use of continuous wave laser energy and its correlating factors, such as wavelength, spot size, and energy and duration of treatment.[1,2] We need to move away from this technology and selectively target cells without producing structural or coagulation damage to the trabecular meshwork (TM). Selective laser trabeculoplasty (SLT) uses a short-pulsed laser to selectively target melanin within the TM without causing thermal damage to surrounding cells or tissues. The ideal laser for this targeted outcome is the Q-switched frequency-doubled (532 nm) Nd:YAG laser from Quantel Medical, which produces a biological effect without coagulation.

THE BASIS OF SLT

Selective Photothermolysis Scheme & the Art of Confining Thermal Energy

There are three basic elements at the base of SLT to achieve the confinement of thermal energy:

1. an intracellular target of melanin granule,
2. no competing chromophores, such as hemoglobin, and
3. a short laser pulse to confine the heat energy.

Since SLT mainly targets the melanin granule, thermal relaxation time of the tissue must also be considered. Thermal relaxation time of the melanin granule is 1 µs. If a laser treatment time longer than 1-µs micropulse duration is used, then there is thermal dissipation from the melanin granule into the surrounding tissues. If a laser treatment time shorter than 1-µs micropulse duration is used, then the energy remains within the target.[3] This is the concept behind SLT (Figure 1). Additionally, melanin absorption is very high in the 532- to 600-nm range, which is why green and yellow lasers are used both in the TM and retina.

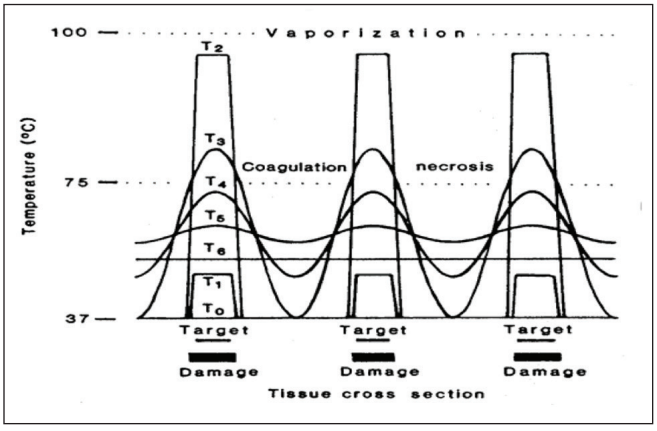

Figure 1. Selective photothermolysis scheme.

THE ADVANTAGES OF SELECTIVITY: A MIXTURE OF PIGMENTED AND NONPIGMENTED TM

In the laboratory setting, the TM cells are fed melanin and irradiated to selectively target the pigmented TM, leaving nonpigmented cells unaffected. With this process, there is no thermal dissipation outside the TM cells. Using an assay of fluorescent dyes, we are able to identify the targeted irradiated cells and leave the nonpigmented cells unaffected.

In ALT there is long pulse duration and continuous wave laser; all of the cells are effectively targeted, and there is a risk of exceeding the threshold, which would vaporize the cells. In contrast, the benefit of SLT is that it functions well below the thermal relaxation time of the tissue and can selectively target the pigmented cells (Figure 2).[4]

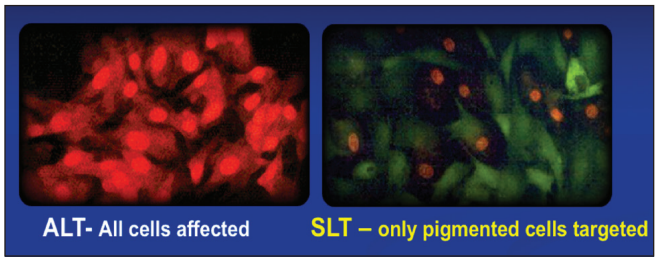

Figure 2. ALT versus SLT thermal absorption (selective vs all cells).

In human organ culture of TM, low-energy SLT is safe and shows no thermal damage compared to high-energy ALT, which shows coagulation damage.[4] This is particularly important when considering MIGS because of the inner and outer scarring of Schlemm canal and TM.[4]

WHEN TO CONSIDER SLT

In our practice, we are using SLT as the primary therapy for primary open-angle glaucoma. Traditionally, the primary therapy was considered to be a prostaglandin analogue (PGA), but that might not be the best treatment to consider first as patient noncompliance may hinder treatment outcomes. Patients with significant IOP fluctuation; visual field progression despite controlled IOP; low-tension glaucoma (LTG); prior canal surgery with MIGS or after MIGS; and chronic angle closure are all important when considering SLT. Considerations for SLT are further made for various other types of glaucoma, including pseudoexfoliation, pigmentary glaucoma, pseudophakia, and steroid-induced glaucoma.

