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A Study of Selective Laser Trabeculoplasty as Adjunctive Treatment in Patients Affected by Open Angle Glaucoma for Control of Intraocular Pressure in Indian Eyes

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Prospective Interventional Pilot study of selective laser trabeculoplasty as adjunctive treatment in patients affected by open angle glaucoma for control of intraocular pressure in Indian eyes.
Methods: This prospective Interventional pilot study included 29 eyes of 29 patients affected by open angle glaucoma, were treated with Selective laser trabeculoplasty (360 degree trabecular meshwork treated with 100 spots) for IOP control between January 2011 to December 2011. Of these 29 patients, 24 were males, 5 were females. Mean age was 58.96±18.19 years. Primary open Angle Glaucoma was diagnosed in 22 patients, Secondary Open Angle Glaucoma in 6, and Juvenile Open Angle Glaucoma in 1 patient. All patients underwent complete ophthalmic evaluation before SLT and at each follow up. This evaluation included visual acuity, IOP (GAT), slit lamp examination with 90D. The gonioscopy and visual field analysis was done at 6 &12 months. The IOP was measured on day 1, day 7, 1 month, 3 month, 6 month and at 1 year post SLT On GAT.

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Results: Main outcome measure was lowering of intraocular pressure on Goldmann Applanation Tonometry. The mean IOP Pre SLT (Selective Laser Trabeculoplasty) was 24.62±6.38, IOP was reduced to 14.20±4.10 mmHg on Day 1 (42.32% reduction), on day 7 it was 15.96±4.731 mmHg (35.17% reduction), at 1 month it was 17.27±4.77 mmHg (29.82% reduction), at 3 months it was 19.41±4.40 mmHg (21.10% reduction), at 6 months it was 16.93±4.03 mmHg (31.23% reduction) and at 1 year it was 16.47±4.04 mmHg (31.3% reduction). After 3 months of follow up, 6 eyes out of 29 eyes, required Trabeculectomy with mitomycin C, for inadequate IOP control post SLT. These patients were considered as failures. In 2 patients topical medications decreased following SLT, remaining patients continued on same antiglaucoma medications. At follow up of 3 months 22 eyes (75.86%) out of 29 eyes maintained atleast 20% reduction from baseline IOP (Pre SLT IOP). At 6 months and 1 year of follow up 22 eyes out of 23 (95.65%), maintained atleast 20% reduction from baseline IOP (Pre SLT IOP). None of our patient had any complication or side effect following SLT.
Conclusion: Selective laser trabeculoplasty is effective and safe as a secondary/adjunctive treatment for lowering IOP in patients of open angle glaucoma not adequately controlled with medical therapy in Indian eyes. SLT has good compliance and affordability.

Keywords: Laser treatment; glaucoma; trabeculoplasty; intraocular pressure.

1. INTRODUCTION

Glaucoma is a slow progressive degeneration of the retinal ganglion cells (RGCs) and the optic nerve axons. Although increased intraocular pressure is a major risk factor of glaucoma, other factors include increased glutamate levels, alterations in nitric oxide (NO) metabolism, vascular alterations and oxidative damage caused by reactive oxygen species. Glaucoma is the second leading cause of blindness globally, accounting for 12.3% of the total blindness [1-3]. Glaucoma is a chronic progressive optic neuropathy that usually affects people over 40 years of age. It has characteristic visual field loss and is often associated with high intraocular pressure [1]. The pathogenesis of glaucoma progression is not completely known, but value of IOP is related to retinal ganglion cell loss. The IOP is maintained by constant balance between aqueous humour secretion from ciliary body and its drainage by trabecular meshwork (conventional is most common) and uveoscleral outflow. [2] In open angle glaucoma the IOP is increased due to increased resistance to aquous humor outflow via trabecular meshwork (Figs. 1 and 2) [2]. Glaucoma is typically bilateral and causes progressive loss of peripheral vision leading to significant disability [Figs. 1 and 2]. If unchecked patient continues losing vision leading to blindness [1-3].

Glaucoma is second largest cause of blindness worldwide after cataract. WHO estimates that about 105 million people suffer from glaucoma around the world and an estimated 5.2 million are blind from it [2]. This is because there is no reliable and cost effective way of detecting and treating the disease in large population. The burden of blindness from different types of glaucoma is high [3-4].

