Original Article

Real-Life Effectiveness and Safety of Selective Laser Trabeculoplasty as Primary, Adjunctive, and Substitutive Therapy

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Abstract

Objectives: To assess real-world outcomes of selective laser trabeculoplasty (SLT) in naive patients compared to SLT as adjunctive treatment (AT), investigating SLT's intraocular pressure (IOP) reduction and its potential to decrease topical medication.

Materials and Methods: Patients undergoing SLT with no prior glaucoma surgery or laser treatment were grouped based on the intended objective: SLT as primary treatment (PT), SLT as AT, and SLT as substitutive treatment (ST). Survival in the PT and AT groups was defined as ≥20% IOP reduction from baseline and IOP ≤21 on two consecutive visits with the same or fewer medications and no additional glaucoma procedure, including repeat SLT. Survival in the ST group was defined as decreasing topical medication while maintaining or reducing IOP.

Results: The study included 120 eyes of 120 patients with a mean follow-up of 32.7 months. The PT group showed superior IOP reduction than the AT group at 24-36 months (22.1% vs. 14.5%, p=0.039). Non-responders comprised 28.6% of the PT group and 37.0% of the AT group. The PT group demonstrated better survival rates than the AT group at 12, 24, and 36 months (69.0% vs. 47.1%, 38.8% vs. 31.4%, and 31.1% vs. 23.5%, respectively). In the ST group, 34.2% of patients were successful at 12 months, increasing to 38.3% at 24 months. At 24 months, 50.0% of patients had reduced at least one medication.

Conclusion: SLT showed two-thirds effectiveness, with one-third being non-responders. It was more effective as PT, with higher IOP reduction and success rates. SLT reduced topical medication in half of patients.

Keywords: Selective laser trabeculoplasty, glaucoma, SLT, laser glaucoma therapy

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Introduction

Elevated intraocular pressure (IOP) is the primary modifiable risk factor in the progression of glaucoma. Despite the availability of topical IOP-lowering medications, which are often used as first-line treatment,[1] their effectiveness is frequently undermined by issues such as non-compliance and side effects, leading to less than 50% of patients continuing treatment after 1 year.[2] While surgical options are effective, they are not without risks, underscoring the need for less invasive alternatives.

Selective laser trabeculoplasty (SLT) presents a minimally invasive, cost-effective alternative that does not require daily patient compliance.[3,4,5,6] Demonstrating IOP-lowering efficacy comparable to that of a single topical antihypertensive drug,[6,7,8,9] SLT is also considered safer and more repeatable than argon laser trabeculoplasty.[3,10,11] The procedure targets pigmented trabecular meshwork cells with a Q-switched, frequency-doubled, 532-nm neodymium-doped yttrium aluminum garnet (Nd:YAG) laser to increase aqueous outflow and reduce IOP.[12,13,14] Although transient side effects like mild anterior chamber inflammation and temporary IOP spikes occur, they generally resolve without long-term consequences.[8,15]

Initially overshadowed by new and effective pharmacological treatments,[16,17,18] SLT has gained prominence as both a primary and adjunctive treatment (AT) due to increasing concerns over medication overuse and non-adherence.[19,20] Hypotensive outcomes of SLT vary across studies, influenced by patient

characteristics such as glaucoma stage,[5,6] baseline IOP,[21,22] prior treatments,[22] and methodological differences. In the LiGHT trial, 74% of patients who underwent primary SLT remained drop-free at 36 months.[22] However, further real-world studies are needed to validate these findings.

This study aimed to assess the real-world effectiveness of SLT in reducing IOP when used as primary treatment (PT) in treatment-naïve patients, as an AT in medicated patients, and as substitutive treatment (ST) for those with controlled IOP facing adherence or tolerability issues.

Materials and Methods

Patients

This single-center review analyzed real-world patients who underwent SLT between June 2017 and January 2022, with a minimum 12-month follow-up. Only one randomly selected eye per patient was included, and those with prior glaucoma surgeries or laser treatments (SLT or argon laser trabeculoplasty) were excluded. While the study was prospectively designed, including patient recruitment, data extraction was conducted retrospectively. The research adhered to the Declaration of Helsinki and received approval from the Barcelona Clinic Hospital Ethics Committee (HCB/2022/0959, 23/02/2022). All patients provided consent for the review of their clinical data for this purpose.

