

# Argon versus Selective Laser Trabeculoplasty

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## CASE REPORT

A 79-year-old man of African ancestry is referred for management of glaucoma. His medical history is notable for hypertension, diabetes mellitus, and seasonal allergies. His brother is also your patient, and has moderate open-angle glaucoma with field loss. Current systemic medications include Atenolol and an oral hypoglycemic agent. Visual acuities are OD 20/25 and OS 20/30 (OU, +.75 sphere). Slit-lamp biomicroscopy reveals mild, diffuse conjunctival hyperemia and papillae, which the patient relates to “hay fever”. Both corneas are clear, with thicknesses of 500 and 490  $\mu\text{m}$ , in the right and left eyes, respectively. Both anterior segments are deep and quiet, and both angles are open, without synechiae and trace pigmentation, to ciliary body for 360°. Intraocular pressures are OD 20 mm Hg and OS 24 mm Hg on latanoprost OU q.h.s. (pre-treatment IOPs are not known). Stereoscopic examination reveals asymmetric glaucomatous optic neuropathy, left eye greater than right, which is confirmed using confocal scanning laser ophthalmoscopy. An early superior arcuate scotoma is present in the right eye, and a superior nasal step and paracentral scotoma are present in the left eye.

## Questions:

1. How effective and safe is laser trabeculoplasty and when would you use it?
2. Are there any indications for laser trabeculoplasty as the initial management of ocular hypertension or glaucoma?
3. How do argon laser trabeculoplasty and selective laser trabeculoplasty differ? Are there any theoretical or practical clinical differences between them?

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## COMMENTS

Comments by Gail Schwartz, MD, Glaucoma Consultants, Greater Baltimore Medical Center, Baltimore, Maryland

This patient has definite glaucomatous optic nerve damage, relatively thin central corneas, a brother with glaucoma, and is on a systemic beta-adrenergic antagonist. We do not know his untreated intraocular pressure (IOP), cup-to-disc ratio, or his response to topical medication, such as the latanoprost. It is clear that his IOP is inadequately controlled. His options include switching or adding topical medications and/or laser trabeculoplasty. Considerations of incisional surgery should be deferred until other, more conservative options are attempted.

Laser trabeculoplasty, including both argon laser trabeculoplasty (ALT) and selective laser trabeculoplasty (SLT), is extremely safe. The effectiveness and duration of effect vary among patients. In patients with ocular hypertension or early glaucoma, I consider trabeculoplasty as an alternative to medications as primary therapy, as supported by the National Eye Institute’s Glaucoma Laser Trial (GLT),<sup>1,2</sup> though most patients choose drop therapy prior to moving to laser trabeculoplasty. In clinical practice, I most commonly offer laser trabeculoplasty after the patient has tried or is using 1 or 2 topical glaucoma medications with inadequate IOP control.

Practical issues in this patient include choosing the appropriate target range and assessing the optimal means to achieve this goal. Although laser trabeculoplasty offers a compliance-free, safe intervention, it realistically may not offer enough IOP lowering for this gentleman, and he would likely require a target in the low teens, particularly given his relatively thin cornea thickness.

Argon laser trabeculoplasty (ALT) and SLT offer different approaches to a similar treatment, and their precise mechanisms of action are not entirely clear. ALT was initially thought to induce thermal alterations of the trabecular meshwork, such that the trabecular beams adhere to each other, widening the inter-trabecular spaces, thereby facilitating outflow but inducing scarring. More current thought regarding the mechanism of action suggests that thermal alterations of the trabecular meshwork initiates a biologic cascade of events that results in enhanced outflow. SLT is thought to selectively target the pigmented trabecular cells with short pulses of low en-

ergy, causing a photochemical rather than coagulative reaction, with less scarring. Both ALT and SLT stimulate macrophage recruitment and release of cytokines. The macrophages in turn engulf the debris in the trabecular meshwork, improving outflow. ALT may also induce macrophage recruitment as a byproduct of photocoagulation. ALT is more effective in more pigmented angles as compared with lightly pigmented angles; SLT has been reported to be independent of the overall level of trabecular pigment. Most patients undergoing ALT will have 1 session of 360° or 2 sessions of 180°. ALT retreatment of previously treated areas is not commonly performed and may be more likely to produce a post-laser IOP rise. Small peripheral anterior synechiae have been reported to be common after ALT, but these limited synechiae did not adversely affect the IOP outcome in the GLT, which was performed in an era where the amount of energy delivered per application was considerably higher than it is today. Synechiae are uncommon following SLT as there is less photothermal injury. In theory, SLT should not induce as pronounced structural changes in the TM as ALT, leading to speculation that it may be possible to perform repeated treatments of the same areas of meshwork, although this remains to be proven in a prospective clinical trial. IOP outcomes have not been reported to differ statistically between the two procedures in previously unoperated eyes. There may be slightly more inflammation in the first week post-laser with SLT, which in several studies has not caused any long-term adverse events. A postoperative rise in IOP may occur after either procedure.

