A COMPLICATION-FREE APPROACH TO GLAUCOMA THERAPY

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Selective Laser Trabeculoplasty is a safe, simple and effective treatment modality and is known for its high benefit-to-risk ratio. Very few side effects have been noted and reported with SLT, suggesting a limited risk of complications as compared to other glaucoma therapies. Indeed, compared to medications, which can cause various systemic and ocular side effects, SLT is virtually free of complications.
Since its introduction in 2001, Selective Laser Trabeculoplasty (SLT) has been gaining steady popularity as a treatment option for various types of glaucoma. Indeed, the number of laser trabeculoplasty (LTP) procedures performed in the United States and worldwide more than doubled between 2001 to 2004 alone.1,2 One of the reasons for the rapid adoption of SLT has been the absence of complications, or only rare, minor, and transient complications associated with the procedure. In fact, the complications that I have observed with SLT are minimal and self-limiting; hence I prefer to call them adverse effects rather than complications.

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Common Adverse Effects of SLT

The most common adverse effects of SLT include blurred vision for 5-10 minutes after the procedure, mild discomfort during laser delivery, redness for a few hours to a day or two, and sore eyes and photosensitivity for a day or two. However, these side effects are minor and transient, require no treatment, and do not have any impact on long-term vision.3 (For a summary of adverse effects following SLT treatment, as reported in peer-reviewed journals, refer to Appendix 1 on pages 28-33.)

Another common adverse effect seen with SLT is a transient increase in intraocular pressure (IOP) following the procedure. This has been seen in all published reports and is independent of the use of pre-operative hypotensive prophylaxis.2 This increase in IOP typically ranges from 2 mmHg to >10 mmHg in 2-38% of patients.2 In most cases, the IOP spike resolves spontaneously within a day or two without the need for anti-hypertensive medication.

Anterior uveitis is also another commonly reported adverse effect of SLT. Latina et al., in their multi-centre trial published in 1998 in Ophthalmology, found that approximately 83% of eyes had mild-to-moderate anterior chamber inflammation.4 This was visible one hour after SLT treatment, decreased by 24 hours, and was resolved within five days.4 Another recent single case study by Koktekir et al. published in Clinical & Experimental Ophthalmology also demonstrated severe bilateral anterior uveitis after unilateral SLT.5 The inflammation disappeared within two weeks of topical anti-inflammatory therapy. On the other hand, a 64-eye prospective study by Klamann et al. published in Journal of Glaucoma found SLT to be effective without any adverse effects, such as anterior chamber inflammation or increased macular thickness.6

A study by Martinez-de-la-casa et al. in 2004 measured flare using a laser flare meter and also found that inflammation was significantly lower after SLT than after ALT.7 Furthermore, an 80-eye study by Ayala et al. published in Acta Ophthalmologica found that none of the eyes had anterior chamber inflammation after 90° SLT.8 Therefore, although these side effects are known to occur, they don’t necessarily occur in all patients.

Minimizing Side Effects While Maximizing Success

My own research over the past several years with SLT has revealed that factors such as baseline IOP and degree of treatment can affect the success of SLT, while increased pigmentation of the trabecular meshwork (TM) is responsible for post treatment IOP spike. A study that I published in British Journal of Ophthalmology in 2005 comparing the effect of 90°, 180°, and 360° treatment with SLT and latanoprost in a randomized clinical trial found that although the response rate and success rate of SLT were higher with a greater degree of area treated, so was the incidence of adverse effects.2 Therefore, while the success rate was greater with 360° than 180° and 90° treatment (82% with 360°, 65% with 180°, and 34% with 90-degree treatment respectively), I found that the incidence of the most common adverse effect in the study population, uveitis, was also higher with 360° than 180° and 90° treatment (50% after 360°, 41% after 180°, and 31% after 90°). (Refer to Figure 1.) Similarly, post-SLT IOP spikes and transient pain and discomfort during treatment were also more common after 360° treatment (IOP spikes: 27% after 360°, 16% after 180°, and 11% after 90°; pain/discomfort: 39% after 360°, 20% after 180°, and 6% after 90° SLT).8

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**Figure 1: Comparison of Treatment Success and Adverse Effects with 360°, 180° and 90° SLT**

<table>
<thead>
<tr>
<th></th>
<th>360 Degree</th>
<th>180 Degree</th>
<th>90 Degree</th>
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<tbody>
<tr>
<td>Success Rate (%)</td>
<td>82</td>
<td>65</td>
<td>34</td>
</tr>
<tr>
<td>Incidence of Uveitis (%)</td>
<td>50</td>
<td>41</td>
<td>31</td>
</tr>
<tr>
<td>IOP Spike (%)</td>
<td>27</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>Transient Pain/Discomfort (%)</td>
<td>39</td>
<td>20</td>
<td>6</td>
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“... factors such as baseline IOP and degree of treatment can affect the success of SLT while increased pigmentation of the TM is responsible for post treatment IOP spike.”

