Intraocular Pressure Trends After Selective Laser Trabeculoplasty with a Solid-State 532-nm System (VISULAS Green): A Real-World Study

Tendências da Pressão Intraocular Após Trabeculoplastia Seletiva a Laser com um Sistema de Estado Sólido de 532 nm (VISULAS Green): Um Estudo em Contexto Real

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ABSTRACT

INTRODUCTION: To evaluate the effectiveness of selective laser trabeculoplasty (SLT) performed with the VISULAS® green platform in clinical practice, with attention to diagnostic subgroups.

METHODS: Retrospective analysis of 59 eyes (48 patients) treated with VISULAS SLT. Baseline characteristics, intraocular pressure (IOP) over time, responder rates (≥20% reduction), and need for additional therapy were assessed using mixed-effects models clustered by patient. Subgroup analyses included number of baseline medications, diagnosis, and lens status.

RESULTS: Mean baseline IOP was 20.3 mmHg. IOP decreased to 18.4 mmHg at 1 month, but reductions at 3 and 6 months were not statistically significant. Eyes on fewer medications at baseline had greater pressure lowering, whereas heavily medicated eyes showed minimal response. Descriptively, ocular hypertension showed smaller reductions than primary open-angle glaucoma, although this difference was not statistically significant. In this series, pseudoexfoliative glaucoma tended to respond less favorably, contrasting with some prior reports of greater reductions. Lens status was not an independent determinant after adjustment. At 1 and 6 months, 26% and 22% of eyes, respectively, achieved ≥20% IOP reduction. Five eyes (8.5%) required filtering surgery and two (3.4%) needed escalation of medical therapy. Transient IOP spikes occurred in 7.9% of eyes, with no major adverse events.

CONCLUSION: VISULAS SLT provided modest short-term IOP lowering in real-world practice, with the greatest benefit in eyes on few or no topical medications and less reliable efficacy in pseudoexfoliative glaucoma. Safety was favorable, and the need for subsequent intervention was low. These findings highlight the importance of patient selection and contribute novel data on diagnostic subgroups treated with the VISULAS platform.

KEYWORDS: Glaucoma, Open-Angle/therapy; Intraocular Pressure; Laser Therapy; Trabeculectomy.

RESUMO

INTRODUÇÃO: Avaliar a eficácia da trabeculoplastia seletiva a laser (SLT) realizada com a plataforma VISULAS® green na prática clínica, com atenção a subgrupos diagnósticos.

MÉTODOS: Análise retrospetiva de 59 olhos (48 doentes) tratados com SLT VISULAS. Foram avaliadas as características basais, a pressão intraocular (PIO) ao longo do tempo, as taxas de resposta (redução ≥20%) e a necessidade de terapêutica adicional, utilizando modelos de efeitos mistos agrupados por doente. As análises de subgrupos incluíram o número de medicações basais, o diagnóstico e o estado do cristalino.

RESULTADOS: A PIO basal média foi de 20,3 mmHg. A PIO diminuiu para 18,4 mmHg ao 1.º mês, mas as reduções aos 3 e 6 meses não foram estatisticamente significativas. Os olhos com menos medicação basal apresentaram maior redução da pressão, enquanto os olhos com medicação mais intensa mostraram resposta mínima. Descritivamente, a hipertensão ocular apresentou reduções menores do que o glaucoma primário de ângulo aberto, embora esta diferença não tenha sido estatisticamente significativa. Nesta série, o glaucoma pseudoexfoliativo tendeu a responder menos favoravelmente, contrastando com relatos prévios de maiores reduções. O estado do cristalino não foi um determinante independente após ajuste. Aos 1 e 6 meses, 26% e 22% dos olhos, respetivamente, atingiram redução da PIO ≥20%. Cinco olhos (8,5%) necessitaram de cirurgia filtrante e dois (3,4%) necessitaram de escalada da terapêutica médica. Ocorreram picos transitórios de PIO em 7,9% dos olhos, sem eventos adversos major.

CONCLUSÃO: A SLT com VISULAS proporcionou uma redução modesta da PIO a curto prazo em contexto real, com maior benefício em olhos sob pouca ou nenhuma medicação tópica e eficácia menos consistente no glaucoma pseudoexfoliativo. A segurança foi favorável e a necessidade de intervenção subsequente foi baixa. Estes resultados sublinham a importância da seleção de doentes e contribuem com dados inéditos sobre subgrupos diagnósticos tratados com a plataforma VISULAS.