Specific to this patient, laser trabeculoplasty is a very reasonable option and the one I would select, but most likely in conjunction with a different medical regimen. The results of the Advanced Glaucoma Intervention Study support the early use of trabeculoplasty in African-American patients.<sup>3</sup> I would choose SLT over ALT based on the theoretical lack of ultrastructural damage and the lightly pigmented trabecular meshwork. However, an additional possible 25% IOP-lowering with laser trabeculoplasty may not yield the desired target range. Regarding additional medical options, the patient is on a systemic beta-blocker for which the dose is unknown, so a topical beta-blocker may have a blunted effect. Masking oral hypoglycemia with a topical beta-blocker in this diabetic individual is not likely to be an issue since he is already on a systemic beta-blocker. Alpha-agonists and topical carbonic anhydrase inhibitors are also options.

*Comments by Mark Latina, MD, Associate Clinical Professor of Ophthalmology, Tufts University School of Medicine, Reading Health Center, Reading, Massachusetts*

Based on the findings presented, the patient in this case has moderate to advanced glaucoma with confirmed glaucomatous disc damage and visual field abnormalities. Although the IOP off medications is not known, given the patient's race,

family history, presence of disk damage, and visual field defects, further treatment to lower IOP is indicated. Treatment options include the addition of medications, laser trabeculoplasty, or filtration surgery. Based on the information presented, I would set a target IOP in the mid to low teens for this patient in both eyes.

Argon laser trabeculoplasty is most commonly used as second-line therapy following treatment with medications and usually before invasive glaucoma surgery such as trabeculectomy. Overall, ALT has an 85% success rate and is considered safe with postoperative elevation of IOP and postoperative inflammation as the major complications of the procedure. Based on the GLT and AGIS studies, ALT has been demonstrated to be a safe and effective modality to lower IOP in patients as primary therapy and may be more effective at controlling IOP in blacks compared with trabeculectomy in patients with advanced glaucoma, although the impact of this statistical finding has had little impact on clinical practice in general.

The GLT study demonstrated that ALT is as effective as medications when used as first-line therapy for the management of glaucoma. After a mean of 7 years of follow-up, the patients having had ALT as primary therapy had better IOPs, better visual fields, and better disc status than those having taken medications first. However, despite the results of the GLT study, ALT has not replaced medications as the first choice for primary management of glaucoma. One of the reasons for ALT's disfavor may be related to its destructive nature resulting in permanent scarring to the trabecular meshwork and aqueous outflow pathway. Because ALT produces scarring of the trabecular meshwork and can induce anterior chamber inflammation, especially in African Americans, I like most physicians, have reserved ALT as a second line of treatment to be used in patients who have been placed on 1 to 2 medications but still require a lower IOP. However, ALT is very useful as first-line therapy in patients who cannot tolerate medications or patients with poor compliance. Thus, even though the GLT study demonstrated the equivalence of laser trabeculoplasty to treatment with medications as first-line therapy, the study did not really change our behavior concerning the management of glaucoma.

Selective laser trabeculoplasty represents a new alternative to ALT for the treatment of open angle glaucoma. SLT uses a q-switched frequency doubled Nd:YAG pulsed laser emitting at 532 nm with a 3 nsec pulse duration. Using this short-pulsed laser, SLT selectively targets pigmented trabecular meshwork cells without causing structural or coagulation damage to the TM.<sup>4</sup> SLT could be coined "Cold Laser Trabeculoplasty". This is in contrast to ALT, which uses an argon laser emitting continuous wave radiation resulting in heating of the trabecular meshwork and histologic evidence of scarring.

Selective laser trabeculoplasty would be my choice of treatment of this patient for several reasons. First, SLT treat-

ment is likely more benign than ALT and less likely to produce scarring. Second, this patient has a lightly pigmented TM. In my experience, the magnitude of IOP reduction in SLT is much less dependent on the degree of trabecular pigmentation than with ALT.

Specifically, I would treat 180° of the angle of the left eye first, check for IOP spikes, and treat the opposite eye 180° within 1 week of the first eye assuming no adverse effects. I would pre-treat the patient with paraminoclonidine 0.5% and postoperatively treat with a topical non-steroidal anti-inflammatory for 2 days and observe the patient for at least 2 months to evaluate the response to treatment. SLT has been shown to produce an average IOP reduction of 25% in patients on medications or having had prior ALT. Adverse effects have also been minimal. IOP spikes immediately following treatment occur in approximately 5 to 7% of cases.

For both practical and theoretical considerations I believe that the SLT is a better choice for laser trabeculoplasty than ALT, especially when used as primary therapy or early in the management of glaucoma, because of its lack of destruction to the trabecular meshwork structure and its potential to be repeatable with lower risks.

