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Retrospective Study

Selective laser trabeculoplasty as adjunctive treatment for open-angle glaucoma versus Following incisional glaucoma surgery in chinese eyes

SLT as adjunctive treatment for OPAG *vs* PGS

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Abstract

BACKGROUND

Selective laser trabeculoplasty (SLT) is a relatively safe and effective therapy in lowering intraocular pressures (IOP) for glaucoma.

AIM

To study the long-term effects of selective laser trabeculoplasty (SLT) on intraocular pressure (IOP) and number of glaucoma medications used in Chinese eyes.

METHODS

This is a retrospective study in which 75 eyes of 70 patients with open-angle glaucoma (OAG, n =36) and eyes with prior glaucoma surgery (PGS, n =39) were included. Changes in mean IOP and number of glaucoma medications used evaluated at 1 day, 1 wk, 1 mo, 3 mo, 6 mo, 12 mo, and 36 mo after laser treatment.

RESULTS

All patients (33 male, 37 female) were Chinese. The mean age was 44.34±16.14 years. Mean pre-SLT IOP was 22.75±2.08 mmHg in OAG and 22.52±2.62 mmHg in PGS. Mean IOP was significantly reduced 1 day, 1 wk, 1 mo and 3 mo after laser treatment ($P<$ 0.05, respectively). Whereas, there were no significant differences between baseline and SLT treated groups at 6th month both in OAG (P =0.347, $P>0.05$) and in PGS (P =0.309, $P>0.05$). Six months after SLT treatment, some patients received retreatment of SLT or were given more topical IOP-lowering medication to control the IOP. By the end of our study, the average IOP decreased to 20.73±1.82 mmHg in OAG and 20.49±1.53 mmHg in PGS groups. The number of glaucoma medications used was significantly reduced until the end of three years compared to baseline.

CONCLUSION

SLT could reduce IOP as adjunctive treatment both in OAG and PGS groups. SLT significantly reduced the number of glaucoma medications used 3-year following treatment in glaucoma patients.

Key Words: Key word: selective laser trabeculoplasty, open-angle glaucoma, intraocular pressure, prior glaucoma surgery, adjunctive treatment

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Core Tip: SLT could reduce IOP as adjunctive treatment both in OAG and PGS groups. SLT significantly reduced the number of glaucoma medications used 3-year following treatment in glaucoma patients.

INTRODUCTION

Selective laser trabeculoplasty (SLT) is a relatively safe and effective therapy in lowering intraocular pressures (IOP) for glaucoma which was first described in1995 by Latina and Park[1]. This is an Nd:YAG laser improves aqueous outflow by selectively targeting the pigmented trabecular meshwork(TM) cells and presumably does not produce any damage to the microstructure of the TM[2].

SLT could be offered as initial treatment at decreasing IOP for open angle glaucoma (OAG) and ocular hypertension. The Laser in Glaucoma and ocular Hyper Tension (LiGHT) study demonstrated that SLT could be offered as first-line treatment at decreasing IOP without the adverse effects and costs of long-term medication use[3]. However, in the LiGHT study, nearly 15% of patients treated with SLT required additional IOP lowering interventions within 1 year, and some patients require retreatment to maintain IOP lowering[3]. SLT treatment can be particularly helpful for patients with poor compliance and drug intolerance[3]. A randomized clinical trial

reported that there was no statistically significant difference between SLT treated group and drug therapy group after one year[4]. Ang, GS *et al* demonstrated that the rate of successful IOP reduction was higher in the medication compared with SLT group at 24 mo [5]. However, SLT did not cause any changes affecting ocular blood flow as tropic intraocular pressure drugs[3]. It has been reported that repeated treatment of SLT safely provides significant IOP reductions in OAG through nearly 8 years of follow-up [6].

SLT could be used to reduce the IOP of patients who failed to achieve target IOP after receiving maximally tolerated medical therapy (MTMT). Previous studies have demonstrated significant reductions in mean IOP and the number of glaucoma medications used in patients who received SLT as a secondary treatment after receiving MTMT[7]. A five-year study showed that although the long-term decrease of IOP after SLT treatment may not be obvious, the numbers of drug use were reduced[8].

SLT could reduce the uncontrolled intraocular pressure after glaucoma surgery. There are many anti-glaucoma surgeries including trabeculectomy, Ahmed glaucoma drainage valve, trabeculectomy combined with cataract extraction and other surgical methods[9]. In patients with prior glaucoma surgery (PGS), the IOP rises again due to glaucoma filtering bleb scar, inflammatory reaction, and other reasons. A prospective study reported that the IOP of 18 patients with uncontrolled IOP after trabeculectomy decreased by 24% treated with SLT for 9 mo[10]. Previous studies have also demonstrated that two groups of patients with PGS (n =53) and without operation history (n =53), the IOP reduction rates were 7.3% and 10.8% respectively after SLT treatment at 6 mo of follow-up (P = 0.42, P > 0.05)[11].