Glaucoma therapy plays important role in delaying the nerve fibre loss. Treatment at present can be pharmacological (drug therapy mainly topical), laser Trabeculoplasty [5,6], glaucoma filtration surgery. It plays an important role in lowering intraocular pressure (IOP). Also it is helpful in reducing the cost of treatment, noncompliance [7-11]. Patients have been found to miss one or the other topical medication. Reasons can be life style related, lack of awareness and financial condition. Glaucoma Filtration Surgical procedure is also associated with multiple complications like hypotony, bleb leak, shallow anterior chamber (AC), choroidal detachment [12] and long term complications like cataract and bleb related endophthalmitis [13] can be avoided. Also India is a developing country so need to have a cost effective treatment. Selective laser trabeculoplasty (SLT) is good treatment as it lowers IOP effectively and it has less complications and is very effective for lowering intraocular pressure. It is cost effective, avoids need of compliance [7-11] of the patient. SLT offers advantage that it uses selective wavelength which cause stimulation of only pigmented epithelium of trabecular meshwork, it does not distort the anatomy so it can be reused if required for lowering intraocular pressure (IOP), also it does not interfere with surgical outcome in future. We have included selective laser trabeculoplasty in our study as it has been proven to lower intraocular pressure effectively in Caucasian eyes but its data in Indian context is lacking.

2. RATIONALE OF THE STUDY

This study is important especially in Indian context as there is no such study using SLT in lowering intraocular pressure in cases of open angle glaucoma not adequately controlled with medical therapy done so far in India. SLT lowers intraocular pressure effectively, reduces cost of treatment on patient, independent of compliance [7-11] (Both these factors are very important for patients in developing country like India).

3. MATERIALS AND METHODS

Patients were recruited from glaucoma clinic of Advanced Eye Centre, Post Graduate Institute of Medical Education and Research, spanning a period of one year from Jan 2011 to Dec 2011. Informed consent was obtained from each patient after a complete description of the study. All patients were subjected to a detailed ophthalmological examination including best corrected visual acuity, contrast sensitivity, slit lamp examination of anterior segment, intraocular pressure measurement by Goldmann Applanation tonometer, gonioscopy, detailed stereoscopic examination of fundus with +90 diopter lens (Volk lens) and visual field testing programme 24-2/30-2 on Humphrey Field analyser (Humphrey® Field Analyzer /HFA™ II-i Series).

3.1 Design

Prospective Interventional Pilot study of selective laser trabeculoplasty as adjunctive treatment in patients of open angle glaucoma for control of intraocular pressure.

