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Research Article

Selective Laser Trabeculoplasty versus Brimonidine Tartrate 0.2%/Timolol Maleate 0.5% as Adjunct Therapy in Primary Open Angle Glaucoma: A Randomized Prospective Pilot Study

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Abstract

Purpose: To compare the intraocular pressure lowering efficacy of selective laser trabeculoplasty to brimonidine tartrate 0.2%/timolol maleate 0.5% in patients with uncontrolled primary open-angle glaucoma on a prostaglandin analog alone. A secondary outcome was to evaluate the complication rates of selective laser trabeculoplasty.

Patients and Methods: Twenty-three patients were randomized to two treatment groups within this prospective, observer-masked single site, all optometrist, pilot study. Group 1 (N=12) received 360 degrees of selective laser trabeculoplasty as additional treatment while Group 2 (N=11) was started on FCBT. Outcomes of both groups were measured at eight weeks.

Results: Both treatment regimens were found to be statistically significant in lowering IOP when used as adjunct therapy. The average IOP reduction for Group 1 and Group 2 was 28.4% (SD = .17) and 28.2% (SD = .12) respectively. The incidence of an intraocular pressure spike following SLT in this patient population was found to be 8.3%. No major complications were observed in this study.

Conclusion: Selective laser trabeculoplasty and brimonidine tartrate 0.2%/timolol maleate 0.5% were shown to be equivalent in lowering intraocular pressure in uncontrolled primary open angle glaucoma patients when used as adjunct therapy for patients on a prostaglandin analog. Additionally, this is the first prospective study of optometrists performing selective laser trabeculoplasty. Although this study had a small sample size, the results appeared to show that efficacy and complication rates were comparable to previously published data; however, these results need to be confirmed with a larger multi-centered trial.

Trial Registration: ISRCTN Study ID ISRCTN30070325, retrospectively registered 12/14/2018. http://www.isrctn.com/ISRCTN30070325.

Keywords: Intraocular pressure; Primary open-angle glaucoma; Selective laser trabeculoplasty

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Abbreviations

SLT: Selective Laser Trabeculoplasty
POAG: Primary Open Angle Glaucoma
PGA: Prostaglandin Analog

Key Messages Regarding Feasibility

The ability to recruit patients was one of the main issues with the studies feasibility. To fully power the study, we knew we needed a large n so that is why we choose to do a pilot study first to see if a larger study would be indicated. We knew both treatments were effective individually but wanted to compare them to see if one was superior to the other in a head to head study.

A larger study can be completed at a relatively low cost and a larger n is needed to provide a stronger powered study which could help clinicians choose the most appropriate second line therapy for their glaucoma patients.

The main study needs to be a larger multicentered trial with a much higher sample size and longer follow up period. Ideally at least 1 year of data should be collected to ensure the effect of SLT or drops don't wear off quickly as glaucoma is a chronic disease. Additionally, stratified randomization needs to be utilized to ensure both treatment groups have similar demographics. Using simple randomization was a weakness of the pilot study.

Background

While Prostaglandin Analogs (PGA) is often the preferred first-line choice in the management of glaucoma, there is much debate over the optimal second-line therapy when a PGA alone is insufficient. In 2002 the first topical PGA was approved by the Food

and Drug Administration as first-line therapy for lowering Intraocular Pressure (IOP) in Primary Open-Angle Glaucoma (POAG) or ocular hypertension [1]. These medications are Prostaglandin F2-alpha receptor agonists and increase uveoscleral outflow [2]. Once-daily dosing has minimized the treatment burden on patients, and declining costs as well as generic options have increased adherence making PGAs ideal for mono-therapy [3-4]. It is not uncommon for a PGA alone to insufficiently reach an IOP target. If IOP fails to drop adequately or progression is confirmed, or suspected, additional treatment should be considered. Commonly, second-line medical therapy includes a topical fixed-dose combination agent due to its efficacy and expectation that it will provide the best chance of adherence [5]. Other non-pharmacological therapies, such as Selective Laser Trabeculoplasty (SLT), a frequency-doubled Q-switched Neodymium-doped Yttrium Aluminum Garnet 532 nm green laser that was first introduced by Latina and Park in 1995, may provide some advantages in certain patients and perhaps deserves equal consideration [6,7].