PALAVRAS-CHAVE: Glaucoma de Ângulo Aberto/tratamento; Pressão Intraocular; Trabeculectomia; Tratamento a Laser.

INTRODUCTION

Glaucoma is the leading cause of irreversible blindness worldwide, affecting more than 70 million people, of whom an estimated 10% are bilaterally blind.[1] Primary open-angle glaucoma (POAG) is the most prevalent form, and intraocular pressure (IOP) remains the only modifiable risk factor for disease progression.[2] Consequently, IOP lowering is the cornerstone of glaucoma management.

The concept of selective laser trabeculoplasty (SLT) was first established by Latina and Park in 1995, who demonstrated in vitro that Q-switched, frequency-doubled 532 nm laser pulses could selectively target pigmented trabecular meshwork cells while sparing adjacent non-pigmented tissue, thereby avoiding thermal or structural damage.[3] Subsequent clinical trials confirmed this therapeutic potential. Notably, Nagar and colleagues in 2005 conducted a randomized prospective study comparing 360° SLT with once-daily latanoprost in ocular hypertension and POAG, reporting comparable mean IOP reductions of approximately 30% and similar responder rates, thereby supporting SLT as an effective first-line alternative to prostaglandins.[4] These early findings paved the way for larger randomized trials, such as the one by Katz et al and the landmark LiGHT trial, which firmly established SLT as a safe and effective initial treatment for open-angle glaucoma.[5-7]

Selective laser trabeculoplasty is a well-established treatment for lowering intraocular pressure in patients with POAG and ocular hypertension (OHT).[4-6] The procedure uses a frequency-doubled 532 nm Nd:YAG or Nd:YVO_4 laser to selectively target pigmented trabecular meshwork cells, improving aqueous outflow without causing thermal damage. Over the past decade, SLT has gained widespread use as first-line therapy, following robust evidence of efficacy and safety, which demonstrated superior long-term IOP control and reduced medication dependence compared to topical therapy alone.[6,7]

Newer SLT platforms, such as the ZEISS VISULAS® (Carl Zeiss Meditec AG, Jena, Germany), maintain the same therapeutic principle as conventional selective laser trabeculoplasty, namely selective photothermolysis of pigmented trabecular meshwork cells using a 532-nm wavelength. However, they differ from earlier SLT devices in terms of laser architecture and treatment delivery. The VISULAS® platform uses a frequency-doubled Nd:YVO_4 laser source with nanosecond pulse duration and a multi-spot application pattern (52 microspots) within a 400-µm treatment area, rather than the single-pulse delivery typically associated with earlier SLT systems.

While the biological target and intended mechanism of action remain comparable to conventional SLT, technical differences in the VISULAS® green platform influence the intraoperative treatment endpoint and workflow. In conventional SLT, visible microcavitation bubbles are commonly used to titrate laser energy, whereas the VISULAS® system generally does not produce visible bubbles. As a result, energy titration relies primarily on trabecular pigmentation and predefined energy settings rather than real-time visual feedback. This shifts treatment towards a more protocol-based approach, potentially simplifying intraoperative decision-making and reducing reliance on subjective operator judgment, particularly for less experienced users. Importantly, these distinctions reflect differences in treatment delivery rather than a change in the therapeutic concept of SLT.

However, these differences should be interpreted mainly as operational rather than proven clinical advantages, as current evidence does not clearly demonstrate superior efficacy or safety compared with conventional SLT platforms.

To characterize treatment response in routine practice, we reviewed our real-life clinical experience with the VISULAS® green SLT, analyzing IOP changes over a 6-month follow-up and assessing optic nerve structural stability using OCT.

METHODS

STUDY DESIGN AND POPULATION

This was a retrospective observational study conducted at a tertiary ophthalmology centre. We reviewed the clinical records of patients who underwent 360° selective laser trabeculoplasty (SLT) with the ZEISS VISULAS® green laser between April 2024 and February 2025. Most eyes had POAG, with SLT performed either as treatment initiation or escalation in cases where the individual target IOP had not been achieved. All SLT procedures were performed by the two glaucoma surgeons of the department; although this was their first clinical experience with the VISULAS® platform, both were experienced in trabecular laser procedures (ALT/SLT), and no clear learning curve effect was identified during the study period.

