ORIGINAL RESEARCH

Effect of Selective Laser Trabeculoplasty on the Fellow Eye

Matthew Hirabayashi[1], Elizabeth Mellencamp[2], Sabrina Duong[3], Jayce Simoncic[4], Carlton Homan[5], Joshua King[6], Jella An[7]

Received on: 19 January 2023; *Accepted on:* 10 October 2023; *Published on:* 17 January 2024

Abstract

Aim: Determine if selective laser trabeculoplasty (SLT) affects the fellow eye's intraocular pressure (IOP).

Materials and methods: A retrospective review of 76 pairs of eyes from 76 adult glaucoma patients who underwent SLT in one eye with at least 2 months between treatments were evaluated for IOP and medication reduction in the untreated fellow eye. Success was defined as ≥20% IOP reduction or ≥1 medication reduction without any additional IOP lowering procedures or medication. The primary outcome measures were success, IOP, and medication reduction in the untreated fellow eye at 6 months.

Results: At 6 months after SLT treatment, 48.7% (38/76) treated eyes and 36.8% (28/76) untreated fellow eyes met success criteria. IOP reduction in the treated eye was 2.6 ± 5.8 (14.1%; $p < 0.002$) and 0.8 ± 4.3 (5.1%, $p = 0.122$) in the fellow eye. The fellow eye was significantly more likely to meet success criteria if the treated eye was successful [odds ratio (OR): 6.00, 95% confidence interval (CI) (2.11–17.06), $p < 0.002$].

Conclusion: After a unilateral treatment with SLT, over one-third of the fellow eyes experienced either ≥20% IOP reduction or medication reduction. Additionally, fellow eyes were six times as likely to meet success criteria if this was observed in the treated eye. These findings may support the proposed biochemical mechanism for the therapeutic action of SLT.

Clinical significance: The implication for clinicians is that SLT treatment in one eye may allow the fellow eye to benefit and provide a prediction on the fellow eye's response without subjecting both eyes to the rare but present complications of SLT.

Keywords: Fellow eye, Retrospective chart review, Selective laser trabeculoplasty.

Journal of Current Glaucoma Practice (2023): 10.5005/jp-journals-10078-1420

Introduction

Glaucoma persists as the leading cause of global irreversible blindness and has been projected to increase in prevalence to 111.8 million people in 2040.[1] Laser trabecu1loplasty (LT) has existed since the 1970s with argon laser trabeculoplasty (ALT) representing its first incarnation.[2] Technological developments have allowed the application of laser energy to the angle to progress through two subsequent iterations: selective laser trabeculoplasty (SLT) and micropulse laser trabeculoplasty.[3–5] Since 1995, SLT has allowed the advantage of equal efficacy to ALT while minimizing damage to the trabecular meshwork (TM) through selective targeting of the pigmented cells by its frequency-doubled short pulse (Q-switched) neodymium-doped yttrium aluminum garnet laser.[6] LT plays an important role in the treatment of glaucoma as the American Academy of Ophthalmology proposes it as a first-line treatment for open-angle glaucoma and ocular hypertension, and the recent LiGHT trial has affirmed its value in treatment-naïve eyes for a wide variety of glaucoma types.[7–9] The mechanism of action for this therapy, though, is still poorly understood. Since SLT causes no structural damage to the TM while having equal or better efficacy than ALT, the mechanism is thought to be biochemical rather than structural.[10] The process of selective photothermolysis results in trabecular and endothelial cell proliferation, cytokine release, and macrophage recruitment (inflammation) in the angle. The net effect is an improved aqueous outflow and reduction of intraocular pressure (IOP). The cytokines released by this process improve transendothelial flow in Schlemm's canal and induce remodeling of the TM's extracellular matrix through metalloproteinase expression.[11] Since the mechanism is through these cellular modulators, it is possible for a "crossover effect" in the fellow, untreated eye, reducing IOP through similar mechanisms. Some have proposed the presence of "soluble mediators of IOP" that may access the fellow eye through systemic circulation.