Treatment decisions should be individualized, and the best results are most likely achieved when multiple treatment modalities are considered. Mead et al. suggests "an encounter that is patient-centered and focuses on collaborative goal setting is one in which the provider is (a) receptive to the patient's opinions and expectations and (b) involves the patient in decision-making about treatment [8]". Inaccessibility of non-pharmacologic treatments has historically and continues to limit some patients to only medical therapy when other treatments may be better suited for their care. However, legislation in several states has modernized patient access to laser glaucoma treatments.

A potential shift in paradigm thinking between medical and laser therapy is evolving and will shape future choices for adjunct treatment in patients who fail prostaglandin analog monotherapy. Several studies have previously looked at using SLT as initial therapy [6,9-14]. To the authors' knowledge this is the first reported study comparing SLT to the combination drop brimonidine tartrate 0.2%/ timolol maleate 0.5% (Combigan, Allergan, Inc. Irvine, CA/USA) in a head-to-head trial in uncontrolled POAG patients on a PGA.

This study was designed to compare brimonidine tartrate 0.2%/ timolol maleate 0.5% and SLT in providing satisfactory outcomes as adjunct treatment to prostaglandin analogs. The safety of SLT was also evaluated and compared to reported standards.

Methods

This was a prospective, randomized, observer-masked pilot study performed by optometrists at a single site. The study was conducted in accordance with all the ethical principles outlined by the Declaration of Helsinki and was approved by the institutional review board at the University of Pikeville (IRB number: MOD_15_0015).The study adheres to all CONSORT guidelines. All subjects signed an informed consent prior to participating in the study.

The primary purpose of this study was to compare the intraocular pressure lowering efficacy of selective laser trabeculoplasty to the beta blocker and alpha-2 adrenergic agonist fixed combination medicine, brimonidine tartrate 0.2%/timolol maleate 0.5% (Combigan, Allergan inc.Irvine, CA/USA), in patients with primary open-angle glaucoma who were not controlled, as determined by the treating physician (i.e. IOP not at target, progressive visual field or nerve fiber changes, etc.), on a prostaglandin analog alone. The main endpoint was the intraocular pressure reduction of selective laser trabeculoplasty and brimonidine tartrate 0.2%/timolol maleate 0.5%at eight weeks. A secondary outcome was to evaluate the complication rates and efficacy of SLT procedures when performed by optometrists.

Eligible subjects were adult patients aged 25 to 90 years old with uncontrolled POAG who were being treated with PGA monotherapy. Consecutive patients, between October 2015 and July 2018, meeting the inclusion criteria were asked to participate in the study. Parallel design was used with the intended allocation ratio of 1:1. Exclusion criteria consisted of: a best corrected visual acuity worse than 20/40, history of angle closure or an occludable angle on gonioscopy, untreated IOP less than or equal to 21 mmHg, patients who have used a second IOP lowering medication in the past two months, angle recession on gonioscopy, pseudoexfoliation glaucoma, pigment dispersion glaucoma, prior incisional glaucoma surgery, prior micro invasive glaucoma surgery, previous selective laser trabeculoplasty or argon laser trabeculoplasty, previous laser peripheral iridotomy, previous refractive surgery, inflammatory eye disease, contraindication to any of the topical medicines including asthma, chronic obstructive pulmonary disease, bradycardia, or a hypersensitivity reaction, a change in dosage, or addition of, a systemic medication that could affect IOP during the study, women who were pregnant or who intended to become pregnant during the study (as verbally asked during the medical history and consenting process, no formal pregnancy test was administered for this study), or patients with significant dementia who were not able to fully comprehend the informed consent.

Subjects enrolled in the study were randomized with simple randomization, using concealed envelopes, to either receive 360 degrees of SLT treatment or use brimonidine tartrate 0.2%/timolol maleate 0.5% twice a day (q12h). If the patient needed additional treatment in both eyes, then the second eye received the same treatment as the first; however, only one eye was eligible to participate in the study. The eye with the higher baseline intraocular pressure was chosen to be the study eye. If the baseline intraocular pressure was equal in both eyes, then the right eye was chosen as the study eye. All participants continued to use their PGA once a day at nighttime during the study. Compliance in each group was monitored using a daily drop log.