Therefore, our aim was to determine the efficacy of SLT as adjunctive treatment in patients with previous incisional glaucoma surgery whose IOP remains or becomes uncontrolled, and the number of medications used up to three years.

MATERIALS AND METHODS

Outpatients who underwent SLT were reviewed retrospectively at the Department of Ophthalmology, Third People's Hospital of Chengdu, Affiliated Hospital of

Southwest Jiao Tong University from September 2016 to January 2020. This is a single-center study. During this research, the ethical use of human subjects was approved by the Ethics and Research Committee of Chengdu Third People's hospital ([2022]-S-5). All the patients signed written informed consent.

In our study, 75 consecutive eyes of 70 patients (33 male, 37 female) with OAG (n = 36), and PGS (n = 39) were enrolled. The information of patients is shown in Table 1. Inclusion criteria: age ≥18y, an increased IOP (> 21mmHg), open atrial angle and scleral process can be seen by gonioscopy, OAG diagnostic criteria are met. OAG diagnostic criteria: glaucomatous optic nerve damage (cup-to-disc ratio, C/D>0.5, or difference in the C/D>0.2), visual field defect, MD < -1.00DB[12]. Inclusion criteria of PGS group: those diagnosed as OAG, who have undergone trabeculectomy, drainage nail implantation, Ahmed glaucoma valve implantation or trabeculectomy combined with cataract extraction (Table 2); These patients have been treated with MTMT, but fail to reach the target IOP[11]. Exclusion criteria consisted of patients who were, unable to have SLT successfully performed, history of uveitis, or lost to follow up before one month. Also, patients with other prior major incisional eye surgeries were excluded apart from cataract surgery alone.

All patients received SLT more than one year after anti-glaucoma surgery. These patients agreed to SLT treatment and signed the consent form for laser surgery.

Eyes were pretreated with topical anesthesia of 0.4% obucaine hydrochloride (Benoxil). And Latina anterior chamber gonioscope was placed after anesthesia. SLT was performed with a q-switched, frequency-doubled 532 nm Nd: YAG laser (selecta duet, Lumenis, Israel) which has a spot size of 400 μm and pulse duration of 3ns. Nonoverlapping 100 ± 10 Laser spots were applied to 360 degrees of the trabecular meshwork (TM). The initial energy level was set at 0.8 mJ. The energy was increased or decreased until cavitation bubbles within the TM were just noted. In this study, the therapeutic energy was 0.6-1.2mj. Pranoprofen eye drops were used as postoperative medications.

Detailed ophthalmic examinations including visual acuity, intraocular pressure, slit lamp microscope, gonioscopy, visual field, OCT for retinal nerve fiber layer (RNFL) thickness, funduscopic examination were conducted both before SLT. After SLT, the patients were followed up regularly (1d,1w,1, 3, 6mo, 1 and 3y). Complications, IOP and C/D were observed at each follow-up time point. The IOP was measured by Goldmann applanation in all patients. The 3 years follow-up were monitored by National Institute for Health and Care Excellence guidance to avoid bias in clinical decision-making.

Statistical Analysis

SPSS 23.0 (version 23.0, IBM Corporation, Armonk, NY, USA) statistical software was used for statistical analysis. The means and standard deviations (SD) of IOP at different time points before and after SLT treatment was calculated. The paired t-test of two independent samples was used to compare the IOP between baseline and post treatment at different time points for statistical analysis; The statistical analysis of the number of medications used were analyzed using Wilcoxon signed rank test and tested using GEE Poisson regression models. The variables that did not meet the normal distribution were analyzed using the Mann-Whitney U test. The comparative evaluation of treatment effects between and within different types of glaucoma after SLT was tested by analysis of variance. The success rate was calculated with Kaplan-Meier survival curve analysis. $P < 0.05$ was considered statistically significant.

RESULTS

In this study, SLT was performed on 75 eyes from 70 OAG patients (33 males and 37 females) included. Before SLT treatment, all eyes were given glaucoma medications (1 to 4 drugs). The average age of patients receiving SLT was 44.34±16.14y (Table 1). The mean IOP before treatment was 22.75±2.08 mmHg in OAG and 22.52±2.62 mmHg in PGS (Table 3).