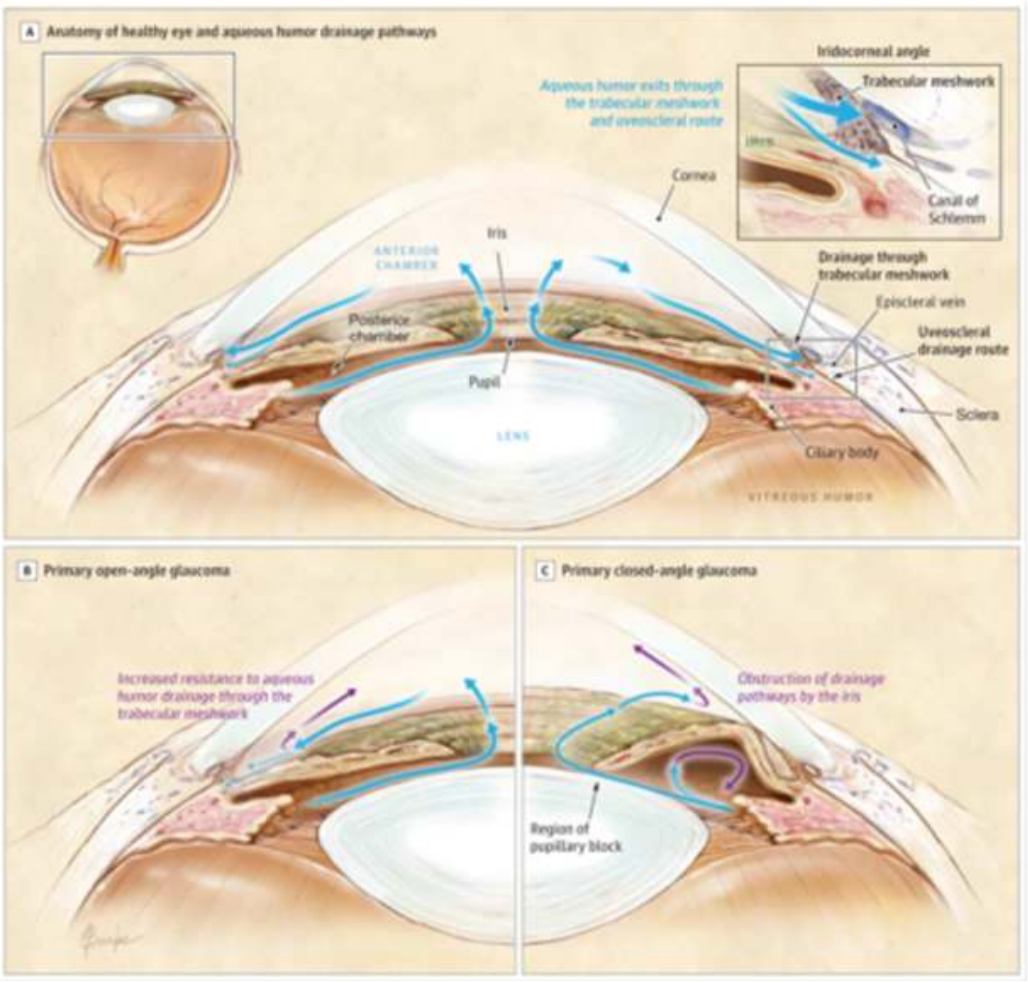

Fig. 1. Showing aqueous drainage in normal and in cases of open angle and closed angle glaucoma [2]

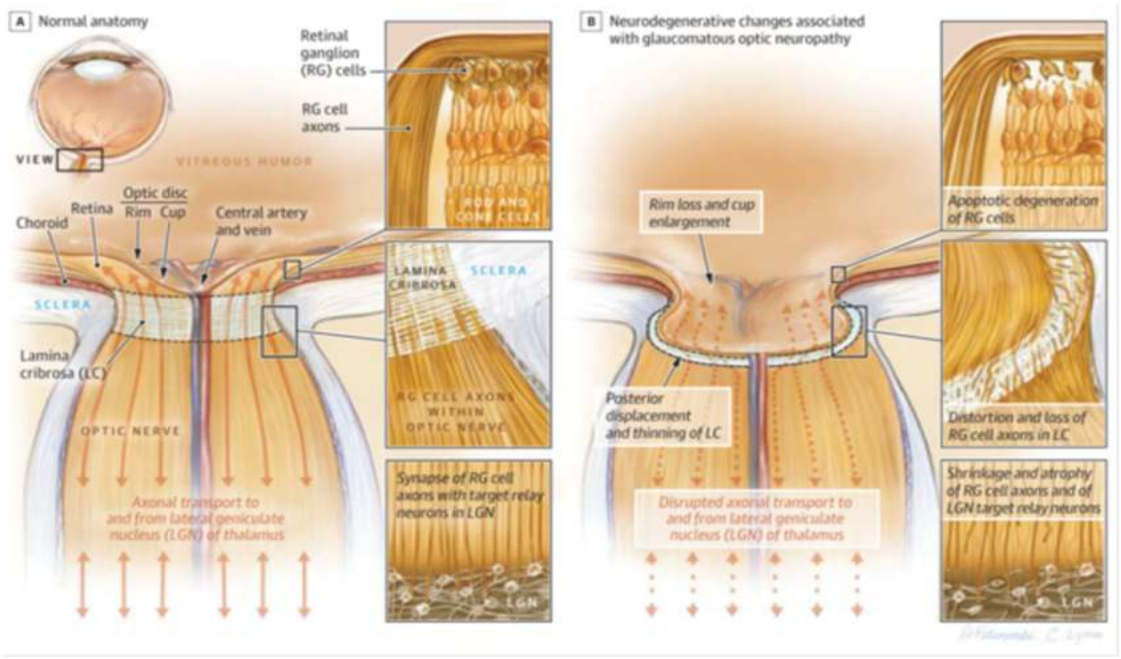

Fig. 2. Diagrammatic depiction of normal anatomy and ganglion cell damage associated with glaucomatous damage to optic nerve [2]