## DISCUSSION

### George A. Cioffi, MD

Drs. Schwartz and Latina have thoughtfully outlined their clinical considerations and discussed various options for potential future interventions in this gentleman. Among the most important findings in this patient's history are his age, race, positive family history of glaucoma, diabetes mellitus, and systemic hypertension treated with an oral beta-adrenergic blocker. In addition, his predilection for seasonal allergies may speak in favor of therapeutic interventions that are less likely to stimulate an allergic response. On ocular examination, the patient has relatively thin corneas, as well as glaucomatous optic neuropathy. His glaucomatous optic neuropathy is worse in his left eye than his right eye, as evidenced by his structural examination and the concurrent visual function deficits. We therefore assume that an intraocular pressure of 24 mm Hg is too high in his left eye with definitive glaucomatous optic neuropathy and a paracentral scotoma. In short, his therapy must be advanced. An eloquent discussion of laser trabeculoplasty, both argon and selective, is presented by the discussants. In addition to these considerations, several pragmatic issues come into play in deciding on a therapeutic course for this gentleman.

It is unfortunate that the pre-treatment IOPs are unknown. This prevents us from knowing if the latanoprost has been effective, or if this gentleman is a poor responder to this particular medication. Therefore, a prudent first step in the treatment of this patient would be to obtain old medical rec-

ords, if available, or alternatively, to take the patient off the latanoprost and establish baseline IOPs. This information will be important in both the present and future treatment of this patient.

After baseline pressures are determined, we should outline the available therapeutic options. If the baseline pressures without treatment ranged between 20 and 25 mm Hg, discontinuing the latanoprost and switching to an alternative therapy would be an appropriate first intervention. As both discussants point out, the utility of a topical adrenergic beta-blocker in patients who are already receiving an oral agent of the same class usually provides limited IOP lowering. Therefore, topical carbonic anhydrase inhibitors and alpha-adrenergic agonists may be more appropriate medications. The downside of each of these classes includes the need for 3 times a day dosing and the potential for allergic response. Alternatively, one of the other prostaglandin analogues could also be tried. However, there is presently very little published information regarding how response rates vary between these agents within an individual. Therefore, we may expect limited success when switching to a second topical agent in this patient.

The Glaucoma Laser Trial demonstrated that African-American patients did well with initial ALT. Therefore, substitution of ALT for the latanoprost may be an appropriate intervention for this gentleman. The choice between an ALT and an SLT often remains a very pragmatic decision for most ophthalmologists, as there is not widespread availability of SLT. That said, the theoretical advantages of SLT remain attractive, albeit unproven. As of this writing, there is no data that supports the superiority of either technology or that SLT can be used repeatedly as is often claimed. However, in this 79-year-old man with diabetes mellitus and systemic hypertension, the likely need for multiple sessions of laser trabeculoplasty is slim. If either ALT or SLT fails to have a significant and sustained effect, most ophthalmologists will move onto other interventions. If the effect were significant and sustained, 2 sessions of trabeculoplasty, administered several years apart, would likely cover the patient's expected lifetime.

If after stopping latanoprost, the baseline intraocular pressures were significantly higher than the mid-20s, addition of a second topical medication or laser trabeculoplasty would be the next step. Assuming that the latanoprost has been successful in blunting the peaks of the diurnal variation, one could consider using either topical CAIs or alpha-agonists twice daily. Trabeculoplasty could be used, but the patient should be warned that he would most likely need to continue the latanoprost indefinitely. Finally, incisional surgery should not be dismissed in this patient. The success rates for surgery are generally as good if not better than the other options discussed. In addition, maximal medical therapy is generally arrived at much more quickly than in the past, with surgery as an acceptable early option. Therefore, our potential therapeutic options

include adding or switching to an alpha agonist or topical CAI, switching to another prostaglandin-like drug, laser trabeculoplasty, or trabeculectomy.

Now that we have outlined the various therapeutic options available to us, we must decide upon the likelihood that any chosen option will have the desired magnitude of therapeutic effect. Whether the addition or substitution of a medication or the application of laser trabeculoplasty is chosen for this gentleman, a significant response to therapy is desired. When adding medications, such as topical CAIs or alpha-agonists, a 20% reduction of intraocular pressure is an expected response. In general, a somewhat greater response would be expected if the latanoprost were discontinued and a new agent administered. As both discussants point out, a typical response following laser trabeculoplasty would be a 20 to 25% reduction. Therefore, the expected IOP following any of these interventions in this patient's left eye would be 18 to 20 mm Hg. Depending on the initial baseline pressures, this may be an appropriate therapeutic goal, while understanding that

close monitoring of the structural and functional status of the optic nerve remains the only measure of therapeutic success or failure. However, for most patients with moderate to advanced disease, IOPs in the high teens are not desirable. Therefore, the clinician should consider surgical intervention in this patient, especially if 1 subsequent addition or substitution of medication or laser trabeculoplasty fails to reach the target IOP.

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