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ORIGINAL RESEARCH

Predictors of success in selective laser trabeculoplasty for primary open angle glaucoma in Chinese

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Purpose: To determine the predictors of success for adjuvant selective laser trabeculoplasty (SLT) in Chinese primary open angle glaucoma (POAG) patients.

Methods: This prospective study recruited Chinese subjects with unilateral or bilateral POAG currently taking medication to reduce intraocular pressure (IOP). All subjects received a single session of 360° SLT treatment and continued their medications for 1 month. SLT success was defined as IOP reduction ≥20% at 1 month. The following covariates were analyzed in both groups via univariate and multivariate analyses: age, sex, lens status, initial IOPs, post-SLT IOPs, number and type of medications, SLT shots and energy, and pre-SLT investigations.

Results: In 51 eyes of 33 POAG subjects, the success rate of SLT was 47.1%. Certain groups of patients were associated with greater success using univariate analysis. These groups included the following: older age (coefficient =0.1; OR: 1.1; *P*=0.0003), a higher pre-SLT IOP (coefficient =0.3; OR: 1.3; *P*=0.0005), using four types of antiglaucoma medication (coefficient =2.1; OR: 8.4; *P*=0.005), a greater degree of spherical equivalent (coefficient =2.1; OR: 8.4; *P*=0.005), and the use of a topical carbonic anhydrase inhibitor (coefficient =1.7; OR: 6.0; *P*=0.003). None of the covariates were significant using multivariate analysis.

Conclusion: Older age, a higher pretreatment IOP, using multiple antiglaucoma medications especially topical carbonic anhydrase inhibitor, and higher refractive errors were associated with greater SLT success.

Keywords: primary open angle glaucoma, selective laser trabeculoplasty, intraocular pressure, success, Chinese

Introduction

Selective laser trabeculoplasty (SLT) is an increasingly popular treatment for primary open angle glaucoma (POAG) because it is a simple office procedure that is effective and repeatable, with minimal downtime and few long-term side effects.[1] However, some of biggest challenges of using SLT are in predicting which patients will respond, by how much, and for how long. The response rate ranges from 59% to 96%, and the amount of intraocular pressure (IOP) reduction ranges from 18% to 40% over a 6–12 month period.[1] Previously, factors that have been consistently reported to predict SLT success throughout the literature include no prior antiglaucoma medication use[1–3] and a higher IOP before SLT.[4] There is limited information in the literature investigating the predictors for SLT success in the Chinese population. Differences in angle pigmentation may affect the outcome of SLT,[5] making predictive factors different in this population from Western counterparts. The aim of this study is to determine the predictors of adjuvant SLT success in a Chinese POAG population.

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Methods

This prospective cohort study sequentially recruited Chinese subjects from the ophthalmology clinic of a university hospital, Queen Mary Hospital, Hong Kong, Special Administrative Region, People's Republic of China, from September 2011 to September 2012. The study included subjects with POAG currently on antiglaucoma medication. SLT was offered as adjuvant therapy to these patients either to reduce polypharmacy or to achieve a lower target IOP based on their individual clinical needs. Subjects were excluded if they had preexisting corneal pathology or scars, previous argon laser trabeculoplasty or SLT treatment, or if they did not comply with follow-up visit requirements. There was no washout prior to SLT. A single session of SLT was performed by a single surgeon (JWYL) using a Q-switched neodymium-doped yttrium aluminium garnet (Nd:YAG) laser (Ellex Solo™; Ellex Medical Pty. Ltd., Adelaide, Australia), for 360° in all patients with an initial energy of 0.8 mJ and titrated until bubble formation was just visible. For those with bilateral disease, both eyes were treated in the same laser session. In all treated eyes, a single drop of Alphagan® P (Allergan, Inc., Irvine, CA, USA) was instilled immediately after SLT. A dexamethasone 0.1% and Neomycin 0.5% combination eye drop (Dexoptic-N; Ashford Laboratories Pvt. Ltd., Mumbai, India) was used twice daily for 1 day and was continued for a few more days only if anterior chamber reaction was detected during follow-up. Patients returned for follow-up visits on day 1 and 1 week, 1 month, and 3 months after SLT. Patients continued the same antiglaucoma drug regime for the first month after SLT. Medications were subsequently titrated to achieve individual target pressures based on clinical requirements.