Patients were grouped based on the treatment objective: SLT as PT, SLT as AT for medicated patients needing further IOP reduction, and SLT as ST for patients with controlled IOP but facing tolerability or adherence issues.

Procedure

SLT was performed by multiple ophthalmologists using the OPTIMIS Fusion® laser system (Quantel Medical, Cournon-d'Auvergne, France), equipped with a Q-switched 532-nm Nd:YAG laser. The procedure followed a 360-degree protocol without overlapping impacts, utilizing a 400-µm spot size and a 4-ns duration. Laser power started at 0.6 mJ and was incrementally increased until microbubbles appeared, with a maximum power of 1.2 mJ. A total of 95-105 spots were necessary to complete the 360 degrees. A Volk Optical SLT lens and 1% methylcellulose were used during the procedure. Preoperatively, patients received 2% pilocarpine hydrochloride (Mizar Farmacéutica S.L., Barcelona, Spain) and 5 mg/mL apraclonidine drops (Iopimax®, Alcon-Couvreur N.V.). Postoperative care included topical diclofenac 1 mg/mL (Angelini Pharma España, Barcelona, Spain) administered every 8 hours for 1 week, in addition to the continuation of pre-laser hypotensive medication, which was discontinued as needed.

Measures

Baseline data, including age, sex, diagnosis, pseudophakia, angle pigmentation, number of topical medications, visual acuity, and Goldmann applanation tonometry measurements, were collected from electronic medical records. Primary outcomes were changes in IOP and the number of hypotensive drops used.

IOP changes and medication usage were recorded at 3, 6, 12, 24, and 36 months. A 1-month margin was allowed for data collection (±0.5 months of the target time point) after 3 months due to the retrospective nature of the study. Data from 24 to 36 months post-SLT were grouped for some analyses, using the most recent assessment. Alternative procedures for IOP control, such as surgery or repeat SLT sessions, were documented. Patients requiring additional procedures were censored at their last visit before the intervention.

For survival analysis, failure in the PT and AT groups was defined as an IOP reduction of <20% from baseline at two consecutive visits, IOP ≥21, an increase in glaucoma medications from baseline, or any further glaucoma procedure, including repeat SLT. In the ST group, survival was defined as maintaining the same or lower IOP while reducing at least one medication from baseline without requiring additional glaucoma procedures.

Statistical Analysis

Statistical analysis was conducted using STATA 17 software (StataCorp LLC). For the initial characterization of the groups, chi-squared tests and either analysis of variance (ANOVA) or Kruskal-Wallis tests were employed. Intergroup comparisons of IOP changes between the PT and AT groups were performed using multivariable linear regression models including previously described related variables. For the survival analysis, Kaplan-Meier survival analysis and multivariable Cox regression were conducted. For the ST group, the mean number of medications used at each time point was compared to baseline using paired-samples Wilcoxon tests. Results are expressed as frequency and percentage or means and standard deviation (SD) with 95% confidence intervals (CI).

Results

A total of 120 eyes with a mean follow-up time of 32.7 months (SD: 6.1 months) were included in the analysis. Of these, 103 eyes (86%) had a follow-up of at least 24 months. Table 1 displays the baseline demographic and clinical characteristics. There were statistically significant differences (attributable to group designs) among the three groups in baseline IOP ($p<0.001$) and baseline number of treatments ($p<0.001$). However, no statistical differences were found for age, sex, pseudophakia, angular pigmentation, or diagnosis. Similarly, when comparing baseline characteristics between the PT and AT groups, significant differences were found in baseline IOP ($p<0.001$) and number of treatments ($p<0.001$), as well as age ($p=0.016$). No differences were found for sex ($p=0.51$) or angle pigmentation ($p=0.49$). IOP was measured in all patients between 6 and 24 hours after treatment, and no instances of IOP exceeding pre-laser levels were detected.

Selective Laser Trabeculoplasty as Primary versus Adjunctive Treatment

The study included 42 eyes in the PT group and 27 eyes in the AT group, with mean follow-up times of 32.7 months (SD: 5.9) and 30.7 months (SD: 6.9), respectively. The difference in

follow-up time between the two groups was not statistically significant (p=0.2).