HOLD THAT BOTTLE OF PGA: SLT AS THE PRIMARY THERAPY

The most important therapeutic goal in glaucoma is to keep the patient's IOP controlled while not relying on the patient to control it. Compliance is a critical problem with glaucoma patients. SLT provides 100% compliance because there are no postoperative responsibilities for the patient. Simplifying treatment as much as possible ultimately leads to moving patients off of topical medications, which leads to long-term problems in conjunctival changes making it more difficult to perform glaucoma surgery.

In a multicenter clinical trial comparing SLT to latanoprost ophthalmic solution (Xalatan, Pfizer) as primary therapy, it was statistically shown that SLT was equivalent to medical therapy and just as effective as the PGA (Figure 3).[5]

The efficacy of SLT is also demonstrated in primary angle-closure glaucoma. A randomized clinical trial comparing 50 patients with 180° open-angle TM, treated with either SLT or PGA, showed no difference between SLT and PGA in absolute or percentage IOP reduction.[6]

In a similar study testing outcomes and prognostic factors of SLT for open-angle glaucoma patients receiving the maximum-tolerable medical therapy, or PGA, found that a lower number of preoperative medications yielded

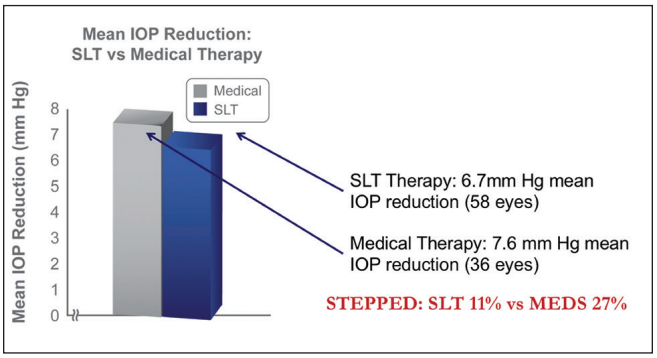

Figure 3. SLT provides equivalent IOP reduction with fewer concerns around side effects and patient compliance.
Adapted from the SLT versus MED study.[5]

a higher success rate with SLT.[7] The overall success rate of patients treated with preoperative medications is 45%, whereas the success rate with SLT as the primary therapy is between 85% and 90%.

As a primary therapy, SLT can be easy to perform and can be completed in a clinical office setting using the YAG/SLT Optimis Fusion laser (Quantel Medical). SLT requires only physician time but saves the patient from taking medications, therefore eliminating patient compliance concerns. Additionally, since there is no scarring of the TM, SLT can be used before or after MIGS procedures.

NUTS AND BOLTS: CLINICAL APPLICATION OF SLT

The best results for SLT as a primary therapy occur with 360° of angle treatment, though 180° of angle treatment is also effective.[8-10] When considering energy levels, energy titration is based on the TM pigmentation. The pigment will influence energy settings. Heavily pigmented TM will require an energy setting of approximately 0.6 mJ; lighter pigmented TM will require a setting of approximately 0.9 mJ. The more pigmented, the less energy required. The desirable endpoint is to see small intermittent cavitation bubbles. Postoperatively, the patient requires very little treatment outside of a topical nonsteroidal anti-inflammatory drug, which is used for only 1 to 2 days following the laser treatment.

The strongest predictor of success in SLT is the baseline IOP correlated with the percentage of IOP reduction. There have been numerous studies testing the effect of SLT for IOP reduction, with more than 10 of those studies showing a 20% to 30% IOP reduction.[11-13] Additionally, the responder rate of SLT after prostaglandin E (PGE) versus aqueous suppressants was significantly higher when the patient was not on PGE as primary therapy.