The following parameters were recorded during the study: age, sex, lens status (phakic or pseudophakic), presenting IOP without medication (obtained from medical records), pre-SLT IOP, post-SLT day 1 IOP, post-SLT 1 week IOP, number of types of antiglaucoma medications, number of SLT shots, and average laser energy used. In addition, we measured pre-SLT average retinal nerve fiber layer (RNFL) via a Spectralis® optical coherence tomography, pre-SLT visual field index (VFI) on a Humphrey Field Analyzer (Humphrey Instruments, Inc., San Leandro, CA, USA), pre-SLT endothelial cell count via a noncontact specular microscopy (Noncon ROBO-CA; Konan Medical USA Inc., Irvine, CA, USA), pre-SLT central corneal thickness via videokeratography (Orbscan® IIz; Bausch & Lomb Incorporated, Bridgewater, NJ, USA), pre-SLT Snellen visual acuity, and pre-SLT spherical equivalent via kerato-refractometer (Topcon KR-8900; Topcon Europe Medical B.V., Capelle aan den IJssel, the Netherlands). We recorded the type of antiglaucoma eye drops that patients used pre-SLT, including beta-blockers, carbonic anhydrase inhibitors, prostaglandin analogs, alpha agonists, or pilocarpine. All IOP readings were measured via Goldmann applanation tonometry by a single investigator, and trained optometrists measured all other ocular parameters. Subjects were asked to return for follow-up at approximately the same time intervals during the day to minimize the effect of diurnal IOP fluctuation.

This study adhered to the tenets of the Declaration of Helsinki. Informed patient consent and approval by the institutional review board were obtained prior to study commencement. The authors declare no financial or proprietary interests.

Definition of success

The definition of SLT success was determined as ≥20% IOP reduction at 1 month after SLT as compared to the pre-SLT IOP. The 1-month post-op IOP was selected for continuity since all antiglaucoma medications were kept unchanged until then. Antiglaucoma medications were titrated to achieve individual target pressures, so the IOPs measured beyond 1 month were not solely representative of the efficacy of SLT.

Statistics

The association of the 24 covariates (Table 1) with SLT success was analyzed using univariate logistic analysis and multiple regression analysis. The high collinearity among the covariates hindered the interpretation of traditional multiple logistic regression. To overcome this, variable selection by elastic net approach was first conducted to remove redundant covariates where the estimates of coefficients equaled to zero prior to multiple regression analysis.

We performed both the univariate and multivariate regression analyses for the following three datasets separately: 1) both eyes, 2) right eyes only, and 3) left eyes only. We found that the significant variables detected from the right and left eyes were different, signifying that each eye has a unique underlying distribution that was different from the fellow eye. Furthermore, the analysis using data from both eyes was more comprehensive in including all variables that were significant than using just the right or left eye alone. Hence, we adopted the methodology of including both eyes in the dataset as this revealed all the possible significant variables.

Table 1 Univariate and multivariate regression analyses of the covariates affecting SLT success in POAG

	Univariate logistic analysis				Multiple regression			
	P-value	Coefficient estimates	Standard deviation	Odds ratio	*P*-value	Coefficient estimates	Standard deviation	Odds ratio
Age	0.0003*	0.11	0.04	1.11	0.18	0.38	0.28	1.46
Sex	0.79	0.15	0.57	1.17	0.15	3.73	2.56	41.59
Pseudophakic	0.53	–0.56	0.92	0.57	0.20	–7.49	5.83	0.00
Phakic	0.83	–0.12	0.57	0.89	0.66	1.11	2.51	3.05
Presenting IOP (without medication)	0.80	–0.02	0.06	0.98	0.28	–0.39	0.36	0.68
Pre-SLT IOP	0.0005*	0.28	0.09	1.32	0.11	1.10	0.69	3.01
Day 1 IOP post-SLT	0.60	0.05	0.10	1.05	0.32	–0.62	0.63	0.54
1 week IOP post-SLT	0.56	0.05	0.08	1.05	0.41	0.40	0.48	1.49
1 type of antiglaucoma medication	0.64	–0.29	0.62	0.75	0.30	4.28	4.11	72.37
2 type of antiglaucoma medication	0.17	–0.98	0.75	0.38	0.36	–3.35	3.67	0.04
3 type of antiglaucoma medication	0.58	–0.36	0.66	0.69	Excluded from multivariate logistic analysis			
4 type of antiglaucoma medication	0.005*	2.12	0.85	8.36	Excluded from multivariate logistic analysis			
SLT shots	0.38	0.01	0.01	1.01	0.99	0.00	0.16	1.00
SLT energy	0.37	0.01	0.01	1.01	0.94	0.01	0.16	1.01
Pre-SLT RNFL	0.18	–0.02	0.02	0.98	0.96	0.00	0.06	1.00
Pre-SLT VFI on HVF	0.09	–0.02	0.01	0.98	0.24	–0.09	0.07	0.92
Pre-SLT endothelial cell count	0.90	0.00	0.00	1.00	0.16	0.00	0.00	1.00
Pre-SLT central corneal thickness	0.54	0.00	0.01	1.00	0.18	–0.05	0.04	0.95
Pre-SLT Snellen VA	0.95	–0.08	1.35	0.92	0.93	0.51	5.98	1.67
Pre-SLT spherical equivalent	0.02*	0.18	0.09	1.19	0.50	0.20	0.30	1.22
Pre-SLT use of prostaglandin analogs	0.02	1.61	0.73	5.00	Excluded from multivariate logistic analysis			
Pre-SLT use of β-blockers	0.22	0.81	0.68	2.25	Excluded from multivariate logistic analysis			
Pre-SLT use of carbonic anhydrase inhibitors	0.003*	1.79	0.62	5.98	Excluded from multivariate logistic analysis			
Pre-SLT use of α agonist	0.63	0.29	0.61	1.33	Excluded from multivariate logistic analysis			