3.2 Selection Criteria

3.2.1 Inclusion criteria

1. Age >18 years
2. Either sex
3. Primary open angle glaucoma
4. Pseudoexfoliation syndrome
5. Pigment dispersion syndrome
6. Patients ready to give consent for Selective Laser Trabeculoplasty
7. Patients available for follow-up up to at least 3 month

3.2.2 Exclusion criteria

1. All glaucoma patients with co-existing ocular pathology such as media opacities, retina and macular diseases
2. 2.Patients who has undergone glaucoma surgery or laser iridotomy or ALT or LTP
3. Advanced visual field defects (scotoma within 10 degrees of fixation or split fixation on Humphrey visual field 24-2)
4. Angle closure glaucoma

3.3 Operative Technique

The SLT device in clinical use is a 532-nm frequency-doubled, Q-switched Nd: YAG laser (SLT ELLEX LASER) with a 3 ns pulse and 400-mm beam diameter. After topical anesthesia, Latina SLT lens (Ocular Instruments Bellevue, WA) is used to focus a low-power laser aiming beam at the pigmented trabecular meshwork. The size of the treatment spot is 400 µm. This is enough to cover the entire width of the trabecular meshwork, making accurate aiming less critical. We have increased the energy until small ‘‘champagne bubbles’’ are observed; it was then decreased by 0.1 mJ and treatment continued over 360 degree of trabecular meshwork. Approximately 100 spots applied to the full angle circumference. SLT treatment was continous, confluent but non overlapping. After the procedure, patients continued to take their preoperative glaucoma medications until the IOP is re-evaluated till 3 months of study. Post op Non-steroidal or corticosteroid anti-inflammatory drops were not used.

4. POST SLT FOLLOW UP

We did not use any topical steroids or non-steroidal anti-inflammatory treatment given.

Patient was continued on previous antiglaucoma medication.

Ophthalmic examination were done at intervals of 1 day, 1 week , 1 month, 3 months, 6 months

and at 1 year following SLT which included VA, IOP (on Goldmann Applanation Tonometry) and slit lamp examination.

5. RESULTS

Main outcome measure was lowering of intraocular pressure on Goldmann Applanation Tonometry. The mean IOP Pre SLT (Selective Laser Trabeculoplasty) was 23.78±6.39, IOP was reduced to 14.20±4.10 mmHg on Day 1 (42.32% reduction), on day 7 it was 15.96±4.731 mmHg (35.17% reduction), at 1 month it was 17.27±4.77 mmHg (29.82% reduction), at 3 months it was 19.41±4.40 mmHg (21.10% reduction), at 6 months it was 16.93±4.03 mmHg (31.23% reduction) and at 1 year it was 16.47±4.04 mmHg (31.3% reduction). After 3 months of follow up, 6 eyes out of 29 eyes, required Trabeculectomy with mitomycin C, for inadequate IOP control post SLT. These patients were considered as failures. In 2 patients topical medications decreased following SLT, remaining patients continued on same antiglaucoma medications. At follow up of 3 months 22 eyes (75.86%) out of 29 eyes maintained at least 20% reduction from baseline IOP (Pre SLT IOP). At 6 months and 1 year of follow up 22 eyes out of 23 (95.65%), maintained atleast 20% reduction from baseline IOP (Pre SLT IOP). None of our patient had any complication or side effect following SLT.

6. DISCUSSION

Selective laser trabeculoplasty is a fast emergent technology in the management of open angle glaucoma. We wished to study its effectiveness and utility through our study in Indian eyes. In the present study, 29 eyes of 29 patients with open angle glaucoma were included.