To demonstrate, a prospective study for baseline factors predictive of SLT response showed that eyes treated without PGE showed statistically greater IOP reduction compared to eyes treated with PGE therapy prior to SLT.[14]

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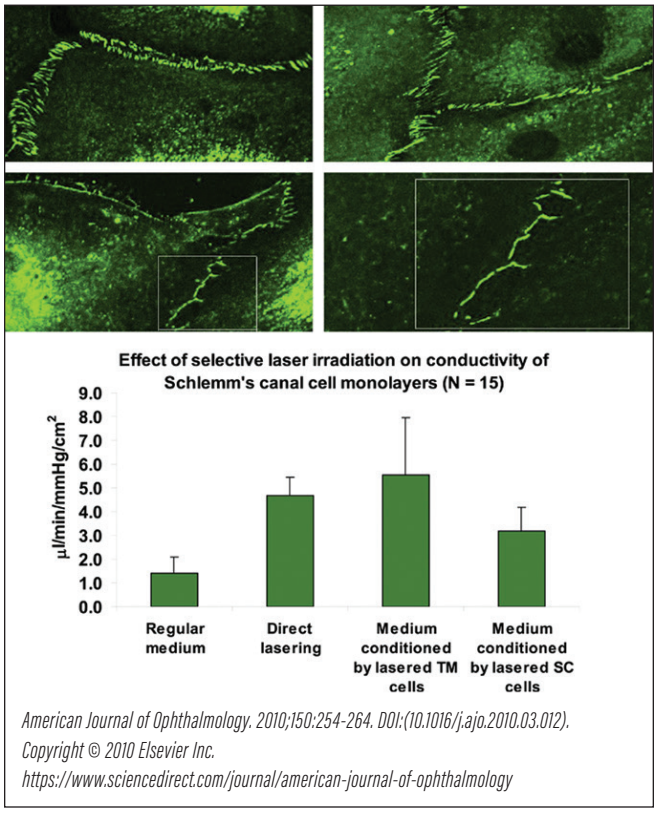

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Figure 4. SLT and PGE permeability of Schlemm canal cells.
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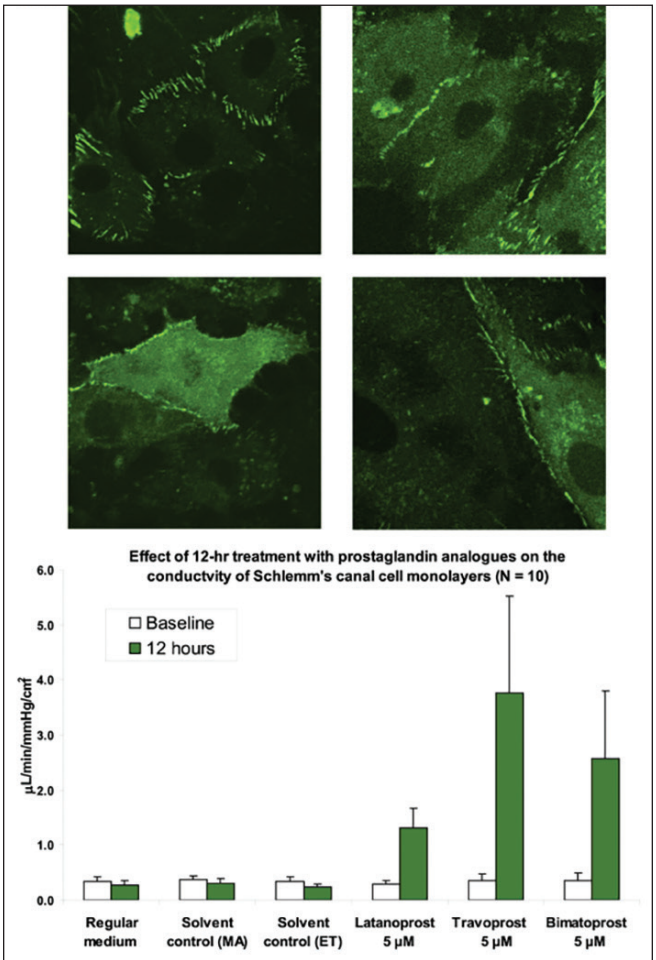

