ORIGINAL RESEARCH

Efficacy of Selective Laser Trabeculoplasty in Primary Angle-closure Glaucoma after Peripheral Iridotomy

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Abstract

Aim: To evaluate the efficacy of selective laser trabeculoplasty (SLT) in Southeast Asian eyes with primary open-angle glaucoma (POAG) vs primary angle-closure glaucoma after peripheral iridotomy (PACG-PI).

Materials and methods: Records of glaucoma patients who underwent SLT and had a 24-month follow-up were reviewed. Pre- and post-treatment intraocular pressure (IOP), percentage of IOP reduction in POAG, and PACG-PI groups, and probability of failure were analyzed. SLT failure was defined as any eye that did not have IOP lower than 20% compared to the baseline or had an IOP higher than the baseline on two consecutive visits. Adding medication, repeating SLT, or surgical intervention to control IOP was also considered a failure.

Results: Sixty-three POAG and 12 PACG-PI eyes were eligible. The mean (standard deviation [SD]) age was 62.9 (10.2) years in POAG and 60.3 (6.2) years in PACG-PI. Mean (SD) prelaser IOP in POAG was 19.0 (4.4) mm Hg and 20.7 (4.7) mm Hg in PACG-PI. At 24 months post-SLT, mean (SD) IOP was 14.1 (4.7) mm Hg and 13.6 (2.0) mm Hg in POAG and PACG-PI, respectively. There was no significant difference in percentage of IOP reduction (22.8 ± 23.0% for POAG and 30.7 ± 19.5% for PACG-PI, $p = 0.96$), or failure probability ($p = 0.10$) between both groups.

Conclusion: The efficacy of SLT at 24 months was comparable between POAG and PACG-PI.

Clinical significance: Selective laser trabeculoplasty may be an option to further lower IOP in eyes with angle closure with visible trabecular meshwork (TM) after iridotomy, especially in highly pigmented eyes of Southeast Asians.

Keywords: Primary angle-closure glaucoma, Primary open-angle glaucoma, Selective laser trabeculoplasty.

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Introduction

Glaucoma is one of the leading causes of irreversible blindness. It affects nearly 70 million people worldwide, of which nearly half are Asians.[1] Although the overall prevalence of POAG is higher than primary angle-closure glaucoma (PACG), the latter is more common in Asians and carries a heavier burden of visual morbidity.[2]

Intraocular pressure is a major modifiable factor of glaucoma. Laser trabeculoplasty is one of the most common procedures for POAG because it can lower IOP adjunctively to medication or as the primary treatment in well-responsive cases.

Selective laser trabeculoplasty is a type of laser trabeculoplasty that designed to selectively target pigmented cells of the TM. The degree of TM pigmentation affects the success of SLT in lowering the IOP. SLT is an effective treatment in POAG patients, especially those with highly pigmented angles.[3] Previous studies have proven that SLT has similar potency in reducing IOP and produces lesser thermal damage to adjacent tissues compared to argon laser trabeculoplasty (ALT)—the former photocoagulative laser trabeculoplasty.[4–6]

In PACG, limited visibility of the TM in anatomically narrow angle has precluded the use of SLT. Laser peripheral iridotomy (LPI) can eliminate pupillary block component in angle closure and deepen the anterior chamber. The widened angles after LPI in angle closure eyes allow the laser beam of SLT to access the TM.[7–9] There were few reports that revealed the efficacy of SLT in PACG after iridotomy. Aljasim et al.[10] compared the success rate of SLT in eyes with primary angle closure (PAC) or PACG and POAG. The IOP reduction of at least 20% after SLT in angle closure group was comparable to the POAG group. When the efficacy of SLT was compared to topical prostaglandin, Narayanaswamy et al.[11] found no difference between both groups in the absolute mean reduction of IOP after a 6-month follow-up.

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Given that efficacy of SLT depends on the degree of angle pigmentation,[3,12] we speculate that IOP lowering response may differ among ethnic groups. However, to the best of our knowledge, no previous study has evaluated the efficacy of SLT in people with POAG and PACG-PI in Southeast Asian eyes, which contain plenty of pigments in the irides. Therefore, this study evaluated the efficacy of SLT in Southeast Asian eyes with POAG and PACG-PI.

Materials and Methods

The study protocol was approved by the Institutional Review Board, Faculty of Medicine, Chulalongkorn University. Medical records of glaucoma patients who underwent SLT from 2008 to 2011 at the King Chulalongkorn Memorial Hospital were retrospectively reviewed.