A baseline exam was performed and included a detailed ocular, family, social, and medical history. Additionally, blood pressure, pulse, pupils, extraocular muscles, visual acuity, Goldmann applanation tonometry, gonioscopy, pachymetry, and a slit lamp exam were conducted. Participants randomized to the SLT treatment arm had a one-hour IOP check to monitor for IOP spikes. Any rise in IOP above 10 mmHg from baseline at the one-hour follow-up was treated with brimonidine tartrate 0.2%. If this did not control IOP spike, then treatment to control the IOP was at the doctor's discretion. All SLT patients also received Prednisolone acetate 1% four times a day for four days, to help improve patient comfort following the procedure.

The eight-week follow-up exam for both groups was performed by a different investigator than the enrolling doctor to ensure masking, thereby minimizing bias, and was done within two hours of the initial baseline exam to control for potential diurnal IOP fluctuations.

The follow-up exam included visual acuity, Goldmann applanation tonometry, blood pressure, pulse, pupils, extraocular muscles, and a slit lamp exam.

Baseline IOP was calculated by averaging two IOP measurements taken 30 minutes apart during the baseline exam. If these IOP measurements were greater than +/- 2 mmHg, then a third IOP measurement was taken 30 minutes later. At each IOP measurement, two readings were taken and averaged together.

SLT was performed using a standard protocol and followed specific study guidelines [10]. A Lumenis Selecta II (Lumenis Ltd., Yokneum, Israel) was used to treat 360 degrees of the angle with 100 (+/-10) evenly spaced spots. The pigment in the angle was graded, using the Scheie scale, and the initial power setting for patients with Grade I or II pigment was set at 1.0 mj [15]. The power was then titrated in 0.1 mj steps until there was a visible response of cavitation bubbles or pigment blanching. For patients with Grade III or IV angle pigment the initial power was set at 0.8 mj.

The target sample size for this pilot study was 30 patients. Twenty-six patients met enrollment criteria for the study. Three patients were excluded from the data analysis due to noncompliance, scheduling issues, and observer unmasking. Therefore, data from 23 patients was analyzed for this study. No subjects were lost to follow up. Given the effect sizes seen in the results of changes in IOP levels for each group from baseline to 8-weeks, statistical power of this sample size is 0.75. To fully power this study to p=0.05, a sample size of 42 patient would have been needed.

All collected data was analyzed by computing a combination of descriptive statistics and inferential statistics (specifically frequency distributions, correlation coefficients, independent t-test, dependent t-test, two-factor analysis of variance, and Chi-square) using SPSS v. 24.

Results

Patients were evenly distributed between the two study groups; the demographics of each group can be found in Table 1. The first group (n=12) received 360 degrees of SLT in one eye and the second group (n=11) received brimonidine tartrate 0.2%/timolol maleate 0.5% bid in one eye. The gender distribution was also similar between groups, approximately 55 percent male and 45 percent female. However, the racial distribution of the two groups was not similar. While the first group was half Caucasian and half African-American, the second group was overwhelmingly Caucasian (82%).

In addition, there were differences between the two groups in the brand of PGA eye drops used by the patients, with Group 1 being relatively equally distributed between the three brands while almost three-fourths of the patients in Group 2 used Lumigan 0.01% (Allergan, Inc.Irvine, CA/USA) eye drops. The patients were also dissimilar in the amount of pigmentation in the posterior trabecular meshwork with two-thirds of the patients in Group 1 being at Grade II while patients in Group 2 ranged from Grade 0 to Grade III.

IOP was significantly reduced in both groups from the baseline visit to the eight week follow up (Table 2). For patients receiving 360 degrees of SLT in one eye (Group 1), the average baseline IOP was reduced from 21.3 mm Hg to 14.8 mm Hg at eight weeks (p = .001, 95% CI [3.39. 9.53]). Similarly, for patients receiving brimonidine tartrate 0.2%/timolol maleate 0.5% bid in one eye (Group 2), the average baseline IOP was lowered from 20.8 mm Hg to 14.7 mm Hg at eight weeks (p <0.001, 95% CI [3.58. 8.55]).