6.1 Extent of Laser

We treated 360 degree of trabecular meshwork in single sitting. Various treatment protocols have been described in literature varying from 90 degree to 360 degree treatment [14-23]. SLT have been shown to have better efficacy with 360 degree treatment. Study by Nagar et al. 26 showed an IOP reduction of >20% in 34% of eyes treated with 90 degree, 65% with 180 degree and 82% with 360 degree SLT treatment. This suggests that 360 degree SLT treatment is associated with higher success rate. Therefore we choose to treat 360 degree trabecular meshwork in single sitting. Our patients had a mean baseline IOP of 23.78±6.38 mmHg, after SLT it dropped to 19.00±5.04 mmHg at 3 months follow up. This drop of >20% was seen in 54% of the treated eyes. Reported response rate with 360 degree SLT treatment varies from 24% to 82% [14,20]. Response rate of 54% in our population is lower than reported by Lai et al. [24] in Chinese population and Nagar et al. [14] in Caucasian population. This could be due to lower baseline IOP in our patients, as all of our patients were on anti glaucoma treatment. Hirn C, et al. [21] did 360 degree trabecular meshwork SLT in patients who were on maximum tolerated medical therapy. They found significant reduction in mean IOP at 1 year. They noted IOP lowering of 5.6 mmHg which is similar to seen in present study.

6.2 Use of Topical Anti Inflammatory Agents

Post operatively we did not use any anti-inflammatory treatment. Currently there is no consensus on the use of steroidal or non steroidal anti-inflammatory agents. Steroids have been used to counter the in anterior segment inflammatory response in post SLT period. Proposed mechanism of SLT include “biologic theory” that says Laser stimulating cellular activity [25,26]. Following SLT, there is an increase in the recruitment and number of macrophages in the trabecular meshwork due to release of cytokine (IL1, TNFα) that cause remodelling of the extracellular matrix, allowing increased aqueous outflow from the eye [26]. It has been proposed that use of anti-inflammatory therapy might contribute to decrease in IOP lowering efficacy of SLT as proposed by Alvarado [27]. Therefore we did not use steroidal or non-steroidal anti-inflammatory treatment post-operatively as it can potentially decrease the efficacy of SLT.

6.3 Efficacy in Open Angle Glaucoma Subgroups

Published literature shows that IOP lowering similar in different form of OAGs (POAG, NTG, PXG, PG) [21,40]. In our patients, IOP lowering was similar in 3 subgroups of glaucoma [JOAG (22.67±4.62), POAG (18.52±5.42), and SOAG (19.29±3.20)] at 1 year.

In our case series there was 1 case of JOAG which showed decrease in mean IOP compared from baseline at 1 year. Role of SLT in JOAG has not been reported earlier.

Published literature shows that IOP lowering similar in different form of OAGs (POAG, NTG, PXG, PG): Recent studies of using SLT in the treatment of NTG in an Asian population have shown that the amount of IOP-lowering is slightly less than in POAG probably due to the lower pre-treatment IOP [28-30]. In our study there was no significant difference between open angle glaucoma subgroups.

6.4 Effect of Nature and Number of Topical Drugs

IOP lowering efficacy is not affected by number of topical antiglaucoma medications. In present study SLT was done in patients on maximum usable antiglaucoma medication for each patient. Most of our patients were on 4 drugs (12 eyes) or 3 drugs (11 eyes). Patients who were on single drug were on Prostaglandin. As reported by Hirn C, et al. [21] demonstrating role of SLT in lowering IOP in maximum tolerated medical therapy. So, SLT is effective in lowering IOP even in patients on maximum tolerated medical therapy. Francis B et al. [19] reported that SLT is good as an adjunct to medical therapy and reducing no. of topical antiglaucoma medication. Mc Ilraith et al. [16] reported SLT as initial and adjunctive to medical treatment. SLT not only lowers IOP in patients with different number of topical antiglaucoma medication but also it can be used to decrease no. of topical antiglaucoma medication and avoids need for additional antiglaucoma medication or need for glaucoma filtration surgery [14,16,18,21].

7. ROLE OF AGE AND GENDER

In our study efficacy of SLT is not affected by sex. Our study includes 24 males and 5 females. The patients were enrolled between January 2011 to December 2011. There was so gender based selection bias but the number of female eyes are too small to conclusively comment about the response of SLT. Nevertheless our study showed a definite male predominance. The following study also supports that age and gender are not significant predictors of SLT success [21,31].