Change in Intraocular Pressure

The mean percentage IOP reduction from baseline for the PT vs. AT groups was 17.3% (95% CI, 13.6 to 21.0) vs. 10.0% (95% CI, 2.5 to 17.5) at 12 months and 21.3% (95% CI, 16.1 to 26.5) vs. 13.2% (95% CI, 6.1 to 20.3) at 24 months (Table 2). In the raw multivariable linear regression, the differences in percentage IOP reduction were significant at 6 months (p=0.03), 12 months (p=0.06), and 24 months (p=0.06). In the multivariable linear regression adjusted for age, baseline IOP, baseline number of topical treatments, and pseudophakia, the PT group had 9.4% greater IOP reduction than the AT group (95% CI, -5.2 to 24.0; p=0.2) at 12 months and 25.1% greater (95% CI, 1.4 to 48.8; p=0.02) at the 24-36 months period (Table 2 and Figure 1). The multivariable analysis showed that higher baseline IOP was a strong predictor for a more significant SLT effect (p=0.002), and a higher baseline number of IOP-lowering medications was associated with a lower SLT effect (p=0.01). Age was not a predictor (p=0.4).

Survival Analysis

Twelve eyes (28.6%) in the PT group and 10 eyes (37.0%) in the AT group did not respond to SLT, given that they failed to achieve an initial 20% IOP reduction or an IOP under 21 mmHg. If non-responders are included in the survival analysis, the probability of success in the PT group was 52.4% at 6 months and decreased to 43.9%, 27.8%, and 22.2% at 12, 24, and 36 months post-SLT, respectively. For the AT group, the success rate was 37.0% at 6 months and declined to 29.6%, 19.8%, and 14.8% at 12, 24, and 36 months, respectively.

Among those with initial response, the PT group showed a success rate of 73.3% at 6 months, which declined to 60.0%, 38.8%, and 31.1% at 12, 24, and 36 months post-SLT, respectively. In the AT group, the success rate was 58.8% at 6 months and declined to 47.1%, 31.4%, and 23.5% at 12, 24, and 36 months, respectively (Table 2).

The median survival for responders in the PT group was 24 months, while it was 12 months in the AT group (p=0.05). The multivariable Cox regression model adjusted for the same factors revealed no significant differences between the groups (hazard ratio: 1.08, 95% CI, 0.5 to 2.6), with a p value of 0.86. Kaplan-Meier graphs are displayed in Figure 2.

Selective Laser Trabeculoplasty as Substitutive Treatment

The ST group included 51 eyes. The mean follow-up time was 33.8 months (SD: 5.6), and 48 eyes (94%) completed at least 24 months of follow-up. SLT successfully achieved a reduction in hypotensive medication while maintaining equal or lower IOP in 39.5%, 34.2% and 38.3% of the eyes at 6, 12, and 24 months.

The mean number of medications at baseline was 1.63 (SD: 0.7) with a mean IOP of 18.6 mmHg (SD: 3.9). The mean medication reduction was statistically significant at all time points, with a reduction of 0.65 medications (95% CI, 0.43 to 0.87) at 12 months and 0.52 medications (95% CI, 0.29 to 0.75) at 24 months. By 24 months, 50.0% (95% CI, 35 to 65) of patients had reduced at least one medication, and 10.4% (95% CI, 3.5 to 23) had discontinued two medications from baseline (Figure 3 and Table 3).

Table 1. Baseline description by groups

	SLT as primary treatment n=42		SLT as adjunctive treatment n=27		SLT as substitutive treatment n=51	
Follow-up (months)	32.7	(5.9)	30.7	(6.9)	33.8	(5.6)
Age (years)	60.0	(11.0)	67.1	(11.8)	62.4	(14.8)
Sex female	23	56.1%	11	42.3%	25	49.0%
Pseudophakia	15	35.7%	15	55.6%	21	41.2%
Mean baseline IOP (mmHg)	22.8	(2.9)	19.9	(3.7)	18.6	(3.9)
Mean baseline number of medications	0.0	(0.0)	2.0	(0.8)	1.6	(0.7)
Angular pigmentation	1.7	(0.7)	1.5	(0.6)	1.7	(0.8)
Diagnosis						
POAG	9	21%	8	30%	10	20%
PXG	3	7%	1	4%	4	8%
OHT	20	47%	7	26%	20	39%
PACG	4	10%	2	7%	2	4%
Pigmentary glaucoma	3	7%	0.0	0%	4	8%
NTG	0	0%	4	15%	3	6%
Others	3	7%	5	19%	8	16%