	Group 1: 360° of selective laser trabeculoplasty(SLT) in one eye	Group 2: Brimonidine tartrate 0.2%/ Timolol maleate 0.5% bid in one eye
Number of Participants	12	11
Average Age (SD)	66.1 (10.4)	65.9 (9.2)
Gender		
Male	58.3%	54.5%
Female	41.7%	45.5%
Race		
Caucasian	50.0%	81.8%
African American	50.0	9.1
Hispanic	0.0	9.1
PG Eye Drops		
Xalatan	33.3%	18.2%
Lumigan	41.7	72.7
Travatan	25.0	9.1
Gonio Pigment		
Grade 0	8.3%	20.0%
Grade I	25.0	40.0
Grade II	66.7	30.0
Grade III	0.0	10.0
Grade IV	0.0	0.0

Table 1: Participant demographics.

	N	Intra Ocular Pressure Baseline Mean (SD)	Intra Ocular Pressure at 8 Weeks Mean (SD)	p
Group 1	12	21.3 (3.9)	14.8 (3.0)	.001
Group 2	11	20.8 (4.7)	14.7 (3.3)	<.001

Table 2: Average change in intraocular pressure between the two groups.

Statistically, SLT was equivalent to brimonidine tartrate 0.2%/ timolol maleate 0.5% at reducing IOP at eight weeks. There was no significant difference in the average percent IOP reduction between SLT patients (M = 28.43%, SD = .17) and patients who used drops (M = 28.22%, SD = .12), p = .973. Patients from both groups in this study experienced an average 6-7 mmHg reduction after eight weeks; these results indicate that patients receiving either of these treatments have a 0.95 confidence of experiencing a 3-4 mmHg reduction from their baseline IOP after eight weeks.

Further analysis showed that 90.9% of patient in Group 2experienced a 15% or greater IOP reduction compared to 75.0% of patients in Group 1, X^2 (1, N=23) = 1.03, p=.315. This difference was maintained with a 20% or greater IOP reduction benchmark. Group 2 achieved a 20% or greater IOP reduction 81.8%, while Group 1 achieved it 58.3%, X^2 (1, N=23) = 1.50, p=.221. However, neither the 15% reduction or the 20% reduction difference was statistically or clinically significant.

Additional differences were found when analyzing the percent change in IOP by the gonioscopy pigment grades for each group,

F(1, 6) = 1.103, p = .405 (Table 3). For patients receiving 360 degrees of SLT in one eye (Group 1), the average percent reduction was greater at Grade II, while for patients receiving brimonidine tartrate 0.2%/timolol maleate 0.5%bid in one eye (Group 2), the average percent reduction was greater at grade 1.

	Group 1			Group 2		
	N	Intra Ocular Pressure Percent Reduction Mean	SD	N	Intra Ocular Pressure Percent Reduction Mean	SD
Gonioscopy Pigment						
Grade 0	1	7.1%	--	2	15.9%	.048
Grade I	3	22.9%	.236	4	37.8%	.134
Grade II	8	33.2%	.145	3	27.2%	.055
Grade III	0			1	23.7%	--
Grade IV	0			0		

Table 3: Average percent change in intraocular pressure with gonioscopy pigment by group.

At the 20 percent or higher IOP reduction level, there was a statistical difference between the gonioscopy pigment grades, F(3) = 3.776, p = .034; but not between SLT and drops, F(1) = 2.289, p = .151 (Table 4). However, at the 15 percent or higher IOP reduction level, there was a statistical difference between both the gonioscopy pigment grades, F(3) = 5.454, p = .010; and between SLT and drops, F(1) = 6.885, p = .019. Since these results follow what is seen in table 3, it should not be surprising that the same conclusion can be made about angle pigment and treatment.

	Group 1		Group 2	
	N	Intra Ocular Pressure Percent Reduction Mean	N	Intra Ocular Pressure Percent Reduction Mean
Gonioscopy Pigment			2	0.0%
Grade 0	1	0.0%	4	100.0%
Grade I	3	33.0%	3	100.0%
Grade II	8	75.0%	1	100.0%
Grade III	0		0	
Grade IV	0			

Table 4: Twenty percent or greater change in intra ocular pressure with gonioscopy pigment by group.