8. IOP LOWERING: EFFICACY OF SLT

Mean reduction Of IOP achieved was 4.04±1.01 mmHg (16.41% of baseline IOP) at 1 year in our study. The reduction is comparable to other studies by Latina et al. [15] (4.6 mmHg at 26 weeks), Kajiya et al. [32] (6.7 mmHg at 6 months), Hodge et al. [33] (5.8 mmHg at 1 year), Damji et al. [34] (4.8 mmHg at 6 months), Johnson et al. [20] (3.74 mmHg at 3 months), Jay Katz et al. [23] (6.3 mmHg at 10 months), Hirn C et al. [21] (5.6 mmHg at 11.97 months).

Detailed comparison of our study with previously reported studies is given in Table 1.

9. ADVERSE EVENTS

9.1 Anterior Chamber Inflammation

In the initial study of 180 degrees SLT by Latina and coworkers, 83% of SLT-treated eyes exhibited mild-to-moderate inflammation, appearing within 1 hour after treatment, decreasing by 24 hours after treatment, and completely resolved in all cases within 5 days of treatment [14]. Martinez-de-la-Casa et al. [35] evaluated flare using the Kowa flare meter, and found significantly lower flare readings after SLT than ALT. Damji and colleagues reported more anterior chamber inflammation in the first 1 hour after SLT than ALT [34]. Nagar and colleagues reported a 50% rate of anterior chamber inflammation in eyes receiving 360 degrees SLT versus 0% in latanoprost-treated eyes [14]. A single case report of hyphema after SLT has also been reported [36]. The damage to the cornea to due the close proximity of the cornea with the trabecular meshwork has been reported [37-38].

None our patient had significant anterior segment inflammation.

9.2 Ocular Discomfort

Latina and colleagues reported that 15% of eyes receiving SLT reported discomfort after the procedure [15]. Martinez-de-la-Casa and colleagues evaluated postoperative pain using a 10-point scale and found significantly lower pain scores after SLT compared with ALT during and immediately after treatment; these differences were gone by 24 hours post treatment [35]. Nagar and colleagues reported a 39% rate of discomfort in eyes undergoing 360 degrees SLT and a 0% rate in eyes receiving latanoprost [14]. None of our patient had ocular discomfort following SLT immediate post op and on Day 1.

Table 1. Shows comparison of our study with different studies

Study	Population	Treatment	Baseline IOP (mm Hg)	Follow up	IOP reduction	Definition of success	Response Rate	Comments
Present study	29 eyes of 29 patients of OAG	360 degree SLT	23.78±6.38	1 year	4.04 ± 1.01 mmHg (17% of baseline IOP).	IOP control without retreatment or without additional antiglaucoma or surgery	60%	Response to SLT not affected by age , different diagnosis, number of topical medication
Latina et al. [15]	53 eyes	SLT nasal 180 degree	24.6	26 weeks	4.6 mm Hg	IOP reduction ≥ 3 mmHg	73 %	Similar IOP reduction in eyes with or without ALT
Song et al. [17]	94 patients with OAG	180 degree SLT	17.6	Mean 10.6 months	2.1	IOP reduction >3 mmHg	32%	Only significant predictor of failure was lower preoperative IOP
Gracner [18]	10 patients of XFG	Inferior 180 degree SLT	23.6±5.7	12 ±5.5 months	6.0±3.3	IOP reduction ≥20% and no progession on VF or ON changes after 1 year	70%	Results not statistically significant between eyes with POAG and XFG
	10 patients of POAG		22,8±2.4	13.5±4.3 months	6.5±2.8			
Francis et al. [19]	66 patients with medically controlled POAG or XFG	180 degree SLT		12 months		Ability to decrease medication while maintaining target IOP	87 % discontinued a mean of 2.0 medications at 6 months and 1.5 at 12 months	
Lai et al. [24]	29 chinese patients with POAG or OHTN	360 degree SLT (fellow eye treated with medication	26.2±4.2	5 years (82.8% completed follow up)	8.6±6.7 mHg (32.1%)	IOP ≤21 mmHg without medication	72%	Similar IOP reduction by SLT and medication
						IOP ≤21mmHg on MTMT	83%	