Values are expressed as mean (standard deviation) or frequency and percentage. SLT: Selective laser trabeculectomy, IOP: Intraocular pressure, POAG: Primary open-angle glaucoma, PXG: Pseudoexfoliative glaucoma, OHT: Ocular hypertension, PACG: Primary angle-closure glaucoma, NTG: Normal tension glaucoma

Table 2. Survival and mean percentage IOP reduction over time with SLT as primary and adjunctive treatment

	Primary SLT treatment						Adjunctive SLT treatment					
	Eyes	Failed	Partial success	Complete success	Cumulative survival	Cumulative survival on patients with initial response	Mean percentage IOP reduction (95% CI)	Eyes	Failed	Partial success	Complete success	Cumulative survival	Cumulative survival on patients with initial response	Mean percentage IOP reduction (95% CI)
Initial response (1 month)	40	18	0	22	71.4%	-	21.7% (25.7-17.7)	27	12	0	15	63.0%	-	17.0% (23.0-11.0)
3 months	40	22	0	18	59.5%	83.3%	18.1% (22.6-13.6)	25	14	0	11	51.9%	82.4%	12.6% (19.6-5.6)
6 months	33	21	1	11	52.4%	73.3%	18.0% (23.1-12.9)	25	19	1	5	37.0%	58.8%	9.5% (15.6-3.4)
12 months	37	23	1	13	43.9%	60.0%	17.3% (21.0-13.6)	24	16	2	6	29.6%	47.1%	10.0% (17.5-2.5)
24 months	38	18	9	11	27.8%	38.8%	21.3% (26.5-16.1)	24	16	1	7	19.8%	31.4%	13.2% (20.3-6.1)
36 months	29	11	6	12	22.2%	31.1%	24.5% (32.7-16.4)	14	7	1	6	14.8%	23.5%	10.9% (28.2 – -6.5)

IOP: Intraocular pressure, SLT: Selective laser trabeculectomy, CI: Confidence interval

Secondary Effects and Failure

None of the treated eyes showed significant anterior segment inflammation and no transient increase in IOP was recorded. Patients reported no pain or discomfort during the procedure.

We identified 22 non-responders: 12 in the PT group (28.6%) and 10 in the AT group (37.0%), with no significant difference between these rates (p=0.46). The mean age of non-responders was 66.5 years (SD: 10.6), while that of responders was 61 years (SD: 12.5). This difference was also statistically non-significant (p=0.08).

The mean pre-SLT IOP among non-responders was 19.95 mmHg (SD: 3.6). In contrast, responders had a significantly higher mean pre-SLT IOP of 22.4 mmHg (SD: 3.2) (p=0.006). This finding supports the hypothesis that lower baseline IOP is associated with poorer SLT efficacy. The mean number of prior treatments was 0.9 (SD: 1.15) for non-responders and 0.7 (SD: 1.1) for responders (p=0.52).

Failure requiring a secondary glaucoma procedure was observed as follows:

PT group: One eye required SLT retreatment at 12 months, while another underwent non-penetrating deep sclerectomy at 34 months.

AT group: Two eyes required additional SLT at 20 months, and one eye underwent drainage implant surgery using an SL-Molteno3 device (NovaEye Medical, Fremont, USA) at 24 months.

ST group: Four eyes underwent SLT retreatment (one at 7 months, two at 12 months, and one at 25 months). Additionally, one eye underwent Xen® gel stent implantation (AbbVie, Illinois, USA) at 8 months, and another underwent subliminal transscleral laser cyclophotocoagulation (SubCyclo-Quantel, Cournon d'Auvergne, France) at 12 months.