The average number of medications used before SLT treatment was 3.39±0.69 in OAG and 2.97±0.74 in PGS group (Table 4). The course of IOP over the 36 mo of the

study is shown in Table 3. 75 eyes were followed up for longer than one year, and 58 eyes were followed up for more than three years.

In OAG group, IOP began to rise at 6th month (P =0.3465, $P>0.05$). The mean IOP was 22.59±2.26 mmHg at 6th month, there was no significant difference compare to baseline.

Six months after SLT treatment, 6 eyes undertake retreatment of SLT, 4 eyes were given more topical IOP-lowering medication to control the IOP in OAG group.

In PGS group, there was a statistically significant lower IOP in the study compared with pretreatment levels after SLT treatment at all points (P <0.001, Table 3) except the 6th month(P =0.309, $P>0.05$). The average IOP was 21.94±2.11mmHg at 6 mo, there was no significant difference compare to baseline. At 6th month, 4 eyes undertake retreatment of SLT, 2 eyes were given more topical IOP-lowering medication to control the IOP.

In this retrospective study, there was no statistically significant difference between the OAG and PGS groups at all time interval ($P>0.05$, Table 3) except for the third month （P=0.0039, $P<0.05$, Table 3). During the first 3 mo of follow-up, the IOP in PGS group was 18.76 ± 3.92mmHg and that in OAG group was 21.32 ± 2.19mmHg, PGS group had a better and longer effect on IOP than OAG group.

On Kaplan-Meier survival analysis, the success rates after 1, 3, 6, 12, and 36 mo were 87.13%, 76.81%, 68.27%, 47.66% and 24.96% in OAG group, and 84.70%, 67.40%, 59.39%, 42.15% and 27.61% in PGS group, respectively (P = 0.320; Log-rank test; Figure 1, Table 3).

Table 4 presented the number of glaucoma medications used. There were no statistically differences on the first day after SLT treatment compare with baseline (P = 0.083, P > 0.05). As the ocular spike was observed in part of patients at the first day after laser treatment, the number of anti-glaucoma drugs were not changed. The number of drugs was gradually reduced one week after treated by laser and lasted for 36 mo.

Of the 70 patients, 5 had both eyes treated. Six eyes experienced IOP spikes on the first day after SLT. In these eyes, IOP returned to baseline after the appropriate

intervention. No other complications after SLT therapy in any eye. In the span of 3 years, 10 eyes (12.99%) underwent repeat SLT, 5 eyes (6.49%) underwent glaucoma surgery. At 6th month, two patients in PGS group had been excluded because of the progression of visual field, and they underwent glaucoma surgery again.

Conjunctival hyperemia in 56 eyes (72.7%), which disappeared after one day. Anterior chamber reaction in 49 eyes (50.51%). Tyndall (±) ～ (+) in anterior chamber was observed in 1 ~ 2 h after SLT and disappeared after 1 wk. Transient IOP elevation（spike）was observed 1 h after SLT, IOP≥5 mmHg in 6 eyes (7.79%) and IOP≥1 ~ 4 mmHg in 15 eyes (19.48%).

There were no severe complications in these patients, such as ocular inflammation, hyphemia, choroidal effusion, and retinal detachment.

DISCUSSION

Due to IOP spike after treatment, the number of drugs used on the first day after SLT treatment did not decrease. Whereas, on the first day after SLT treatment, the IOP was greatly reduced. The difference was statistically significant at different time points until the 6th month after SLT treatment. Two prospective studies have reported that SLT can effectively reduce IOP 4 and 6 years after treatment in patients who have used the maximum dose of IOP reducing drugs. 44% and 59% of patients have at least 20% of IOP reduction respectively[6,13]. However, our results showed that the action time of SLT lasted about 6 mo. After the sixth month, the IOP of some patients increased again. Therefore, at the 6th month after SLT treatment, some patients underwent SLT treatment again or added the numbers of anti-glaucoma drugs to control IOP. This result is not consistent with the published results, which may be related to race, trabecular meshwork structure or the distribution of trabecular meshwork pigment. The effectiveness and safety of SLT was affected by pigmentation of trabecular meshwork and laser energy[14].

In our study, the PGS group was included. These patients had a history of previous glaucoma surgery, 39 eyes, including 18 eyes after trabeculectomy, 2 eyes after drainage

nail implantation, 4 eyes after glaucoma valve implantation and 15 eyes after trabeculectomy combined with cataract extraction. The chamber angular structure was not changed except for the surgical site in the PGS group, which provided the conditions for the SLT treatment. As there was no significant difference in IOP after SLT treatment between OAG and PGS groups, the history of glaucoma surgery might have little impact on the results of SLT laser treatment. The residual function in the trabecular meshwork pathway still has potential to be modulated in a post-surgical eye, which provided the conditions for the SLT treatment.