Subjects

Inclusion criteria were: (1) Age greater than 20 years, (2) Met the International Society of Geographical and Epidemiological Ophthalmology definition for glaucoma diagnosis criteria for POAG and PACG,[13] and (3) Had regular 24-month follow-up after the first SLT treatment. If both eyes were treated with SLT, eye with higher prelaser IOP was chosen. In the case of equal prelaser IOP, the alternation of the right and left eyes was performed. Exclusion criteria were: (1) History of previous ALT, (2) History of intraocular surgery, except for cataract surgery, which had to be longer than 3 months prior to SLT treatment, (3) Received long-term topical/oral corticosteroid during the follow-up period, and (4) Underwent anterior segment laser other than SLT and/or intraocular surgery during the follow-up period other than glaucoma surgery.

Data Collection

Patient baseline characteristics and SLT parameters were collected. The IOP and numbers of medications at each visit (prelaser and postlaser at 1, 3, 6, 12, 18, and 24 months), number of repeated SLT, and surgical intervention were recorded.

Statistical Analysis

The primary outcome of this study was IOP reduction after treatment with SLT. For normal continuous variables, Student's *t*-test or Wilcoxon rank-sum test were used. Categorical variables were evaluated by Fisher's exact test. A generalized estimating equation (GEE) was used to analyze factors affecting IOP reduction according to the groups, presence of repeated SLT, and numbers of medications changed from baseline to each visit as independent variables. Gaussian family, identity link, and auto-correlated were applied in GEE.

Failure was defined as having an eye that failed to get IOP lower than 20% from baseline or had IOP higher than baseline on two consecutive visits. Regardless of IOP reduction, visits with additional medication, repeated SLT, or surgical intervention to control IOP were also considered a failure. Kaplan-Meier survival analysis was used to compare failure probability between both groups. p-value <0.05 was considered statistically significant. All analyses were conducted with Stata 13.0 (StataCorp LLC, College Station, Texas).

Results

Seventy-five eyes from 75 individuals were eligible; 63 eyes were POAG, and 12 eyes were PACG-PI. The mean (SD) age for POAG was 62.9 (10.2) years, and for PACG-PI was 60.3 (6.2) years. Most of the eyes were pseudophakia in both groups; 41/63 (65.1%) in eyes with POAG and 9/12 (75%) in eyes with PACG-PI.

Median of the treated area was 360° (range 180–360°) in POAG and 315° (range 180–360°) in PACG-PI. The median total energy level was 75 mJ (range 18–155 mJ) in POAG and 89 mJ (range 35–121 mJ) in PACG-PI. Mean (SD) prelaser IOP was 19.0 (4.4) mm Hg in POAG

Table 1: Baseline patient characteristics

Characteristics	*POAG (N = 63)*	*PACG-PI (N = 12)*	*p-value*
Age, year	62.9 (10.2)	60.3 (6.2)	0.40[a]
Gender[a]			0.003
Male	35 (55.6%)	1 (8.3%)	
Female	28 (44.4%)	11 (91.7%)	
Lens status[a]			0.74
Phakia	41 (65.1%)	9 (75.0%)	
Pseudophakia	22 (35.5%)	3 (25.0%)	
Cup-to-disk ratio	0.7 (0.2)	0.6 (0.2)	0.12
Mean deviation, dB	−12.0 (9.2)	−6.91 (9.6)	0.09
Treated area, °[b]	360 (180,360)	315 (180,360)	0.26
Total energy, mJ[b]	75 (18,155)	89 (35,121)	0.83
Laser count[b]	104 (27,202)	110 (48,158)	0.97
Prelaser IOP, mm Hg	19.1 (4.3)	20.7 (4.7)	0.27
Prelaser number of medications, count[b]	2.6 (1.2)	1.5 (1.2)	0.004

Data shown in mean (SD), p-value was obtained from Student's t-test; [a]Data shown in n (%), p-value was obtained from Fisher's exact test; [b]Data shown in median (range), p-value was obtained from Wilcoxon rank-sum test