Eyes with less than 6 months' follow-up were included in earlier timepoint analyses but excluded from the 6-month evaluation. Diagnoses were classified based on clinical documentation as OHT, ocular hypertension with pseudoexfoliation (OHT-PX), POAG, pseudoexfoliative glaucoma (PXG), or normal-tension glaucoma (NTG). Eyes with previous glaucoma surgery, angle closure, uveitis, neovascular glaucoma, or intraocular surgery within the preceding 3 months were excluded. In addition, patients who reported discontinuing their usual IOP-lowering medications after SLT, or who were prescribed new topical therapy at the time of the laser, were also excluded. Therefore, SLT was performed as an adjunct to a stable medical regimen, and patients were instructed to maintain their pre-existing topical therapy throughout follow-up unless treatment escalation became clinically necessary. Demographic characteristics, including age and sex, were recorded. Central corneal thickness (CCT), lens status (phakic or pseudophakic), and the antiglaucoma medication regimen in use at the time of SLT, which was maintained unchanged during follow-up unless escalation was required, was also documented. Additionally, the need for glaucoma surgery within the 6-month follow-up period was noted. In cases where escalation of topical therapy occurred, defined as the initiation of a new medication or increase in dosage, only intraocular pressure (IOP) values measured prior to that change were included in the analysis.

This study was conducted in accordance with institutional protocols for retrospective reviews and did not require informed consent.

LASER PROCEDURE

Selective laser trabeculoplasty was performed using the ZEISS VISULAS® green laser in SLT mode. A single-session 360° treatment of the trabecular meshwork was delivered through a gonioscopy lens, with approximately 100 treatment applications distributed evenly around the trabecular meshwork. Laser energy was selected according to the degree of trabecular pigmentation, following the manufacturer's guidance. No visible cavitation bubbles were observed during treatment, as expected with this laser platform.

INTRAOCULAR PRESSURE MEASUREMENTS

IOP was measured using non-contact tonometry (Nidek TONOREF II) at baseline (immediately before SLT) and at 1 hour, 1 week, 1 month, 3 months, and 6 months after the procedure. The frequency of such medication escalations was documented and is reported in the Results. In cases where the target IOP was exceeded during follow-up, topical medication was escalated at the discretion of the treating physician. IOP values considered in the analysis correspond to measurements obtained prior to any treatment change. All IOP measurements were obtained in a consistent manner by trained clinical staff.

OCT IMAGING

Spectral-domain optical coherence tomography (Cirrus 4000 HD) of the optic nerve head was performed prior to the procedure and at the 6-month follow-up. Retinal nerve fibre layer (RNFL) thickness and optic nerve parameters were recorded to assess structural stability.

OUTCOMES AND STATISTICAL ANALYSIS

The primary outcome was the change in IOP from baseline at each follow-up time point.

The need for surgical intervention or escalation of topical therapy within 6 months was noted as an indicator of insufficient response. Adverse events such as IOP spikes (>5 mmHg from baseline) were also recorded.

Descriptive statistics were used for demographic and clinical characteristics. Longitudinal changes in intraocular

pressure were analysed using linear mixed-effects models with a random intercept for the patient to account for correlation between eyes. Fixed effects included time points (baseline, 1h, 1 week, 1 month, 3 months, 6 months), and baseline IOP was included as a covariate. This approach allowed inclusion of both eyes when available and handled missing values at follow-up.

To evaluate differences between clinical subgroups (e.g., lens status, diagnosis, baseline medication burden), additional mixed-effects models were fitted including the subgroup variable and its interaction with time, with adjustment for baseline IOP.

Responder analyses (≥20% IOP reduction) were performed using generalized estimating equation (GEE) logistic models accounting for inter-eye correlation within patients. Regression coefficients (β), odds ratios (OR), 95% confidence intervals (CI), and corresponding *p*-values are reported. All statistical tests were two-sided, with statistical significance defined as $p< 0.05$. Given the exploratory nature of subgroup analyses, results should be interpreted cautiously.

RESULTS

Population: We analysed 59 eyes, and all included patients maintained their baseline topical therapy throughout follow-up; no medication withdrawal occurred within the analysed cohort. Baseline characteristics are summarised in Table 1; the mean baseline IOP was 20.3 mmHg.

