Ten Key Points Regarding SLT

1. Selectivity and Minimal Damage of Target Tissue

The frequency doubled Nd:YAG laser used in the SLT platform utilizes a wavelength of 532 nm, a spot size of 400 microns, and a pulse duration of 3 nanoseconds. These parameters allow for the selective absorption of laser energy by pigment-containing chromophores in the trabecular meshwork.1 This limits the amount of laser energy absorbed and its spread to adjacent tissue, and prevents the thermal damage (coagulative necrosis) seen with the use of an argon laser.

**Dr. Robert Noecker** published some of the original histological comparisons of ALT and SLT,2 and notes, "In terms of SLT, the pulse duration is very short, so it’s below the thermal relaxation time and there is really no appreciable heating occurring in the cells that are targeted. At the other extreme is ALT, which is applied for a relatively long duration of time. As we’ve seen in scanning electron micrographs, this causes coagulative necrosis, which leads eventually to formation of PAS (peripheral anterior synechiae). Even with MLT (micropulse laser trabeculoplasty), which has intermittent pulsing, there is still the potential for heat-related damage and coagulative necrosis.”

2. Mechanism of Action: Trabecular Outflow

Laser trabeculoplasty is one of the few glaucoma treatments that address the key problem in open-angle glaucomas: decreased trabecular outflow facility. There are several theories of how it exerts this effect, but it is agreed that this is a biologic response.

**Dr. Jorge Alvarado** is on the forefront of basic science research of aqueous outflow and has published several studies on the effects of selective laser trabeculoplasty3–6: “The laser recruits monocytes to the lasering site in the outflow pathway. These monocytes become macrophages and may be a mechanism for clearing the system from obstructive particulate matter. In addition, the laser initiates a signaling system involving key factors such as cytokines released by the trabecular meshwork endothelial cells. These factors move with the aqueous and then bind to the outflow barrier, which is formed by the Schlemm’s canal endothelial cells. Through an effect on cellular junctions or additionally via cytoskeletal changes, they open the barrier.”

3. Clinical Efficacy of SLT

SLT is quite effective as primary or adjunctive treatment to lower IOP. Many clinical trials have shown an IOP reduction of approximately 30%, and demonstrate equality to the most potent class of glaucoma medical therapy: prostaglandin analogues. 7,8

**Dr. Madhu Nagar** has performed many clinical trials on the effect of SLT, including randomized trials comparing it to a prostaglandin analog and also the effect of various degrees of treatment.9 “We have seen a mean IOP decrease of 30% from untreated baseline in our studies, which mimics what is seen in prostaglandin analogues. Treating 360 degrees initially gives the greatest effect. In my experience, the higher the baseline pressure, the better the response, be it in treatment of naïve patients, those where treatment has been washed off, or as an add-on to medications.”

4. Minimal Side Effects and Excellent Risk Profile

One key aspect of SLT is a favorable side-effect profile, even when compared with glaucoma medications. Postoperative inflammation is common but generally mild, and treated with observation, a topical or systemic non-steroidal anti-inflammatory drug, or rarely, topical steroids. The incidence of IOP spike is generally 5% or less, and can be limited by following expert recommendations. In the treatment of primary open-angle glaucoma or steroid-induced glaucoma, a 360 degree treatment is recommended. Most experts agree that a lower power level (barely enough to elicit cavitation bubbles 50% of the time or less) with more treatment spots (up to 200) gives the best ratio of efficacy to side effects. In patients with excessive angle pigmentation such as pigment dispersion glaucoma and pseudoexfoliation glaucoma, much lower powers are used and the treatment can be performed segmentally.

**Dr. Frank Howes** had several comments related to side effects of medications compared to SLT. “As ophthalmologists I think we tend to forget the rare but potentially serious systemic risks of some glaucoma medications such as reduced cardiac and pulmonary function. In addition, ocular surface disease is a real issue with topical therapy. I think with SLT there is a diminishment of conjunctival scarring by the regular use of this modality as opposed to a treatment (medications) that you’re putting a toxin onto the surface of the eye. From the moment patients use it, you are beginning a scarring crisis. With SLT, then, we’re increasing the chance of surgical success. The patients see better and they get less corneal disease: It’s a positive benefit cycle.”

5. Eliminate Compliance Issues

While medical therapy for glaucoma is quite effective, it still relies on the regular and proper administration of the drug to achieve its effect. The use of SLT gives 100% compliance: The physician performs the treatment and knows whether it is effective or not without wondering if glaucoma therapy is being applied correctly.

**Dr. Jay Katz** notes, “I think you can make a strong argument in favor of primary therapy with SLT because we know what a huge problem there is with adherence to medical therapy. The best assumption we have out there is that 50% of our patients are truly compliant with medical therapy.”

6. Favorable Individual and Societal Cost Profile

The issue of cost of glaucoma treatment is twofold: the cost to the individual patient and the cost to society.

According to **Dr. Jay Katz,** “The cost issue is timely, as healthcare expenditures across the world in every country are at the top of the list for concern. Laser trabeculoplasty has been examined in Canada by Dr. Hutnik’s group a few years ago looking at their health care system.10 We’ve done some modeling analysis in the United States with Dr. Cantor’s group, and there is the work being done in Australia. I think the consensus is that, when you’re looking at laser trabeculoplasty as an initial therapy, it seems to be a winner when compared to medical therapy, or even incisional surgery. “

**Dr. Kate Coleman**, Head of the African Multicenter Glaucoma Study and African Glaucoma SLT Trial, added, “One has to also keep in mind the cost of the human resource in delivering the laser versus the qualifications to prescribe a drug. And on top of that, the cost effectiveness of returning somebody into society who’s making an economic contribution. If you’re picking up a treatment that is cost effective to roll out in a supervised fashion at a triage level to a much larger volume of patients, and if you’re going to prevent those patients from entering into the dependency sector for their needs with blindness at an earlier stage, that’s worth billions to the economy.”