The incidence of an IOP spike following SLT in this patient population was found to be 8.3%. No major complications or adverse events associated with SLT such as iritis, hyphema, macular edema, or corneal edema were observed in the study. Additionally, no patients reported any adverse events or allergies in the brimonidine tartrate 0.2%/timolol maleate 0.5% group.

Discussion

Standard initial therapy for POAG patients is often a PGA [12]. However, when PGA therapy does not achieve adequate IOP control, there is no consensus for second-line therapy. Typically, second-line treatment includes additional topical therapy (whether it be a single agent or combination drop) or a laser treatment [16]. Previous studies have compared laser treatments to single agent drops [6-9-14]. To the authors' knowledge, there has not been a study comparing laser procedures to combination medications as adjunct therapy in a head-to-head trial [6-9-14].

The main finding from this single site, prospective, randomized, masked study, that compared SLT and brimonidine tartrate 0.2%/ timolol maleate 0.5%as adjunct therapy in patients with uncontrolled POAG, was that both treatment groups demonstrated a statistically equivalent reduction in IOP. SLT lowered pressure 6.46 mm Hg (M = 28.43%, SD = .17) while patients that used drops achieved a 6.07 mm Hg reduction (M = 28.22%, SD = .12), t(21) = -.034. p = .973). This data suggests both SLT and brimonidine tartrate 0.2%/timolol maleate 0.5% are effective choices in clinical practice.

Though the results were statistically equivalent, there were several differences between the two treatments. Brimonidine tartrate 0.2%/ timolol maleate 0.5% achieved a 20% or greater pressure reduction in 81.8% of patients compared to 58.3% with SLT. However, the 20% IOP reduction was not statistically or clinically significant.

In a prospective randomized trial by Katz et al., SLT was compared to a PGA as primary therapy, whereas in the current study SLT was compared as adjunct treatment. Their results showed that the group that received SLT had an 6.3 mm Hg (26.4%) IOP reduction at one year [12]. Katz et al., results exhibited a comparable pressure reduction to the SLT group in the current study, 6.46 mm Hg (28.43%) at eight weeks, despite the fact the Katz trial had a higher baseline IOP (M=24.5 mm Hg and M = 21.29, respectively).

The efficacy of the current SLT study was also consistent with other previously reported data. McIlraith et al., compared a180 degrees SLT treatment to Latanoprost .005% as initial therapy in patients diagnosed with POAG or ocular hypertension. Their SLT group achieved an IOP reduction of 8.3 mm Hg (31%) [6]. Their study also reported that the SLT group achieved a greater than 20% reduction in 83% of patients [6]. Although the current study found similar SLT efficacy with McIlraith et al., the frequency of a 20% or more IOP reduction occurred less often. The difference could be attributed to using SLT as primary therapy as opposed to adjunct treatment.

Realini T showed that POAG patients, in an African-derived population on Saint Lucia, benefited from bilateral 360 degree SLT treatments and lowered IOP 7.3 mm Hg (34.1%) in right eyes and 7.6 mm Hg (36.0%) in left eyes. Although the pressure reduction was slightly greater in the Saint Lucia study, again SLT was used as primary therapy as opposed to adjunct treatment [14]. Additionally, the racial disparity of the population bases may further contribute to the difference in SLT [17].

Gazzardet al., in the LiGHT trial also compared SLT to eye drops for first line treatment and found that drops lowered IOP from baseline by 33.2% at 36 months while SLT lowered IOP by 32.2%. Additionally, the LiGHT study found that 74.2% of patients in the SLT group required no drops to maintain their individualized target pressure throughout the 36 month study. However, this study only enrolled newly diagnosed, untreated, open angle glaucoma and ocular hypertension patients, while our study evaluated FCBT and SLT as adjunct therapy [9,10].

Hodge et al., did evaluate SLT as adjunct treatment in POAG patients who were uncontrolled on maximum medical therapy and found a 20% or greater reduction in IOP at one year in 59.7% of patients, which is comparable to the current study of 58.3% [18]. Hodge et al., concluded that baseline IOP is a significant indicator of SLT response and may explain why studies that had a higher baseline IOP achieved a greater IOP reduction with SLT [18].