IOP Change Over Time: Mean IOP decreased to 18.4 mmHg at 1 month, 19.2 mmHg at 3 months, and 18.8 mmHg at 6 months (Fig. 1). Using patient-clustered inference on eye-level change, the reduction was significant at 1 month, but not at 3, or 6 months.

Lens Status: Pseudophakic eyes appeared to have a smaller crude response (Fig. 2). However, after adjustment for baseline IOP and time, no significant difference remained (β= +0.17 mmHg, 95% CI −1.46 to 1.80; p=0.84). The lower mean baseline IOP in pseudophakic eyes likely explains the crude association.

Table 1. Baseline characteristics of included eyes (n = 59)

Characteristic	Value
Eye, n	59
Patients, n	48
Age, years, mean (SD)	68.7 (10.8)
Sex, female, n (%)	35 (59)
Baseline IOP, mmHg, mean (SD)	20.3 (4.6)
Diagnosis, n (%)	
Primary open-angle glaucoma	24 (41)
Ocular hypertension	18 (31)
Pseudoexfoliative glaucoma	12 (20)
OHT with pseudoexfoliation	3 (5)
Normal-tension glaucoma	2 (3)
Lens Status, n (%)	
Phakic	34 (59)
Pseudophakic	25 (42)
No. of topical medications, n (%)	
0	19 (32)
1	13 (22)
2	9 (15)
3	13 (22)
4	5 (9)
Central corneal thickness, µm, mean (SD)	549.8 (38.3)
Vertical cup-to-disc ratio, mean (SD)	0.66 (0.15)

SD = standard deviation; IOP = intraocular pressure; OHT= ocular hypertension.

Effect of Baseline Number of Medications: In a model including time and number of baseline medications, each additional drug was associated with a smaller IOP reduction (β= +1.43 mmHg per drug, 95% CI 0.62–2.24; p=0.001). Eyes treated with 0–1 medications started with higher baseline IOP and showed an early but waning reduction,

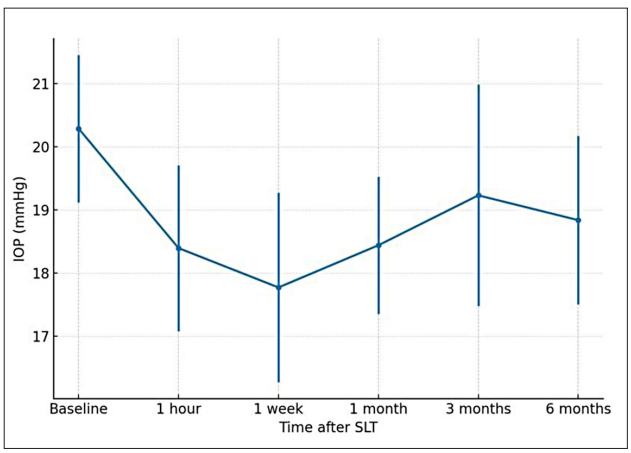


Figure 1. Mean intraocular pressure (IOP) over time after selective laser trabeculoplasty (SLT). Points denote means and error bars represent 95% confidence intervals at each time point.

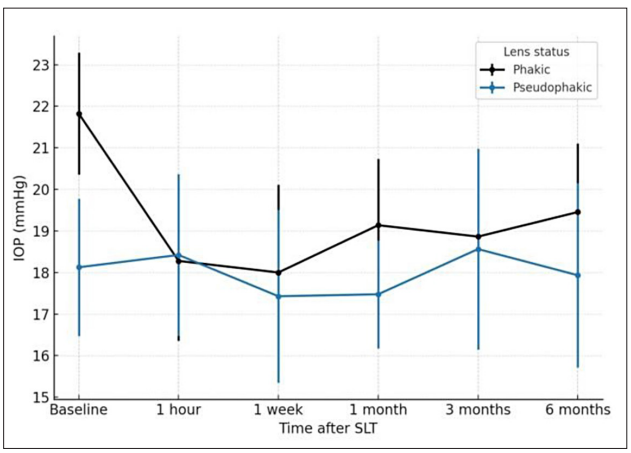


Figure 2. Mean intraocular pressure (IOP) over time after selective laser trabeculoplasty (SLT), stratified by lens status. Points represent means and error bars denote 95% confidence intervals.

whereas eyes on ≥2 medications had lower baseline IOP and little variation over time (Fig. 3).