The energy used was between 0.6-1.2mJ in our study. High energy laser could cause transient high intraocular pressure. For patients with heavy pigmentation in trabecular meshwork, high energy laser may lead to continuous IOP [15]. It was reported that SLT with appropriate high energy (1.2-1.5mJ) can effectively reduce IOP in patients with steroid-induced glaucoma[16]. It is also reported that low-energy SLT treatment is also effective. The results show that low-energy laser could also effectively reduce IOP in OAG patients for 2 years after 360 ° SLT with initial energy of 0.3mJ [17]. In the future research, we could further analyze the impact on IOP with different laser energy.

Our study shows that SLT could reduce the number of drugs as an adjunctive therapy. Juzych reported that in another study of OAG, SLT could effectively reduce IOP and reduce the number of drugs use after 5 years [18]. In a prospective randomized controlled study, the number of drugs decreased in varying degrees 1, 3 and 5 years after SLT treatment [19]. These results suggest that SLT can be used in the treatment of glaucoma patients with poor drug or surgical control.

A limitation of this study is a retrospective study which may have selection bias. It would be a better control for this potential selection bias in a prospective study. There are more types of glaucoma could be treated by SLT, such as glaucoma secondary to silicone oil eye after vitrectomy, steroid-induced glaucoma and so on[16].

CONCLUSION

In summary, SLT may be efficacious in eyes with prior incisional glaucoma surgery. And it provides an effective treatment option to lower IOP to avoid or postpone subsequent incisional glaucoma procedures.

ARTICLE HIGHLIGHTS

Research background

Selective laser trabeculoplasty (SLT) is a relatively safe and effective therapy in lowering intraocular pressures (IOP) for glaucoma. SLT could be offered as initial treatment at decreasing IOP for open angle glaucoma (OAG) and ocular hypertension. SLT could be used to reduce the IOP of patients who failed to achieve target IOP after receiving maximally tolerated medical therapy (MTMT). SLT could reduce the uncontrolled intraocular pressure after glaucoma surgery.

Research motivation

To find out whether SLT could reduce IOP in patients with prior glaucoma surgery.

Research objectives

our aim was to determine the efficacy of SLT as adjunctive treatment in patients with previous incisional glaucoma surgery whose IOP remains or becomes uncontrolled, and the number of medications used up to three years.

Research methods

Outpatients who underwent SLT were reviewed retrospectively at the Department of Ophthalmology, Third People's Hospital of Chengdu, Affiliated Hospital of Southwest Jiao Tong University from September 2016 to January 2020.75 consecutive eyes of 70 patients (33 male, 37 female) with OAG (n = 36), and PGS (n = 39) were enrolled. The IOP was measured both before and after SLT and followed up to 3 years.

The means and standard deviations (SD) of IOP at different time points before and after SLT treatment was calculated. The statistical analysis of the number of medications used were analyzed using Wilcoxon signed rank test. The comparative evaluation of treatment effects between and within different types of glaucoma after SLT was tested by analysis of variance. The success rate was calculated with Kaplan-Meier survival curve analysis.

Research results

Research results:*

The average age of patients receiving SLT was 44.34±16.14y (Table 1). The mean IOP before treatment was 22.75±2.08 mmHg in OAG and 22.52±2.62 mmHg in PGS (Table 3). The average number of medications used before SLT treatment was 3.39±0.69 in OAG and 2.97±0.74 in PGS group (Table 4). 75 eyes were followed up for longer than one year, and 58 eyes were followed up for more than three years. There was no statistically significant difference between the OAG and PGS groups. The success rates after 1, 3, 6, 12, and 36 mo were 87.13%, 76.81%, 68.27%, 47.66% and 24.96% in OAG group, and 84.70%, 67.40%, 59.39%, 42.15% and 27.61% in PGS group, respectively. The number of drugs was gradually reduced one week after treated by laser and lasted for 36 mo.

Research conclusions

SLT could reduce IOP as adjunctive treatment both in OAG and PGS groups. The residual function in the trabecular meshwork pathway still has potential to be modulated in a post-surgical eye, which provided the conditions for the SLT treatment. SLT significantly reduced the number of glaucoma medications used 3-year following treatment in glaucoma patients.

Research perspectives

SLT may be efficacious in eyes with prior incisional glaucoma surgery. And it provides an effective treatment option to lower IOP to avoid or postpone subsequent incisional glaucoma procedures.

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Grade B (Very good): 0

Grade C (Good): C, C

Grade D (Fair): 0

Grade E (Poor): 0

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