7. **Effectiveness of SLT as Adjunctive Treatment**

SLT is also useful as an adjunct to medical therapy and prior failed argon laser trabeculoplasty. Those groups of patients who are uncontrolled despite medical and possibly prior laser therapy are the most challenging, and are often being considered for glaucoma filtration surgery.

**Dr. Mark Latina**, the inventor of SLT and primary investigator in the pivotal trial, discussed the patients treated in this initial clinical study.7 “We enrolled two groups of patients: both with uncontrolled IOP on maximally tolerated medical therapy, but the second also with prior failed ALT. Even in these patients with glaucoma refractory to medical and laser therapy, the results did show that there was about a 65 percent success rate in both groups. Based on those results, we feel that SLT is a viable alternative in patients who have had prior argon laser trabeculoplasty and those that have failed medical therapy.”

8. Replacing Medical Treatment

The typical glaucoma practice consists of treatment naïve patients, those uncontrolled with medical therapy, and the majority group of those controlled with medical therapy. SLT can be used in this latter group as a replacement therapy to reduce dependence on medications.

According to **Dr. Rob Noecker**, “Even glaucoma patients who have good IOP on medications are candidates for SLT. The concept of medical substitution was explored in an early paper by Francis and colleagues.11 The laser may be useful in getting patients off of drops. Even if the IOP is controlled, you’re trying to improve quality of life both economically or with regards to side effects.”

9. Reducing IOP Fluctuation

The importance of diurnal and long-term IOP fluctuation in glaucoma progression has been shown in studies by Asrani, and a secondary analysis of patients in the Advanced Glaucoma Intervention Study (AGIS).(12,13 As shown in sleep studies by Weinreb, selective laser trabeculoplasty may help to limit the IOP fluctuation that can lead to progressive optic nerve damage and vision loss.14

**Dr. Mark Latina** notes, “I think another important point regarding SLT treatment is that we’re not only lowering pressure but we’re reducing IOP fluctuation, which is perhaps, at least in normal tension glaucoma, probably the most important factor for progression, as well as in patients with advanced glaucoma, according to the AGIS study.”

“Normal tension glaucoma is unique in that patients whom we followed over 10 years had pressures that were basically within the normal range, but they would keep fluctuating and the disease would keep getting worse,” says **Dr. Sanjay Asrani** “We found that, following the SLT, there was no significant pressure drop in the mean pressures, but their pressure stabilized like nothing else.15 And the pressure standard deviation and range dropped much more significantly than the mean pressure. Even if the pressure in the office remained at the same level, the disease would stabilize and the disc hemorrhages stopped.”

10. Repeatability of SLT

The final discussion point centers around the ability to repeat treatment with SLT. Most experts define this as treatment of the entire angle with successful IOP lowering for a period of time, followed by diminished response over time, then repeated 360 degree treatment. A study by Hong et al. showed that the IOP-lowering effect of the first SLT treatment was the same as the second laser repeated after at least 6 months.16 Data from a multicenter trial involving the Doheny Eye Institute, Wills Eye Hospital, California Pacific Medical Center, Pacific Eye Institute, and Yale University were presented at the American Glaucoma Society 2011 meeting and showed similar findings with a larger study population. 17 It was found that the final IOP was equivalent after the initial and repeat SLT, and when baselines were matched, the magnitude of IOP lowering was almost identical.

The ability to repeat the laser sets SLT apart from ALT and increases its usefulness in the lifetime treatment of a glaucoma patient.

According to **Dr. Mark Latina**, “As far as repeatability is concerned, the idea behind it was that we’re not causing thermal damage to the trabecular meshwork. We’re not fusing the Schlemm’s canal or trabecular beams together, which can occur with argon laser trabeculoplasty. So, once we’ve treated these patients and they have a rise in pressure over time, we can go back and treat them again successfully.”

Says **Dr. Jay Katz**, “Previously, with argon laser trabeculoplasty there was the consideration that it had a finite life and you’re just delaying things. However, with SLT, when we look at the repeatability studies that are coming out now, whether they’re retrospective or not, they all seem to indicate that you can even get the effect to continue for years upon re-treatment.”

Conclusion

In the ten years since the FDA approval of selective laser trabeculoplasty for the treatment of open-angle glaucomas, the 10 unique features that have emerged are: 1) selectivity and minimal tissue damage of target tissue, 2) mechanism of action of increasing trabecular aqueous outflow facility, 3) efficacy equal to that of the most potent class of glaucoma medications, 4) excellent safety and side effect profile, 5) ability to improve patient compliance, 6) ability to decrease patient cost of treatment as well as societal economic burden of glaucoma treatment, 7) success as an adjunctive treatment in patients who have failed medical or prior laser therapy, 8) reduction of glaucoma medications in patients with medically controlled IOP (replacement therapy), 9) reduction in diurnal IOP fluctuation, and 10) repeatability of SLT in previously treated patients.

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