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THINK OF SLT AS AN OUTFLOW TREATMENT THAT CAN ACT LIKE A PGE

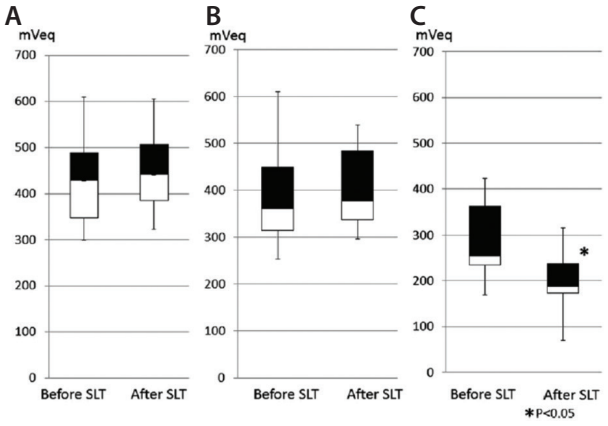
In another study, it was suggested that there are similar effects of SLT and PGE on permeability of Schlemm canal cells.[15] After irradiating Schlemm canal cells, it was found that SLT and PGE are utilizing a similar mechanism and working in a similar manner (Figures 4 and 5). Thinking of SLT as an outflow medication and keeping in mind that the end goal is to lower IOP and introduce complementary mechanisms of action, I prefer to delay PGE (if used at all) and start with SLT with the option of adding inflow medications afterwards.

IS SLT REPEATABLE?

Patients with a successful SLT treatment have a high probability of successful repeat treatment. In a study examining 38 eyes, patients had the first SLT, which lowered IOP.[16] The study reported an average 590-day survival rate. After the second SLT, IOP reduction was lowered further, and the study reported a 1,054-day survival rate. In a similar study looking at the repeatability of primary SLT in patients with primary open-angle glaucoma, the second SLT treatment survived longer than the primary SLT treatment.[17]

REDUCTION OF INTERVISIT IOP FLUCTUATIONS

IOP fluctuations are very important to consider and monitor, especially in patients with more severe glaucoma. In a pure laser study with no medications, 41 patients were treated with 180° and 360° SLT and followed up with after 2 years.[18] It was found that 180° SLT patients reported a 28% IOP reduction, and the 360° patients reported a 35% IOP reduction. In a comparison of 180° and 360° IOP fluctuation, it was found that SLT 360° treatment resulted in statistically reduced IOP fluctuation compared to 180° treatment (< 2.0 mm Hg SD).



Tojo N, Oka M, et al. Comparison of fluctuations of intraocular pressure before and after selective laser trabeculoplasty in normal-tension glaucoma patients. J Glaucoma. 2014;23(8):e138-143. https://journals.lww.com/glaucomajournal/Abstract/2014/10000/Comparison_of_Fluctuations_of_Intraocular_Pressure.20.aspx

Figure 6. The range of IOP fluctuation is shown over 24 hours (A), including time awake (B) and asleep (C).[20]

SLT & LTG

SLT has proven very useful in treating LTG.[19] In the largest prospective study on the efficacy of treating normal-tension glaucoma (NTG) with a single session of SLT,[19] 83 eyes were treated with 360° single-session SLT with a set target IOP at 30% reduction. The results indicated that patients achieved an additional 20% IOP reduction with 27% less medication at 6 months, maintaining a 30% total IOP reduction.

Interestingly, a similar study was conducted comparing fluctuations of IOP before and after SLT in NTG patients.[20] The patients' IOPs were continuously recorded for 24 hours using a Triggerfish contact lens sensor (Sensimed). The study revealed that there was a significant decrease in the range of IOP fluctuation during nocturnal periods (Figure 6).

SLT TREATMENT RECOMMENDATIONS IN PIGMENTARY GLAUCOMA

SLT is an effective treatment in pigmentary glaucoma, but lower pulse energies (0.4 mJ to 0.5 mJ) are required; physicians do not want to observe a cavitation bubble formation, and they must be careful of the intra- and extracellular melanin TM. For this therapy, check for postoperative IOP spikes at 1 hour and within several days following treatment. Long-term outcomes of SLT treatment in pigmentary glaucoma patients showed a higher failure rate, and patients needed to be retreated typically in two sessions at 180° per session as needed.[21]

SLT—A VIABLE FIRST-LINE THERAPY

In conclusion, SLT has a low complication rate with minimal systemic side effects.[22,23] Patients are typically pretreated with iopidine. Postoperative IOP spikes can occur in about 5% of patients and usually within the first 2 hours.[22,23] With pigmentary glaucoma, it is recommended to use lower energy and fewer spots, taking note of persistent IOP spikes.

From a patient perspective, SLT is offered as an in-office laser procedure with an 85% to 90% success rate without the need of medications.[24] Considering the alternative of paying for and using medications daily, most patients opt for SLT as primary therapy.

SLT simplifies glaucoma management, allows earlier treatment, provides a viable primary therapy, and may offer a predictive response to future MIGS therapies. ■

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