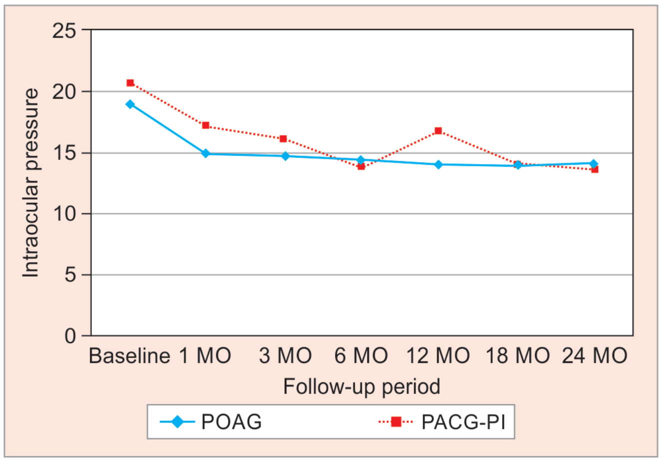

Fig. 1: IOP during follow-up period

and 20.7 (4.7) mm Hg in PACG-PI (Table 1). Figure 1 shows the mean IOP during the follow-up period. At 24 months post-SLT, the mean (SD) IOP was 14.1 (4.7) mm Hg in POAG and 13.6 (2.0) mm Hg in PACG-PI. The mean (SD) number of medications used was 2.1 (1.2) in POAG and 1.5 (1.2) in the PACG-PI at 24 months post-SLT. Mean (SD) IOP reduction at 24 months was 4.9 (4.6) mm Hg [95% confidence interval (CI): 3.6–6.1 mm Hg, $p < 0.001$] in POAG and 7.1 (5.5) mm Hg (95% CI: 3.6–10.6 mm Hg, $p = 0.001$) in PACG-PI (Fig. 1). There were no statistical significances for mean percentage of IOP reduction post-SLT between POAG and PACG-PI at all time points (Fig. 2). The mean percentage of IOP reduction at 24 months was 22.8 (23.0)% in POAG and 30.7 (9.5)% in PACG-PI ($p = 0.27$). Moreover, after adjusting for repeated SLT and the numbers of medications changed from baseline, there were no significant differences in the percentage of IOP reduction between POAG and PACG-PI groups ($p = 0.96$).

The failure rate at 6, 12, 18, and 24 months were 34.9, 42.9, 50.8, and 60.3% in the POAG group, respectively. For the PACG-PI group, the failure rate at 6, 12, 18, and 24 months were 25, 25,

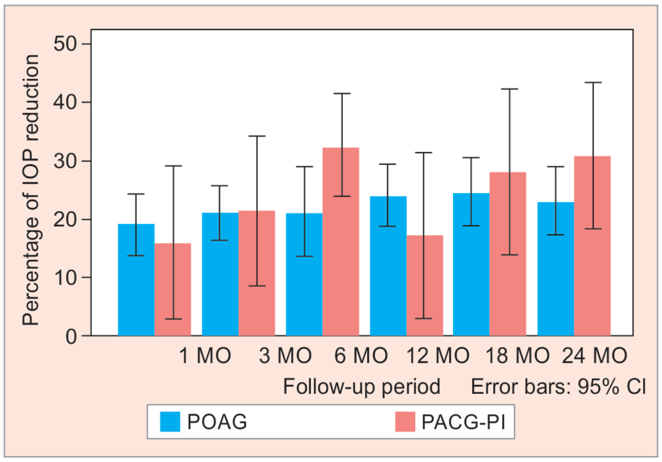

Fig. 2: Percentages of IOP reduction at each visit

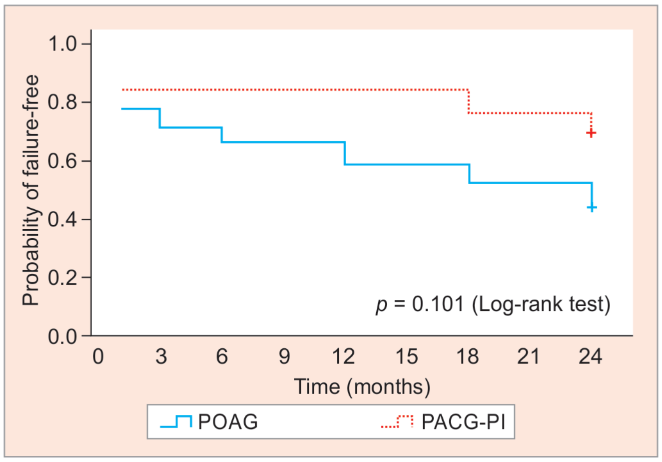

Fig. 3: Kaplan-Meier survival analysis

25, and 41.7%, respectively. Kaplan-Meier survival analysis with logrank test revealed that there were no significant differences between both groups (p = 0.10) (Fig. 3). In the POAG group, 12 eyes received a second SLT treatment, and six eyes required filtering surgery. Neither of the eyes in PACG-PI group required additional interventions.

Discussion

Our study revealed that there were no differences in IOP reduction among Southeast Asians with POAG and PACG-PI that had SLT. In addition, there were no significant differences in the failure rates between both groups.