Other studies have observed this phenomenon with reported IOP reductions of around 10%.[12,13] In this study, we sought to determine the magnitude of IOP or medication burden reduction of SLT in the fellow eye. We hypothesized that SLT would result in a significant reduction in IOP and medication burden in the untreated fellow eye, with a possible relationship between successful responses between the two.

[1]Mason Eye Institute East, University of Missouri, Columbia, Missouri, United States of America

[2–6]School of Medicine, University of Missouri, Columbia, Missouri, United States of America

[7]Wilmer Eye Institute, Johns Hopkins School of Medicine, Baltimore, Maryland, United States of America

Corresponding Author: Jella An, Wilmer Eye Institute, Johns Hopkins School of Medicine, Baltimore, Maryland, United States of America, Phone: +1 2404821100, e-mail: jan22@jh.edu

How to cite this article: Hirabayashi M, Mellencamp E, Duong S, *et al.* Effect of Selective Laser Trabeculoplasty on the Fellow Eye. J Curr Glaucoma Pract 2023;17(4):175–177.

Source of support: Nil

Conflict of interest: None

Materials and Methods

We performed a retrospective chart review of 76 pairs of eyes from 76 glaucoma patients at the University of Missouri who received SLT between 8th May 2016 and 12th January 2017 and had a 6-month

follow-up. Cases where treatment was received in both eyes within 6 months were excluded. Patients were evaluated for IOP and the number of medication classes in the fellow eye before and after treatment at the 6-month follow-up. We obtained approval from the Institutional Review Board (IRB) of the University of Missouri (IRB#2040322). The study adhered to all tenets of the Declaration of Helsinki. Our primary outcome measure was surgical success, defined by a >20% reduction in IOP or any reduction in medication classes. Secondary outcome measures included IOP reduction in mm Hg and reduction in medication in the untreated fellow eye at 6 months following treatment, as well as the relationship between success in the treated and fellow eye. We also recorded demographics, baseline data, adverse effects, and additional glaucoma interventions required at the discretion of the treating physician.

Data was collected for both eyes on the day of but prior to SLT and 2 and 6 months after SLT. The data was analyzed using paired *t*-tests to compare mean baseline 6-month IOPs for the fellow eye and a Wilcoxon signed-rank test to compare baseline and 6-month medication classes. All statistical tests were two-tailed with $\alpha = 0.05$. The values are reported as mean ± standard deviation (SD) for the means and percentages with proportion of population for categorical variables unless specified otherwise.

Intraocular pressure (IOP) was assessed by Goldmann applanation by an ophthalmologist, and medications were reduced at the discretion of the treating physician based on clinical and patient factors.

Results

Baseline demographics are reported in Table 1. Of note, the treated eyes had significantly higher baseline IOP and were on significantly more medication than the fellow eyes owing to treatment of the more therapeutically resistant eye first.

Success

At 6 months after SLT treatment, 48.7% (38/76) treated eyes and 36.8% (28/76) untreated fellow eyes met success criteria (Table 2).

Table 3 illustrates how many cases in the treated and fellow eyes met the success criteria by IOP reduction vs medication reduction.

Intraocular Pressure (IOP) and Medication Reduction

Intraocular pressure (IOP) reduction of the treated eyes was 2.6 ± 5.8 (14.1%; $p < 0.002$), while that of the fellow eyes was 0.8 ± 4.3 (5.1%, $p = 0.122$). Medication reduction was not statistically significant for either group (Table 4).

Relationship between Success in the Treated vs Fellow Eye

We found the fellow eye was more likely to meet success criteria if the treated eye was successful [OR: 6.00, 95% confidence interval (CI) (2.11–17.06), $p < 0.002$] (Table 5).

Discussion

In this study, we have found that about a third of the fellow untreated eyes responded with some degree of IOP lowering following a unilateral SLT treatment. This, coupled with our finding that fellow eyes were 6 times as likely to meet success criteria if the treated eye met one, provides support for the hypothesis that the effect of laser trabeculoplasty may be the result of more than just physical changes to the TM.