I have also observed that patients with increased angle pigmentation, for example patients with pigmentary glaucoma, pigment dispersion syndrome or pseudoexfoliative glaucoma, tend to show higher IOP spikes following SLT treatment. Writing in Eye News, I reported the case of a young patient with pigmentary glaucoma, pigment dispersion syndrome or angle pigmentation, for example patients with pseudoexfoliative glaucoma, tend to show higher IOP spikes following SLT treatment. In a case series by Harasymowycz et al., two of the patients had also previously undergone argon laser trabeculoplasty (ALT) in the same eye, suggesting that patients with previous ALT and a heavily pigmented TM may be at increased risk for IOP spike.11

More recently, I performed a contralateral eye study comparing the effect of 50 shots of 360° SLT versus 100 shots of 360° SLT, the results of which are yet to be published. What I found was that by using only 50 shots of SLT as opposed to 100 shots, I could still achieve the same 28-30% drop in IOP, while considerably reducing adverse effects. Therefore, I am now moving towards a protocol of using 360-degree SLT with only 50-60 shots to maximize success and minimize adverse effects. I also no longer prescribe anti-inflammatory medications following SLT though I still use timolol drops pre- and instead of one session of 360° SLT with 100 shots in order to minimize the IOP spike. Interestingly, in the case series by Harasymowycz et al., two of the patients had also previously undergone argon laser trabeculoplasty (ALT) in the same eye, suggesting that patients with previous ALT and a heavily pigmented TM may be at increased risk for IOP spike.11

Rare Adverse Effects Associated with SLT

1. Peripheral Anterior Synaechia
Peripheral anterior synaechia (PAS) is a rare complication associated with SLT. A prospective, randomized clinical trial by Damji et al. published in British Journal of Ophthalmology comparing SLT and ALT found an incidence of 1.1% of PAS in SLT patients, which was similar to the percentage of ALT patients with PAS.12 There are no other reported cases of PAS in the published literature.

2. Corneal Complications
Two case reports also demonstrate the incidence, albeit rare, of corneal edema that is accompanied by haloes, pain, and reduced vision following SLT.13,14

3. Other Rare Adverse Effects
Other rare adverse effects that have been noted with SLT include one case of hyphema three days following treatment in a 77-year-old woman treated for open-angle glaucoma, reported by Phee et al. in Ophthalmic Surgery, Lasers, and Imaging; one case of bilateral diffuse lamellar keratitis following SLT in a patient who previously underwent laser in situ keratomileusis (LASIK) as reported by Holz et al. in Ophthalmic Surgery, Lasers, and Imaging; one case of severe iritis and choroidal effusion reported by Kim and Singh in the same journal.16,17

The reasons for the observed adverse effects are not well understood. However, they may be a result, at least partially, of molecular changes that occur in the TM upon laser treatment. A recent study by Izzotti et al. published in PLoS One showed that although TM cells do not undergo phenotypic alterations (as measured by scanning electron microscope) following exposure to SLT, they undergo a host of gene expression changes. Genes involved in cell motility and contraction, tissue integrity, and ion exchange showed the greatest changes in expression.21
post-SLT to prevent/control or blunt the post-SLT IOP elevation. Though initial response to 360° treatment with 50-60 shots is comparable to 360° treatment with 100 shots, long term data (3-5 years) is awaited.