A study by Ayala and Chen also compared SLT as adjunct therapy for patients with open-angle glaucoma or pseudoexfoliative glaucoma. Their study reported that patients receiving SLT as adjunct treatment to a PGA lowered IOP by 6.3 mm Hg (26.07%) while patients who were using a non-prostaglandin agent (Carbonic Anhydrase Inhibitor, Alpha-2 Agonist or Beta Blockers) had a similar 5.77 mm Hg (24.53%) reduction with SLT [19]. There was no statistically significant difference in IOP reduction between either group when SLT was added to patients using a PGA or non-prostaglandin agent. The current study showed a similar IOP percentage reduction to Ayala and Chen, despite difference in treatment protocol. Also, their cohort included a large percentage of patients with pseudoexfoliation (53.75%) while those patients were excluded in the current study.

Russo et al., compared argon laser trabeculoplasty and 360-degree selective laser trabeculoplasty treatment as adjunct therapy in uncontrolled POAG patients on maximum medical management. They found that SLT achieved a 19.9% IOP reduction at one month, which is inferior to the IOP reduction of the current study [20]. Some of this difference may be attributed to the methods of laser applications in the studies. The study protocol by Russo et al., called for using only 60 laser spots, while the current study followed the SLT technique described in the Katz et al., trial [12,20]. These comparisons demonstrate that the efficacy rates of SLT in the current study are consistent with previously published data.

Initially, Latina et al., described an SLT technique that treated only 180 degrees of trabecular meshwork. This led many practitioners to adopt the Latina et al. guidelines for treatment [21]. However, other investigations have shown different SLT techniques that optimize efficacy. Nagar et al., found 100 laser spots applied over 360 degrees to be superior in lowering IOP compared to Latina et al., study which used 50 laser spots applied over 180 degrees [12,22,23]. Not surprisingly, the increased laser energy applied during 360-degree treatment led to more frequent transient IOP spikes, 27% in the 360-degree treatment arm compared to 16% in the 180-degree treatment group [22].

Since the early days of SLT, techniques have continued to be refined, and with the proper titration of laser energy, the safety profile of 360-degree SLT treatment is excellent as shown in the current study [12,13]. In keeping with the methodology of Katz et al., patients, not eyes, were randomized to receive either SLT or drops. This eliminated the possible concern of a crossover effect with topical medications, which was a criticism of the Glaucoma Laser Trial [24,25].

In the current study, patients that were treated with SLT were prescribed a topical anti-inflammatory drop following the procedure, which was intended to help improve patient comfort during the postoperative period. Prednisolone acetate 1% four times a day for four days was selected based on a study performed by Relani et al., which showed no negative effect on IOP reduction at three months with this postoperative anti-inflammatory medicine [26].

A subgroup analysis of efficacy in the SLT arm showed a difference with respect to the amount of pigment in the trabecular meshwork. Pigment dependency could help explain the variation in pressure reduction with SLT. In the current study, SLT therapy was found to be less effective in patients when the angle pigment was graded I or less. Pigment cells in the trabecular meshwork exhibit a greater optical absorbance of applied laser energy than non-pigmented surrounding cells [21]. It has been shown that since SLT only targets cells that contain melanin, adjacent or non-pigmented structures are not affected [21]. The laser's brief pulse duration further confines heat to the pigmented cells within the irradiated zone. The denser the pigment the greater the tissue response in the trabecular and endothelial cells [21]. This increased absorption of laser energy has been proposed to allow a greater release of cytokines and subsequent inflammation (recruitment of macrophages), which potentially leads to phagocytosis of debris in the trabecular meshwork and increased outflow [21].

A study by Wasyluk et al., looked at the efficacy of SLT based on iridocorneal angle pigmentation POAG and demonstrated a direct correlation between the IOP reduction with SLT and the observed pigmentation in the angle; however, this correlation remains in question [6,18,27,28]. Hodge et al., and Mcllrath et al., found no correlation between IOP reduction with SLT and angle pigmentation [6,18]. Wasyluk et al., showed patients with a Grade I angle pigment received a 13.7% reduction while patients with Grade 3 angle pigment received a 29.6% IOP reduction at six weeks [27]. Their findings are consistent with the current study and both suggest that less pigmented angles do not benefit as much from SLT as compared to more heavily pigmented angles. Therefore, it may be reasonable to consider brimonidine tartrate 0.2%/timolol maleate 0.5%, which showed no obvious difference between angle pigmentation subgroups, before SLT as adjunct therapy for patients who have minimal to no angle pigment. Other factors such as the patient's preference, IOP reduction need, compliance, and cost considerations will ultimately influence the final decision.