If the treated eye had a positive response to SLT, it is reasonable that the hypothesized "soluble mediator of IOP" in the form of

Table 1: Baseline demographic and glaucoma status data

Subject-level parameters	*n = 74*	*p-value*
Age (year), mean (SD)	68.7 ± 10.1	
Gender, % (*n*)		
Male	55.4 (41)	
Female	44.6 (33)	
Ethnicity, % (*n*)		
Caucasian	77.0 (57)	
African-American	17.6 (13)	
Other*	5.4 (4)	
Eye-level parameters	*n = 76*	
Glaucoma diagnosis, % (*n*)		
Primary open-angle/normal tension glaucoma	80.3 (61)	
Pseudoexfoliation	5.3 (4)	
Others*	14.4 (11)	
Glaucoma severity†, % (*n*)		
Mild	43.4 (33)	
Moderate	19.7 (15)	
Severe	36.9 (28)	
Preoperative (pre-op) IOP treated eye (mm Hg), mean ± SD	18.4 ± 4.8	<0.002
Pre-op IOP fellow eye (mm Hg), mean ± SD	15.5 ± 4.2	
Pre-op medications treated eye (mm Hg), mean ± SD	2.0 ± 1.3	<0.002
Pre-op medications fellow eye (mm Hg), mean ± SD	1.3 ± 1.3	

*Others, combined mechanism, traumatic, steroid response, and angle recession; †glaucoma severity based on HVF 24-2 SITA standard mean deviation

Table 2: The 6-month success in the treated and fellow eye

	Success	*Failure*
SLT treated eye	37 (48.7%)	39 (51.3%)
SLT fellow eye	28 (36.8%)	48 (63.2%)

Table 3: Cases meeting success criteria by IOP reduction, medication class reduction, or both

	IOP reduction	*Medication reduction*
Successfully treated eyes	32/37 (86.5%)	12/37 (32.4%)
Successful fellow eyes	23/28 (82.1%)	10/28 (35.7%)

Table 4: IOP and medication reduction of the fellow eye 6 months after SLT

	Treated eye	*Fellow eye*
	6-month	*6-month*
IOP reduction, mean ± SD (%)	2.6 ± 5.8 (14.1%)	0.8 ± 4.3 (5.1%)
p-value	$p < 0.002$*	$p = 0.218$
Medication reduction mean ± SD (%)	−0.2 ± 0.9 (−1.3%)	0.5 ± 0.9 (3.8%)
p-value	$p = 0.562$	$p = 0.912$

*Statistically significant when *p*-value < 0.05

cytokines or some other biochemical modulator would enter the systemic circulation and eventually reach the TM of the fellow eye where it would exert an effect on IOP there.[12] This observation is not isolated to laser trabeculoplasty alone. There are reports of IOP reduction and increased aqueous flow in the fellow eye following trabeculectomy, likely due to systemic inflammatory mediators leading to ciliary body shutdown.[14] Alternatively, there are also reports of a significant IOP increase in the fellow eye after trabeculectomy.[15] In the case of trabeculectomy, both IOP effects may support the role of a possible systemic modulator for IOP just as a response following SLT doses. The modest 4.3% reduction in IOP in the fellow eye is congruent with current literature ranges of 6–20%.[16–18]

As illustrated above, the fellow eye largely met success criteria by IOP reduction, not medication reduction, which further supports the true effect of IOP lowering experienced in the fellow eye independent of medication reduction.

The major limitation of this study includes a retrospective review of a limited sample of patients. Most of the study patients were of the Caucasian ethnicity with primary open-angle glaucoma, limiting its generalizability. The findings of this study will need to be confirmed by larger prospective studies in the future.

Conclusion

Based on this retrospective study, SLT has a true impact on lowering IOP in the fellow eye. However, clinicians should be aware that treatment with SLT in one eye may not always result in commensurate levels of IOP reduction in the fellow eye. Nevertheless, the fellow eye may still have a high likelihood of having some degree of IOP reduction and more likely so if the treated eye has a successful outcome.

Clinical Significance

The implication for clinicians is that SLT treatment in one eye may both allow the fellow eye to benefit and also provide a prediction on the fellow eye's response without subjecting both eyes to the rare but present complications of SLT.