**Practically Risk Free**

In spite of these few adverse effects, SLT provides a safer and more effective treatment option than ALT and medication. Indeed, SLT has one of the highest benefit-to-risk ratios of all ophthalmic procedures. The greatest advantage of SLT is that it is not associated with the permanent scarring of the TM seen with ALT. Kramer and Noecker reporting in Ophthalmology in 2001 compared the effect of SLT and ALT on TM structure using scanning and transmission electron microscopy and found that SLT did not cause the same coagulative damage nor trabecular beam structure disruption caused by ALT.22 Furthermore, SLT is as good as first-line medical treatment without the ocular and systemic side effects of medications. Medications are associated with a host of ocular side effects such as itching, burning, change in iris colour, and discoloration around the eyes, as well as systemic side effects such as headaches, pain, vision problems, brachycardia, and depression.22,23,24,25,26 As an added benefit, SLT is also free of the compliance issues associated with medications. It works 24 hours a day, 7 days a week, not just keeping IOP under control but also reducing IOP fluctuations.27 Eventually, this translates into reduced cost of glaucoma care, not only due to less dependence on medications but also by reducing the number of clinica visits required. For instance, if a patient on eye drops returns to the clinic with elevated IOP a few years after initiation of medical treatment, a few clinic visits are typically required to determine the reason for the IOP increase - Is the patient being compliant? Is he/she using the drops correctly, spacing them as advised etc.? Or is tachyphylaxis the reason for elevated IOP? But with SLT, the management protocol is much simpler. If patients present with elevated IOP a few years after treatment, it is because the effect of SLT is wearing off and the management decision is either to repeat SLT or start medical therapy depending on clinical need and the patient’s choice. In short SLT takes pressure control out of the hands of the patient and puts it back into the hands of the ophthalmologist.

Safety Comes First with SLT

I strongly recommend SLT for the treatment of glaucoma and ocular hypertension: it is more patient-friendly than medication, is associated with minimal, transient adverse effects and is more cost effective over the long-run. Personally, I find that SLT works best as a first-line therapy: if I were making a treatment decision for glaucoma for my family, or myself, I would certainly choose SLT. Today, I offer SLT to all my patients and find that most of them prefer it. In fact, the most grateful patients are those who switch from topical drugs to SLT since they no longer need to live with a constant reminder of their condition.

**Madhu Nagar, FRCS Ophth, MS Ophth**

Mrs. Nagar is a consultant ophthalmologist at Pinderfields Hospital, Wakefield. A leading proponent of SLT, she has undertaken several studies investigating the efficacy of SLT for glaucoma management and offers it as a first-line treatment, adjunctive treatment and as a replacement therapy. Mrs. Nagar has over 13 years’ experience with SLT and has performed the treatment on more than 1000 eyes.
## Appendix 1: Summary of Adverse Effects Following SLT as Reported in Peer-Reviewed Journals

<table>
<thead>
<tr>
<th>Paper/Study</th>
<th>Perioperative Hypotensive Prophylaxis</th>
<th>Definition</th>
<th>Rate</th>
<th>Anterior Chamber Inflammation</th>
<th>Pain/Discomfort During or After Treatment</th>
<th>Other</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Latina et al</td>
<td>None</td>
<td>≥ 5 mm Hg</td>
<td>13 eyes (25%)</td>
<td>83% mild-to-moderate reaction, resolved within 5 days in all cases</td>
<td>15%</td>
<td>Redness in 9%</td>
<td>No PAS in any case</td>
</tr>
<tr>
<td>2. Latina et al</td>
<td>None</td>
<td>≥ 8 mm Hg</td>
<td>5 eyes (9%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Lanzetta et al</td>
<td>None</td>
<td>10 mm Hg</td>
<td>1 eye (16.7%)</td>
<td>No “significant” inflammation</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Kajiya et al</td>
<td>&gt; 6 mm Hg</td>
<td>6 eyes (33.4%)</td>
<td></td>
<td></td>
<td></td>
<td>No complications reported</td>
<td></td>
</tr>
<tr>
<td>4. Chen et al</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No complications reported. No patient needed acute IOP-lowering or anti-inflammatory treatment</td>
<td></td>
</tr>
<tr>
<td>5. Grancer</td>
<td>0.5% apraclonidine</td>
<td>IOP elevated 2 mm Hg at 3 hours</td>
<td>3 eyes (6%)</td>
<td>&quot;No significant anterior segment inflammation&quot;</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Hodge et al</td>
<td>1% apraclonidine</td>
<td>≥ 6 mm Hg at 1 hour</td>
<td>4 eyes (6%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Damji et al</td>
<td>1% apraclonidine</td>
<td>IOP elevated 3 mm Hg at 1 hour</td>
<td>2 eyes (5.6%)</td>
<td>Mean cells at 1 hour -1.6 after SLT, 0.9 after ALT (statistically significant)</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Damji et al</td>
<td>apraclonidine or brimonidine</td>
<td>IOP elevated ≥ 6 mm Hg at 1 hour</td>
<td>4 eyes (2.8%)</td>
<td></td>
<td>PAS developed in 1 eye (1.1%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Appendix 1: Summary of Adverse Effects Following SLT as Reported in Peer-Reviewed Journals continued