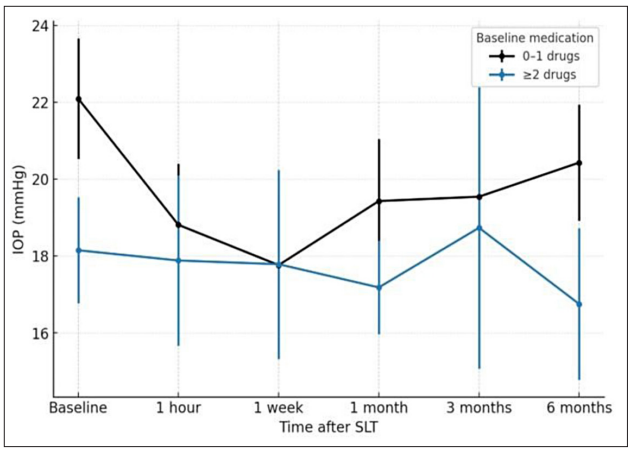


Figure 3. Mean intraocular pressure (IOP) over time after selective laser trabeculoplasty (SLT), stratified by baseline number of medications. Points represent means and error bars denote 95% confidence intervals.

Diagnosis Subgroups: Using POAG as the reference group, pseudoexfoliative glaucoma (PXG) showed a significantly smaller IOP reduction after adjustment for baseline IOP and time (β= +3.28 mmHg, 95% CI 0.34–6.22; p=0.029). When the baseline number of medications was also included in the model, the estimated difference for PXG remained in the same direction (trend towards a smaller reduction) but was no longer statistically significant. This suggests that part of the apparent effect may reflect the heavier treatment burden typically present in pseudoexfoliation. OHT, OHT-PX, and NTG did not differ significantly from POAG in either model, although subgroup sizes were small and estimates imprecise. Descriptively, eyes with ocular hypertension showed smaller reductions than POAG, although this difference was not statistically significant in adjusted models.

Covariates: Baseline IOP was strongly associated with reduction (β≈ −0.55 mmHg per mmHg; p<0.001). Age showed no significant effect after adjustment (β≈ +0.05 mmHg/year; p=0.29). Central corneal thickness (CCT) showed a small positive association (β≈ +0.034 mmHg/µm, ~+0.34 mmHg per 10 µm; p=0.011), a modest effect unlikely to be clinically relevant. Vertical cup-to-disc ratio was not significant (p= 0.36).

Structural Outcomes: Mean RNFL change was +1.86 µm (SD 5.28); this small apparent increase is most consistent with measurement variability rather than biological thickening. The vertical cup-to-disc ratio remained stable.

Safety: Of 38 eyes measured 1 hour post-SLT, 3 (7.9%) had an IOP rise >5 mmHg (values: +6, +9, +6 mmHg). Two of these were pseudophakic PXG on 3–4 medications, and one was a phakic OHT-PX eye on a single drug. No other significant adverse events were observed.

Responder Analysis: At 1 month, 13/50 eyes (26%) achieved a ≥20% reduction; at 6 months, 8/37 eyes (22%) met this criterion. In clustered GEE logistic models, baseline IOP was the only consistent predictor of 1-month response (OR = 1.38 per 1 mmHg, 95% CI 1.05–1.81; p=0.022). No significant associations were found for baseline medications, age, CCT, or vertical cup-to-disc ratio; diagnosis and lens status were not associated with responder status after clustering. Descriptively, POAG and OHT showed the highest responder proportions (~33% and 27%).

Additional Interventions: During follow-up, 5 eyes (8.5%) required filtering surgery and 2 eyes (3.4%) required escalation of medical therapy.

DISCUSSION

In this retrospective series, SLT with the VISULAS green platform yielded a modest, short-term IOP reduction that peaked at 1 month and was not sustained at 3–6 months. Baseline IOP was the strongest determinant of response, and a greater number of baseline medications was associated with less pressure lowering. Because medication regimens were intentionally kept stable, this study cannot determine whether SLT with this platform enables medication reduction. Importantly, when diagnoses were compared with POAG, PXG showed a smaller overall reduction after adjustment for baseline IOP and time; however, when the baseline number of medications was additionally included in the model, the effect estimate for PXG remained in the same direction (trend toward a smaller reduction) but was no longer statistically significant. This attenuation likely reflects collinearity between diagnosis and treatment burden, together with limited subgroup sizes. Lens status was not an independent determinant after adjustment for baseline IOP. Safety was favorable, with only a few transient pressure spikes and no major adverse events. Overall, approximately one quarter of eyes achieved a ≥20% IOP reduction at 1–6 months, and only a minority required surgical or medical escalation.