SLT has proven to be a safe treatment for glaucoma [6,9-12,29-31]. Major complications are rare and usually do not require any further surgical intervention [6,9,10,12,29-31]. In the current study, only one patient (8.6%) in the laser group had a transient IOP spike that resolved in the office with the appropriate topical IOP drops. No major complications or adverse events associated with SLT such as iritis, hyphema, macular edema, or corneal edema were observed in the study.

A study by Damji et al., which compared selective laser trabeculoplasty to Argon Laser Trabeculoplasty reported a transient IOP spike after Argon Laser Trabeculoplasty 3.4% and 4.5% with selective laser trabeculoplasty [32]. Realini's study in St. Lucia showed a 4.9% risk of transient IOP spike [14]. Latina and Colleagues reported intraocular pressure spikes of 5 mm Hg or greater in 25% of SLT-treated eyes, which all resolved with topical intraocular pressure-lowering medications [21]. Nagar et al., as mentioned previously, reported a 27% risk of transient IOP spikes of 5 mm Hg or more in patients receiving 360 degree SLT treatment [22]. A study by Greninger et al., also showed that SLT performed in patients with POAG had transient IOP spikes of at least 6 mm Hg in 7% of eyes [33]. Russo et al., had a 13.9% rate of transient intraocular pressure spikes in the immediate postoperative period [20]. Gazzardet al., in

the LiGHT trial had a very low rate of IOP spikes following SLT at 1.7%, which they hypothesize was due the treatment of patients at an earlier stage of the disease [9,10]. The current study's risks of transient postoperative IOP elevation and other complications are consistent with previously published data.

This study demonstrated that the efficacy and complication rates of SLT when performed by optometrists at this single site are comparable to the rates previously published in the literature. Additionally, the current and previous studies have shown that SLT is a viable option for both initial and adjunct therapy for the treatment of POAG [6,11-13]. Not only does SLT lower IOP, but also it provides better patient compliance and adherence and may be more cost effective than topical drops [3,34]. SLT has been shown to reduce the nocturnal mean IOP and may blunt the nocturnal peak IOP [35,36].

Possible limitations of the current study include its' small sample size, single study site, and short follow-up period. Although the follow up for the current study is short, a previous study showed that intraocular pressure remains stable at six months; therefore, one month values may be predictive of future intraocular pressure control [11,19,21]. The authors suggest that the results of the current study be confirmed with a larger multicenter randomized prospective trial that includes different glaucoma subtypes, a longer follow up period, and a more diverse patient population.

Conclusion

In conclusion, SLT and brimonidine tartrate 0.2%/timolol maleate 0.5% have been shown to be equivalent in lowering intraocular pressure in uncontrolled POAG patients when used as adjunct therapy for patients already taking a PGA Additionally, this is the first prospective study of optometrists performing SLT. Although this study had a small sample size, the results appeared to show that efficacy and complication rates were comparable to previously published data; however, these results need to be confirmed with a larger multi-centered trial.

Declarations

Ethics approval and consent to participate: The study was conducted in accordance with all the ethical principles outlined by the Declaration of Helsinki and was approved by the institutional review board at the University of Pikeville. All subjects signed an informed consent prior to participating in the study.

Consent for publication: Informed consent also included notice of the possibility of publication.

Availability of data and material: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: LP academic paid lecturer for Alcon and Bausch and Lomb. IM academic paid lecturer for Allergan. No other competing interests exist from all other authors.

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Authors' contributions: IM: Conception and design of study, data collection, assembly of relevant literature, writing and review of paper. ML: data collection, database management, analysis and interpretation of data, writing and review of paper. LP: data collection, writing and review of paper. NZ: data collection, writing and review of paper. AS: data collection, writing and review of paper. KS: data collection, writing and review of paper. MS: analysis and interpretation of data, review of paper. FM: data collection, review of paper. All authors read and approved the final version of the manuscript prior to submission.

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