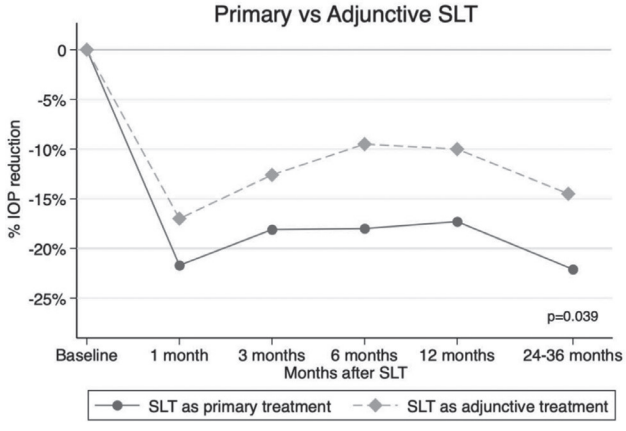

Figure 1. Percentage IOP reduction over time in the primary and adjunctive treatment groups. P value for multivariable linear regression model adjusted for age, baseline IOP, previous number of medications, and pseudophakia

SLT: Selective laser trabeculoplasty, IOP: Intraocular pressure

Discussion

This study evaluated the impact of SLT in three real-world scenarios. Compared to the group in which SLT was used as adjunctive therapy, SLT was more effective as PT, achieving greater IOP reductions (21.3% vs. 13.2% at 24 months and 24.5% vs. 10.9% at 36 months), a lower proportion of non-responders (28.6% vs. 37.0%), and a higher 24-month survival rate among responders (38.8% vs. 31.4%). In the group in which SLT replaced medication, 50.0% of eyes maintained the same or lower IOP while reducing at least one medication by the 24-month follow-up.

In real-world settings, SLT is often considered for newly diagnosed glaucoma or ocular hypertension in patients without prior hypotensive treatment. However, when baseline IOP exceeds certain thresholds, SLT is generally not recommended, as it is unlikely to achieve target pressures. In such cases, treatment typically progresses to topical hypotensive or surgery, depending on the condition of the optic nerve.

Accordingly, IOP in the PT group was mildly elevated (mean 22.8 mmHg) with no prior hypotensive treatment. In contrast, in eyes that underwent SLT as adjunctive therapy, patients were already on hypotensive medication, and the objective was to further reduce IOP due to disease progression or an increase in IOP. In this scenario, it must be assumed that a 20% reduction would be sufficient. If this reduction was deemed insufficient, surgical intervention would be considered. This means that patients with high IOP were not selected for adjunctive SLT but were instead considered for surgical treatment. Consequently, IOP in the AT group was expected to be normal or only mildly elevated, as reflected in the data.

The small but significant age difference between groups suggests that patients with a longer history of glaucoma treatment tend to be older. Therefore, as expected, the PT and AT groups showed significant differences in preoperative IOP, number of hypotensive medications, and age, all of which are known prognostic factors that influence SLT efficacy.[23]

In this study, only higher preoperative IOP and a lower number of preoperative medications were identified as predictive factors for greater treatment efficacy (p=0.02 and p=0.01, respectively). However, when adjusted for age, preoperative IOP, and number of medications, the PT group still achieved better