Recent studies using the VISULAS green system have consistently reported moderate IOP reductions of 3–4 mmHg and responder rates around 50% at 3–12 months.8-10 Pillunat and colleagues observed reductions of −3.5 mmHg (16%) at 1 and 3 months in 34 eyes, with nearly half achieving a ≥20% reduction, while a subsequent series of 25 eyes confirmed a similar effect at 12 months.[8,9] More recently, Church and Wassermann reported on 156 eyes in a real-world setting. In their study, antiglaucoma medications were intentionally discontinued around 10 weeks after SLT, and only reintroduced if pressure control was lost. As a result, the procedure achieved a substantial reduction in medication burden (from an average of 2.3 to 0.8 drops, with ~60% of patients medication-free at 6 months), while intraocular pressure remained largely stable, showing only a modest mean reduction of −1.5 mmHg at 6 months.[10] Taken together, published studies confirm the safety and efficacy of the VISULAS platform, while in our cohort of 59 eyes, the observed reductions were more modest (−1.9 mmHg, significant only at 1 month; responder rates 22%–26%), likely reflecting the relatively low baseline IOP, inclusion of previously treated eyes, and the retrospective design. Importantly, our analysis is, to our knowledge, the first to explore diagnostic subgroups with this device,

suggesting that PXG may respond less reliably, which is an observation not previously reported in VISULAS studies.

The contrast with pivotal randomized trials using conventional 532-nm SLT systems is notable. In the LiGHT trial, a first-line SLT strategy enabled 74.2% of patients to remain drop-free at 3 years and ~70% at 6 years, with slower disease progression and fewer surgical interventions compared with medical therapy.[6,7] By comparison, the effect in our real-world series was smaller and significant only at 1 month, with responder rates below 30%. Several factors may explain this divergence: the relatively low baseline IOP (20 mmHg), the inclusion of previously treated eyes, and the retrospective design, all of which limit the achievable percentage reduction and may dilute treatment effect relative to prospective randomized cohorts.

These differences likely reflect not only study design but also distinct clinical use patterns, as conventional SLT trials often evaluate first-line strategies whereas current VISULAS reports, including ours, largely represent adjunctive use in previously treated eyes.

Several studies have suggested that SLT may be particularly effective in PXG, often achieving greater absolute or percentage reductions than in POAG, largely attributable to higher baseline pressures. For instance, Miraftabi et al reported comparable absolute reductions between PXG and POAG, but a greater percentage reduction in PXG during the first six months, while Kara *et al*. found a mean reduction of −6.1 ± 3.6 mmHg in PXG *versus* −4.4 ± 2.1 mmHg in POAG at one year ($p< 0.001$).[11,12]

While several comparative studies have reported greater absolute or percentage reductions in PXG than in POAG, largely attributable to higher baseline IOP, our data contrast with these findings. In our series, PXG tended to exhibit less IOP lowering, an observation that may be partly explained by the heavier topical treatment burden typical of pseudoexfoliation.

Biologically, several mechanisms could account for a weaker response. It is conceivable that a more advanced or structurally compromised trabecular meshwork in PXG might limit the capacity for laser-induced outflow enhancement; a ceiling effect due to lower pharmacologically achieved baseline IOP; or chronic preservative-related surface and angle changes in heavily treated eyes that blunt the SLT-mediated remodelling response.[13,14] Together, these factors provide a plausible explanation for the observed trend that becomes statistically non-significant after accounting for the number of medications.

SLT appears to be safe in PXG, with a postoperative profile similar to POAG. Ayala & Chen (2011) reported no significant differences in anterior chamber inflammation between groups, while Shazly *et al* (2010) confirmed SLT as a safe and effective initial treatment option for both PXG and POAG.[15,16]

Transient IOP elevations are a recognized complication of SLT and are more likely in heavily pigmented angles rather than being specific to pseudoexfoliation glaucoma. The laser application may release larger amounts of pigment and cellular debris into the outflow pathways.[17]

To date, no published studies have specifically assessed the VISULAS® green SLT platform in PXG. Available evidence with this newer solid-state Nd:YVO_4 laser is limited to POAG and ocular hypertension, where it has shown consistent efficacy and safety. Whether these findings translate to PXG remains to be determined, highlighting a clear need for further investigation.