Kajiya et al. [32]	17 eyes of 10 patients	180 degree SLT	22.8	6 months	6.7 mmHg	NA	NA	
Hodge et al. [33]	72 patients with OAG on MTMT	180 degree SLT	23.8± 4.88	12 months	5.8 mmHg (24.4%)	IOP reduction of >20% after 1 year	60%	IOP reduction significantly related to higher baseline IOP , but not to all other factors examined
Damji et al. [34]	2 groups of 18 eyes with OAG	180 degree SLT	22.8±3 mmHg	6 months	4.8±3.4 mmHg			Similar IOP reduction by ALT and SLT
Lanzetta et al. [39]	8 eyes	360 degree SLT	26.6±7	6 weeks	10.6±5.2	NA	NA	
Chen et al. [40]	2 groups of 32 patients	180 degree SLT	26.06	7 months	6.16(24 %)	IOP controlled without retreatment or trab at 7 months	59%	IOP reduction significantly related to trabecular piugmentation

9.3 IOP Spikes

Latina and colleagues reported IOP spikes of 5mm Hg or greater in 25% of SLT-treated eyes and IOP spikes of 8 mm Hg or greater in 9% of treated eyes [15]. All manifested within 2 hours after treatment, resolved with IOP-lowering medications within 24 hours, and none of eyes exhibited a persistent IOP elevation. Damji and co-workers [34] reported that 3.4% of ALT-treated eyes and 4.5% of SLT-treated eyes exhibited an IOP rise of 6 mm Hg or greater within 1 hour after treatment. Nagar and colleagues reported that 27% of eyes undergoing 360 degrees SLT manifested an IOP spike of 5 mm Hg or more (compared with no IOP spikes in latanoprost treated eyes) [14]. Lai and coworkers reported that 10.3% of 360 degrees SLT-treated eyes manifested an IOP spike of 5mm Hg or greater [24]. None of our patient had persistently raised IOP following SLT. As all our patient were on antiglaucoma therapy following SLT and continued on same medication following SLT. Thus taking care of IOP spike component also.

10. LIMITATION

1. One of the limitations of our study was only 1 year follow-up time. The original purpose of the present study was to evaluate efficacy of SLT in lowering IOP following SLT treatment, so a longer follow-up is needed. Considering IOP, several studies have indicated that IOP remains stable at 6 months [15] and 18 months [33].
2. The initial IOP spikes could have been missed due to the first post procedure visit at 24 hours. But all our patients were on antiglaucoma medications and it was continued after the procedure.
3. There were predominant males in our study [24 males, 5 females], we cannot comment conclusively whether efficacy of SLT is affected by sex.
4. We had predominantly POAG and less of other forms open angle glaucoma subgroups, hence difference in efficacy in various subgroups cannot be commented conclusively.

11. SUMMARY AND CONCLUSIONS

1. In our study we included 37 eyes of 33 patients of open angle glaucoma with baseline IOP of 23.78±6.39 mmHg. Post SLT mean IOP at 1 month was 17.38±5.04 mmHg which was comparable to IOP at 3 months (19.00±5.04 mmHg) at 6 months it was 16.93±4.03 mmHg (31.23% reduction) and at 1 year it was 16.47±4.04 mmHg (31.3% reduction). The IOP at 1 year was significantly lower from baseline IOP (23.78±6.39 mmHg).
2. We did 360 degree SLT of trabecular meshwork in single sitting. We have not given post operatively any anti-inflammatory therapy. The patients continued to use prior antiglaucoma medications.
3. Our results, though limited, seem to show that selective laser trabeculoplasty is effective as a secondary/adjunctive treatment for lowering IOP in patients of open angle glaucoma not adequately controlled with medical therapy in Indian eyes.
4. Our results, though limited, seem to show that SLT is a safe procedure. As none of our patients had any significant side effects.
5. SLT has a good compliance.
6. Our results, though limited, seem to show that SLT can be tried in patients of JOAG also. Although, long term success is questionable but still SLT seems like a promising therapy in such cases. SLT is equally efficacious in different glaucoma subgroups of open angle glaucoma.
7. Our results, though limited, seem to show that efficacy of SLT is not affected by age,
8. Our results, though limited, seem to show that efficacy of SLT in lowering IOP is same in males and females
9. Our results, though limited, seem to show that efficacy of SLT in IOP lowering is not affected by number of topical antiglaucoma medications. In our study patients with maximum tolerated medical therapy also responded to SLT similar to patients who were on single drug. So, SLT can be used as an adjunct to medical therapy and also defer need of glaucoma fitration surgery.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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