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<th>Other</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Martinez-de-la-Casa et al</td>
<td>None</td>
<td>Mean IOP elevation</td>
<td>1.93 ± 3.4 mm Hg in 20 eyes after SLT [3.0 ± 4.8 mm Hg in 20 eyes after ALT]</td>
<td>Flare (by laser flare meter) significantly lower in eyes after SLT compared with ALT</td>
<td>Pain significantly lower after SLT compared with ALT</td>
<td></td>
<td>No change in visual acuity, cup/disc ratio, or visual field mean defect during 12 months follow-up</td>
</tr>
<tr>
<td>10. Melamed et al</td>
<td>None</td>
<td>&gt; 5 mm Hg at 1 hour</td>
<td>5 eyes (11%)</td>
<td>Mild flare and conjunctival redness and injection in 30 eyes (67%)</td>
<td></td>
<td>18 patients (58%)</td>
<td></td>
</tr>
<tr>
<td>11. Lai et al</td>
<td>1% apraclonidine</td>
<td>&gt; 5 mm Hg</td>
<td>3 eyes (10.3%)</td>
<td>“No persistent reaction beyond 1 week”</td>
<td></td>
<td></td>
<td>No patient had an increase in TM pigmentation or formation of PAS</td>
</tr>
<tr>
<td>12. Gracner et al</td>
<td>0.5% apraclonidine</td>
<td>IOP elevated 3 mm Hg at 3 hours</td>
<td>20% of XFG 10% of POAG</td>
<td>“No significant anterior segment inflammation”</td>
<td></td>
<td>None</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IOP elevated 2 mm Hg at 3 hours</td>
<td></td>
<td>10% of POAG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Song et al</td>
<td>Varied</td>
<td>IOP &gt;30 mm Hg or increased elevation &gt; 30%</td>
<td>3 eyes (3.2%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Francis et al</td>
<td>Brimonidine tartrate 0.2%</td>
<td>IOP increased between 5-9 mm Hg</td>
<td>6 eyes (9.1%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IOP increased 10 or more mm Hg</td>
<td>2 eyes (3.0%)</td>
<td></td>
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</tr>
<tr>
<td>15. Nagar et al</td>
<td>None</td>
<td>&gt; 5 mmHg at 1 hour</td>
<td>3 eyes (9%) after 90° SLT, 8 eyes (16%) after 180°, and 12 eyes (27%) after 360°</td>
<td>31% after 90° SLT, 41% after 180°, and 50% after 360°</td>
<td>6% after 90° SLT, 20% after 180°, 39% after 360°</td>
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</thead>
<tbody>
<tr>
<td>16. Cvenkel</td>
<td>None</td>
<td>≥ 5 mm Hg within 2 hours</td>
<td>4 eyes (9.1%)</td>
<td>1+cells in 9 eyes (20.5%)</td>
<td>2+cells in 7 eyes (19.9%)</td>
<td>None</td>
<td>Anterior chamber reaction was observed 1h after SLT and disappeared within 24h in all cases. No PAS noted 2 months after SLT</td>
</tr>
<tr>
<td>17. Kim et al</td>
<td>None</td>
<td>≥ 5 mm Hg within 2 hours</td>
<td>6 eyes (37.5%)</td>
<td>“Mild to moderate anterior chamber reaction in 68.8% of eyes”</td>
<td>None</td>
<td>Anterior chamber reaction and early rise in IOP quickly resolved with drops</td>
<td></td>
</tr>
<tr>
<td>18. Johnson et al</td>
<td>topical alpha agonist and prednisolone acetate</td>
<td>≥ 5 mm Hg or 10% of baseline within 1 hour</td>
<td>2 eyes (12.5%)</td>
<td>None of the eyes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. McIraith et al</td>
<td>brimonidine 0.2% and pilocarpine 1%</td>
<td>&gt; 2 mm Hg at 1 hour</td>
<td>None of the eyes</td>
<td>1+ cells in 48%, 1+ flare in 4% of eyes after 1 hour</td>
<td>None of the eyes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Harasymowycz et al</td>
<td></td>
<td></td>
<td>4 eyes with a heavily pigmented TM developed markedly elevated IOP following SLT; three of which needed trabeculectomy.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>21. Klamann et al</td>
<td></td>
<td></td>
<td>No significant increase in macular thickness was demonstrated due to SLT inflammatory reaction.</td>
<td></td>
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</tr>
<tr>
<td>22. White et al</td>
<td></td>
<td></td>
<td>Transient corneal endothelial changes that have no impact on cell count or visual acuity.</td>
<td></td>
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<tr>
<td>23. Holz et al</td>
<td></td>
<td></td>
<td>One report of bilateral diffuse lamellar keratitis following consecutive SLT in a LASIK patient.</td>
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</table>

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References


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