Clinically, these findings suggest that VISULAS SLT may be most effective in patients on few or no topical medications, where a 2–3 mmHg reduction can help delay treatment escalation. In heavily medicated eyes, the additional effect is minimal, highlighting the need for careful patient selection. The tendency for a weaker response in PXG further underscores the importance of tailoring expectations to disease biology. While the absolute reduction was modest, the excellent safety profile and low rate of subsequent interventions support its role as a safe adjunct in selected cases.

From a practical perspective, the magnitude of IOP reduction observed in our cohort (approximately 2 mmHg in responders) is broadly comparable to the effect often expected from adding a single topical medication. Although only about one quarter of eyes achieved a ≥20% reduction, this level of pressure lowering may still be clinically meaningful in selected patients, either by delaying treatment escalation or potentially allowing reduction of medication burden in scenarios where clinicians choose to adjust therapy after SLT. The favourable safety profile further supports the role of SLT as a pragmatic adjunct in routine practice, even when large pressure reductions are not achieved.

Strengths of this study include the use of mixed-effects models to account for within-subject correlation, detailed subgroup analyses, and the focus on outcomes with the VISULAS platform, which remains underrepresented in the literature. The inclusion of pseudoexfoliative glaucoma provides novel insights. Limitations include the retrospective design, heterogeneity in follow-up with attrition at later visits, the relatively low baseline IOP, and the modest number of eyes in certain subgroups, which limited statistical power. Follow-up was also restricted to 6 months, and longer follow-up (e.g., 12 months) in larger cohorts will be necessary to evaluate long-term durability. Another limitation is that intraocular pressure measurements were not uniformly obtained with Goldmann applanation tonometry, the reference standard method, which may have contributed to measurement variability. Future work should clarify the durability of VISULAS SLT and determine whether diagnostic subgroups, particularly pseudoexfoliative glaucoma, respond differently to this platform. Larger, prospective studies with standardized retreatment protocols will be necessary to confirm these observations and to allow direct comparison with outcomes from conventional SLT systems. In the meantime, our findings support VISULAS SLT as a safe adjunctive option in routine practice, with greatest benefit in patients with a lower medication burden and less consistent efficacy in pseudoexfoliative glaucoma.

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CONTRIBUTORSHIP STATEMENT / DECLARAÇÃO DE CONTRIBUIÇÃO

JMP and ACM: Conceptualization, data interpretation, and drafting of the original manuscript.

MPS: Conceptualization, data interpretation, and critical review of the manuscript.

All authors approved the final version to be published.

JMP e ACM: Conceitualização, interpretação dos dados e redação do manuscrito original.

MPS: Conceitualização, interpretação dos dados e revisão crítica do manuscrito.

Todos os autores aprovaram a versão final a ser publicada.

RESPONSABILIDADES ÉTICAS

Conflitos de Interesse: Os autores declaram a inexistência de conflitos de interesse na realização do presente trabalho. Os autores não têm qualquer interesse patrimonial ou financeiro em quaisquer materiais, produtos ou métodos mencionados. O fabricante do sistema VISULAS Green não teve qualquer papel na conceção ou realização deste estudo, na recolha de dados, na análise de dados, na preparação do manuscrito ou na decisão de submetê-lo para publicação.

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Confidencialidade dos Dados: Os autores declaram ter seguido os protocolos da sua instituição acerca da publicação dos dados de doentes.

Proteção de Pessoas e Animais: Os autores declaram que os procedimentos seguidos estavam de acordo com os regulamentos estabelecidos pela Comissão de Ética responsável e de acordo com a Declaração de Helsínquia revista em 2024 e da Associação Médica Mundial.

Proveniência e Revisão por Pares: Não comissionado; revisão externa por pares.

ETHICAL DISCLOSURES

Conflicts of Interest: The authors have no conflicts of interest to declare. The authors have no proprietary or financial interest in any materials, products, or methods mentioned. The manufacturer of the VISULAS Green system had no role in the design or conduct of this study, data collection, data analysis, manuscript preparation, or decision to submit for publication.

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Confidentiality of Data: The authors declare that they have followed the protocols of their work center on the publication of patient data.

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