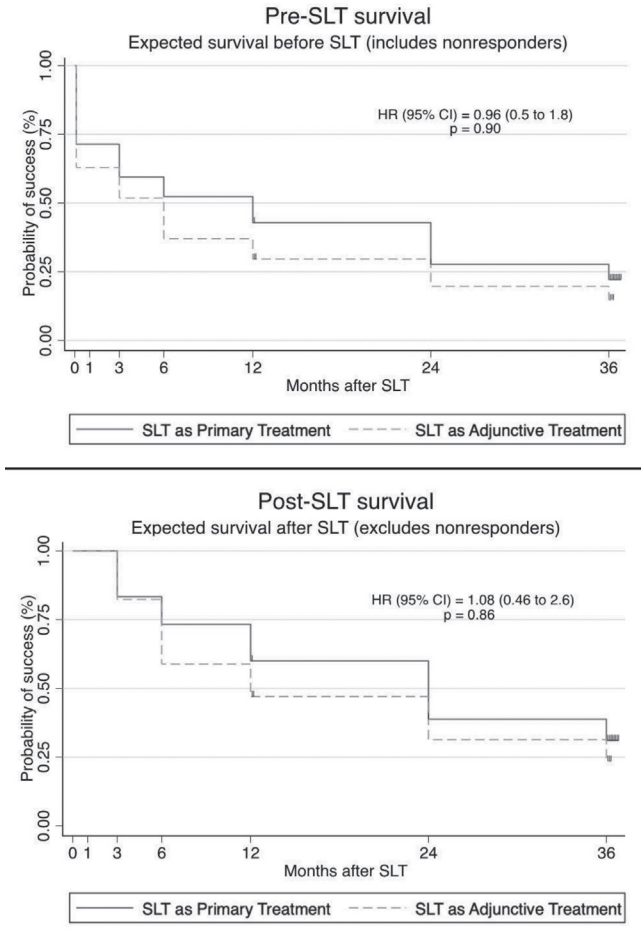

Figure 2. A Kaplan-Meier graph was used to compare SLT survival between the primary and adjunctive treatment groups. The first graph includes all patients in the study, representing expected survival prior to SLT. The second graph represents patients who demonstrated an initial response, excluding those with IOP reduction <20% at first month (non-responders). This graph represents survival after SLT was initially effective. Although there are differences in survival between the two graphs, the overall shape and the differences among the groups remain similar. This suggests that excluding non-responders may lead to an overestimation of the effect of SLT but not its duration over time. P values were obtained using multivariable Cox regression, adjusting for age, baseline IOP, the previous number of medications, and pseudophakia

SLT: Selective laser trabeculoplasty, HR: Hazard ratio, CI: Confidence interval, IOP: Intraocular pressure

Table 3. Success rates, mean percentage IOP reduction, and mean number of medications after SLT as substitutive treatment

	Eyes	Success (%)	Mean percentage IOP reduction (95% CI)	Mean n of medication reduced (95% CI)
Baseline	51	-	Baseline IOP: 18.6 mmHg (SD: 3.9)	Baseline n of meds: 1.63 (SD: 0.66)
3 months	49	26.5%	10.6% (4.8 to 16.4)	0.45 (0.29 to 0.61)
6 months	43	39.5%	7.2% (1.1 to 13.3)	0.58 (0.40 to 0.76)
12 months	41	34.2%	4.4% (-1.6 to 10.5)	0.65 (0.43 to 0.87)
24 months	47	38.3%	5.2% (-2.1 to 12.6)	0.52 (0.29 to 0.75)
36 months	41	19.5%	8.6 % (1.1 to 16.1)	0.52 (0.22 to 0.83)

IOP: Intraocular pressure, SLT: Selective laser trabeculectomy, CI: Confidence interval, SD: Standard deviation

efficacy, with 25.1% greater IOP reductions than the AT group at 24 to 36 months.

We did not examine the differences in SLT efficacy according to angle anatomy or in phakic versus pseudophakic cases. Nevertheless, it can be anticipated that pseudophakic patients are typically older and therefore may have more advanced glaucoma. Consequently, pseudophakia is expected to be more prevalent in the AT and ST groups, as noted in the group descriptions. Additionally, the average pigmentation of the cases was very similar across the groups (1.7, 1.8, and 1.7).

Reported SLT 2-year success rates vary widely (40-85%).[24] The LiGHT trial, a multicenter randomized study, demonstrated that 74.2% of patients undergoing SLT required no drops at 36 months to maintain target IOP.[5,22] However, the study included only naïve patients and allowed second SLT sessions, which may have influenced the results.

This study underscores the importance of assessing SLT's real-world impact, where success rates appear lower. Findings by Khawaja et al.[25] align closely with this study, showing 12- and 24-month survival rates of 45% and 27%, respectively, under similar success definitions. Many studies use less stringent criteria, excluding factors like increased medication use or repeat SLT sessions from failure definitions, which can bias success rates upward.[26,27] To avoid this, follow-up in this study was truncated at the last visit before additional glaucoma procedures.

Additionally, non-responders are often excluded or omitted in other studies.[25,28] In contrast, this study highlights their presence. We argue that this group should always be acknowledged and analyzed to provide a comprehensive understanding of SLT outcomes. When analyzing non-responding eyes, only higher pre-SLT IOP was identified as a predictive factor for treatment response. A larger sample size may be required to better assess the influence of other variables associated with the initial response to SLT.