Laser trabeculoplasty was reported as a promising treatment option in patients with PACG-PI. Shirakashi et al.[14] studied conventional ALT treatment in angle closure glaucoma after iridotomy. They evaluated 19 eyes with PACG after iridotomy or iridectomy with uncontrolled IOP with the maximum number of medications the patients could tolerate. All eyes had IOP greater than 21 mm Hg (mean 24.9 ± 2.5 mm Hg). Successful treatment was seen in 13 eyes (68.4%) at 6 months and eight eyes (42.1%) at 24 months, with a probability of success of 72, 66, and 66% at 6, 12, and 24 months, respectively. Wishart et al.[15] reported that 42% of the eyes improved, or the IOP was unchanged after treatment with ALT. Whereas in our SLT study, the Kaplan-Meier analysis showed the probability of failure to be 25, 25, and 41.7% in PACG-PI group at 6, 12, and 24 months, respectively. Of note, besides the type of laser trabeculoplasty, the criteria of failure and success used in the studies were different.

Ho et al.[16] studied SLT treatment in PAC or PACG eyes with patent iridotomy and a visible angle of at least 90°. Prelaser IOP was 24.9 ± 2.5 mm Hg and postlaser IOP at 6 months was 18.7 ± 2.9 mm Hg with IOP reduction of 23% ($p < 0.05$). At 6 months, the success rate of SLT for IOP reduction >20% without medication was 43% and with medication was 55%. In our PACG group, the mean prelaser IOP was 20.7 ± 4.7 mm Hg and postlaser IOP at 6 months was 13.7± 2.9 mm Hg. Mean percentage of IOP reduction in PACG-PI was 32.6 ± 14.7% at 6 months ($p < 0.001$). The success rate of IOP reduction by 20% from baseline to 6 months was 66.7% without additional medication and 83.3% regardless of the number of medications. This discrepancy may be due to the differences in the area that was treated. In Ho et al.'s report, laser was conducted at least 90° to the visible TM, whereas in our study, the treatment area was more than 180°. This finding suggests that the IOP lowering effect may depend on the degree of laser treatment in angle closure eyes.

In our present study, Kaplan-Meier survival curve revealed no statistical significance between both groups, although the tendency for failure was less with PACG-PI curve. This could be explained by the small sample size of PACG-PI compared to the POAG because the inclusion and exclusion criteria were stringent. For example, a patient who received intraocular surgery other than glaucoma surgery during the follow-up period was not included. This criterion may exclude more PACG-PI cases since these patients were more likely to receive cataract extraction with the intent of lowering IOP. Because of this, PACG-PI cases that had treatment failure were not properly identified.

Interestingly, the total energy used for SLT treatment in PACG-PI group (89 mJ: min/max = 35/121 mJ) was comparable to what was used in POAG (75 mJ: min/max = 18/155 mJ). This might imply that these PACG-PI cases had sufficient undamaged TM that could be well responsive to laser therapy, as did POAG group.

Previous studies have shown that degree of TM pigmentation affects the success in IOP reduction of SLT, which positively correlated with the degree of iridocorneal angle pigmentation.[3,12,17] Responses to SLT treatment are also varied among ethnicities. Goosen et al.[18] performed a study that comprised 148 POAG eyes from 84 patients (71% were Blacks, 25% were Indians, and 4% were Caucasians). The differences in IOP reduction were observed in the mean IOP change from pre-SLT or baseline of all three racial subgroups. Blacks (42.4%) had a greater IOP reduction compared to Indians (27.8%) and Caucasians (28.8%). Aside from Goosen et al.'s study, there are no other studies that have been conducted in different ethnicities comparing the effect of SLT in PACG eyes. A study from Kurysheva et al.[19] revealed that the efficacy of SLT in Russian subjects was comparably high in both PACG-PI and POAG eyes at 1 year; however, the effects waned over time for both groups. However, in our study, the mean IOP levels 2 years after SLT were higher compared to Kurysheva et al.'s study (19.10 vs 13.6 mm Hg in PACG and 19.48 vs 14.1 mm Hg in POAG). The patient characteristics and study methodology may contribute to the disparity in IOP outcomes for both POAG and PACG. Dark brown Asian eyes can achieve greater IOP reduction from SLT, and the efficacy may sustain for a longer period compared to eyes that have less pigmentation in them. Thus, the SLT efficacy should be characterized in a race-specific manner. However, prospective studies to compare the racial differences in SLT response in angle closure disease are required to prove this hypothesis.

The limitations of our study were that the sample size was small and the follow-up period was short. Additional studies with a longer follow-up period are needed to observe the SLT outcomes. Moreover, our study could not evaluate the possible adverse events or postlaser IOP diurnal fluctuations because it was not recorded.

Conclusion

The efficacy of SLT treatment in IOP reduction was not significantly different between POAG and PACG-PI groups. There was no significant difference in failure of SLT between both groups at 24 months.

Clinical Significance

Selective laser trabeculoplasty may probably be an option for further reducing IOP in angle closure eyes with considerable degrees of visible TM after iridotomy, especially in highly pigmented eyes of Southeast Asians.

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