Table 5: Success of treated eye compared to fellow eye at 6 months

	Treated eye success	*Treated eye failure*
Fellow eye success	21	7
Fellow eye failure	16	32
p	<0.002*	

*Statistically significant when *p*-value < 0.05

References

1. Tham YC, Li X, Wong TY, et al. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. Ophthalmology 2014;121(11):2081–2090. DOI: 10.1016/j.ophtha.2014.05.013
2. Wise JB, Witter SL. Argon laser therapy for open-angle glaucoma. A pilot study. Arch Ophthalmol 1979;97(2):319–322. DOI: 10.1001/archopht.1979.01020010165017
3. Ahmed I. Sidebar: micropulse laser trabeculoplasty. Glaucoma Today.
4. Aquino MC, Barton K, Tan AM, et al. Micropulse versus continuous wave transscleral diode cyclophotocoagulation in refractory glaucoma: a randomized exploratory study. Clin Exp Ophthalmol 2015;43(1):40–46. DOI: 10.1111/ceo.12360
5. Ahmed I. Excellent safety profile of micropulse laser trabeculoplasty (MLT) for glaucoma. Glaucoma Today 2014;1–2.
6. Barkana Y, Belkin M. Selective laser trabeculoplasty. Surv Ophthalmol 2007;52(6):634–654. DOI: 10.1016/j.survophthal.2007.08.014
7. Beidoe G, Mousa SA. Current primary open-angle glaucoma treatments and future directions. Clin Ophthalmol 2012;6:1699–1707. DOI: 10.2147/OPTH.S32933
8. Prum BE Jr, Rosenberg LF, Gedde SJ, et al. Primary open-angle glaucoma preferred practice pattern® guidelines. Ophthalmology 2016;123(1):P41–P111. DOI: 10.1016/j.ophtha.2015.10.053
9. Hirabayashi M, Ponnusamy V, An J. Predictive factors for outcomes of selective laser trabeculoplasty. Sci Rep 2020;10(1):9428. DOI: 10.1038/s41598-020-66473-0
10. Gulati V, Fan S, Gardner BJ, et al. Mechanism of action of selective laser trabeculoplasty and predictors of response. Invest Ophthalmol Vis Sci 2017;58(3):1462–1468. DOI: 10.1167/iovs.16-20710
11. Alon S. Selective laser trabeculoplasty: a clinical review. J Curr Glaucoma Pract 2013;7(2):58–65. DOI: 10.5005/jp-journals-10008-1139
12. Rhodes KM, Weinstein R, Saltzmann RM, et al. Intraocular pressure reduction in the untreated fellow eye after selective laser trabeculoplasty. Curr Med Res Opin 2009;25(3):787–796. DOI: 10.1185/03007990902728316
13. Kirzhner M, Shildkrot Y, Hughes BA. Crossover effect of selective laser trabeculoplasty. Investig Ophthalmol Vis Sci 2009;50(13):155.
14. Onakoya AO, Olowoyeye AO, Onyekwelu OMA, et al. Intraocular pressure changes post selective laser trabeculoplasty in the contralateral untreated eyes of Nigerian patients with primary open angle glaucoma. Niger Q J Hosp Med 2015;25(2):133–138.
15. McIlraith I, Strasfeld M, Colev G, et al. Selective laser trabeculoplasty as initial and adjunctive treatment for open-angle glaucoma. J Glaucoma 2006;15(2):124–130. DOI: 10.1097/00061198-200604000-00009
16. Realini T. Is there a crossover effect with selective laser trabeculoplasty? Eye World. Published online September 2009.
17. Vysniauskiene I, Shaarawy T, Flammer J, et al. Intraocular pressure changes in the contralateral eye after trabeculectomy with mitomycin C. Br J Ophthalmol 2005;89(7):809–811. DOI: 10.1136/bjo.2004.050294
18. Yarangümeli A, Köz OG, Kural G. The effect of trabeculectomy on the intraocular pressure of the unoperated fellow eye. J Glaucoma 2003;12(2):108–113. DOI: 10.1097/00061198-200304000-00004