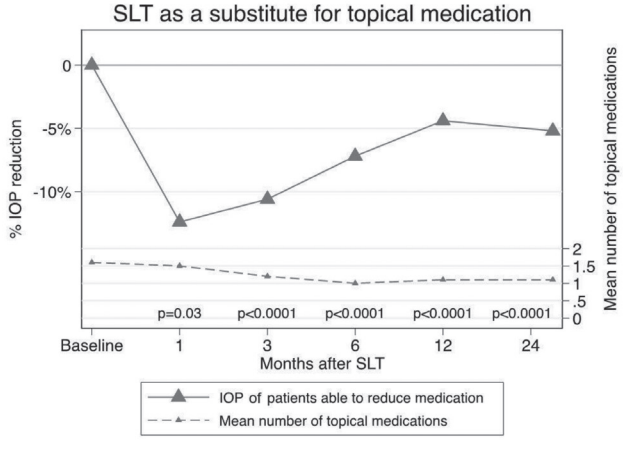

Figure 3. Percentage IOP reduction and mean number of treatments over time on SLT as substitutive treatment. P values for paired Wilcoxon test for mean number of medications at each time point compared to baseline

SLT: Selective laser trabeculoplasty, IOP: Intraocular pressure

Moreover, we acknowledge the importance of further analyzing non-responders to SLT to better understand predictors of treatment failure. While this study primarily aimed to assess a patient profile that can help anticipate the response to SLT, we recognize that a more detailed evaluation of non-responders, considering factors such as age, baseline IOP, and prior medications, would provide valuable insights for refining patient selection criteria. If data availability permits, a more in-depth stratification of non-responders could be explored in future analyses.

Despite 24-hour IOP monitoring, no cases of post-laser ocular hypertension were detected. This is believed to be attributable to the preoperative administration of pilocarpine and apraclonidine, which are known to control post-laser pressure spikes. Furthermore, the continuation of preoperative hypotensive treatment during the initial postoperative weeks likely contributed to this outcome.

This study included all patients who underwent SLT, excluding those with previous glaucoma surgeries or laser treatments. Patients were classified based on clinical criteria without randomization, leading to inherent statistical differences between groups. The PT group was younger, had a lower rate of pseudophakia, and exhibited higher baseline IOP compared to those already on hypotensive treatments. These differences, when adjusted for baseline variables (IOP, age, pseudophakia, and number of topical medications), allowed a more nuanced understanding of SLT's real-world effects.

After adjustment, IOP reduction was 9.4% greater in the PT group than the AT group at 12 months (95% CI, -5.2 to 24.0; p=0.2) and 25.1% greater at 24-36 months (95% CI, 1.4 to 48.8; p=0.04). Baseline IOP emerged as the main predictor of SLT response, with higher baseline IOP correlating with a greater SLT effect (p<0.001 at 24 months), consistent with findings from other studies.[21,22,25,26]

Conversely, a higher number of pre-laser antihypertensive drugs was associated with a reduced SLT effect. Some authors have also observed this,[23] whereas other studies indicated no differences based on pre-SLT treatments.[25,28] This suggests the higher SLT efficacy in the PT group may be due to their elevated baseline IOP, which predicts a stronger response, while the extensive pre-laser medication use in the AT group correlates with a diminished effect. These findings highlight how baseline characteristics influence SLT outcomes and emphasize the need for tailored approaches based on patient profiles.

Limited research has explored the differences in SLT response between naïve and previously treated patients. In a study by Gračner[29], 59 patients underwent 180-degree SLT and were followed up for a mean of 19.6 months. The author reported a similar 24-month survival rate between the PT and AT groups but found a slightly greater IOP reduction in the PT group (28.10% vs. 24.82%; p=0.041). Similarly, McIlraith et al.[30] observed significantly less IOP reduction in pretreated eyes compared to primary SLT treatment. In this study, multivariable analysis showed significantly greater IOP reduction in the PT group compared to the AT group (22.1% vs. 14.5% at

24-36 months; p=0.04), though survival rates did not differ significantly (p=0.64).

Success in survival analysis was defined as at least 20% IOP reduction without additional medications or treatments, consistent with literature standards.[22,24,25,31] Non-responders and those requiring additional procedures, including second SLT sessions, were considered failures, and follow-up was truncated at the last visit before further treatment. While some studies permit multiple SLT sessions,[32] this study focused on the effect of a single session, and follow-up was truncated for 5 patients who underwent a second SLT.

Survival analysis was conducted in two scenarios: including and excluding non-responders. When non-responders were censored, the 2-year survival rate was 42.0% for the PT group and 26.9% for the AT group. Including non-responders, these rates dropped to 29.3% and 16.3%, respectively. Non-responders were found to have significantly lower baseline IOP than responders (mean difference, -2.5 mmHg; 95% CI, 0.7 to 4.2; p<0.06), aligning with prior findings that lower baseline IOP was a determinant of lower SLT efficacy.[33] Pillunat et al.[34] suggested that below a specific IOP level, such as 14 mmHg, we should not anticipate an effective response to SLT. The efficacy of SLT in normotensive glaucoma remains uncertain.[24] While Nitta et al.[35] found SLT effective for this subtype, they noted that a higher baseline IOP predicts a stronger response. Further research is needed to clarify these findings. Some patients may experience only modest effects or fail to respond entirely, emphasizing the need for caution when interpreting studies reporting 100% response rates or excluding non-responders from survival analyses.

There are limited data on SLT as a substitute for hypotensive medication,[36] and its efficacy in eyes under maximal anti-hypertensive treatment is modest.[37] However, SLT can benefit patients with poor adherence, intolerance, or a preference to avoid topical treatments by reducing the need for medications and their associated side effects. In the ST group, SLT eliminated the need for one medication in 50% of treated eyes and two medications in 10.4%. This suggests potential for partial treatment reduction in non-compliant or intolerant patients, delaying the need for surgery. Poor adherence to topical treatments significantly contributes to glaucoma progression,[25,38,39] and SLT may serve as a more effective substitute for the third or fourth drug in polytherapy, particularly when adherence declines or efficacy diminishes.[40]

Multivariable analysis revealed that a higher number of pre-SLT medications was associated with reduced SLT efficacy in the AT group. Nevertheless, medication withdrawal indicates SLT is at least as effective as the last drug in half of the patients, offering continuous IOP control without reliance on adherence. Unlike topical treatments, which lose effect over time, SLT provides consistent pressure reduction throughout the day.[21]

Study Limitations

This research has some limitations. The study excluded patients with previous glaucoma surgeries or laser treatments, which limits the understanding of SLT's efficacy in treating more advanced or complex cases of glaucoma. Although it had a reasonable sample size of 120 eyes, the division into three groups, combined with a significant dropout rate, might have compromised the statistical power necessary to detect meaningful differences, particularly in subgroup analyses. The follow-up period was capped at 36 months, which does not provide information on the long-term outcomes or the durability of SLT's effectiveness over extended periods. Additionally, despite the prospective design for patient recruitment, the retrospective nature of data extraction could have introduced biases. Finally, the lack of randomization in assigning patients to the treatments could lead to selection bias. This occurs when patients' characteristics influence their treatment (topical, laser, or surgery), potentially skewing the results and affecting the overall conclusions of the study. These limitations highlight the need for future studies to incorporate a randomized design, include a broader spectrum of glaucoma cases, extend the duration of follow-up, and ensure consistent and standardized data collection to enhance the reliability and applicability of the findings.

Conclusion

In this real-world setting, SLT was shown to be effective in approximately two-thirds of patients, with around one-third of patients being non-responders. SLT was more effective as initial treatment than as AT, with greater IOP reduction and higher success rates in the PT group at 12, 24, and 36 months. SLT was found to be effective in reducing topical medication, reducing at least one topical medication in more than half of patients.

Ethics

Ethics Committee Approval: The research adhered to the Declaration of Helsinki and received approval from the Barcelona Clinic Hospital Ethics Committee (HCB/2022/0959, 23/02/2022).

Informed Consent: The patients' informed consent was obtained.

Declarations

Authorship Contributions

Surgical and Medical Practices: O.G-C., S.Dj., S.P., C.A.A-P., E.A., E.M., S.D.,

Concept: O.G-C., S.P., S.D., Design: D.O-G., G.S-D., S.D., Data Collection or Processing: S.Dj., O.G-C., Analysis or Interpretation: D.O-G., G.S-D., Literature Search: D.O-G., O.G-C., G.S-D., M.C., Writing: D.O-G., O.G-C., S.Dj., G.S-D., M.C., S.P., C.A.A-P., E.A., E.M., S.D.

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