Note: *Statistically significant.

Abbreviations: HVF, Humphrey visual field; IOP, intraocular pressure; POAG, primary open angle glaucoma; RNFL, retinal nerve fiber layer; SLT, selective laser trabeculoplasty; VA, visual acuity; VFI, visual field index.

Correlations were expressed in coefficients and odds ratio (OR), and a $P<0.05$ was considered statistically significant. All means were expressed as the mean ± standard deviation.

Results

In 51 eyes of 33 subjects that were enrolled in the study, there were ten right eyes, five left eyes, and 18 subjects that received SLT bilaterally. The mean age was 62.4±11.5 years. The mean IOP at initial presentation prior to starting antiglaucoma medication was 24.6±3.3 mmHg with a pre-SLT IOP of 17.7±4.1 mmHg. Patients used 2.4±1.2 types of eye drops prior to SLT. The mean of the SLT shots applied was 147.3±47.1 per session using a mean power of 1.0±0.1 mJ.

The mean IOP at 1 month after SLT was 13.8±3.3 mmHg, representing a mean overall IOP reduction of 17.9%±20.0%. The success rate of SLT was 47.1% (24/51).

Using univariate analysis, the following parameters were significantly associated with SLT success: older age (coefficient =0.1; OR: 1.1; P=0.0003), a higher pre-SLT IOP (coefficient =0.3; OR: 1.3; P=0.0005), using four types of antiglaucoma medication (coefficient =2.1; OR: 8.4; P=0.005), a higher spherical equivalent (coefficient =2.1; OR: 8.4; P=0.005), and the use of a topical carbonic anhydrase inhibitor (coefficient =1.7; OR: 6.0; P=0.003). On multivariate analysis, however, none of the covariates were found to influence SLT outcome significantly (Table 1).

Discussion

In our population of medically treated Chinese POAG patients, a single session of adjuvant SLT achieved a mean IOP reduction of 18% with a response rate of 47%. These results are slightly lower than the previously published IOP reduction range of 18% to 40% and success rate range of 59% to 96%.[1] We postulate that these differences are likely attributed to the fact that the pre-SLT IOP in our population was medically controlled with topical antiglaucoma medication prior to SLT (17.7±4.1 mmHg while on 2.4±1.2 types of antiglaucoma eye drops). SLT was offered as adjuvant therapy to these patients either to reduce polypharmacy or to achieve a lower target IOP based on their individual clinical needs. We demonstrated that a higher pre-SLT IOP was associated with greater SLT success (OR: 1.32; P=0.0005). This finding was consistent with what has been previously reported for the Western population.[4,6,7]

The use of four types of antiglaucoma medications (OR: 8.36; P=0.005) and the prior use of a topical carbonic anhydrase inhibitor (OR: 5.98; P=0.003) were associated with greater SLT success. Those who required four types of antiglaucoma medication were more likely to have a higher pre-SLT IOP (hence necessitating more antiglaucoma medication). Therefore, this may be an indirect effect from a higher pre-SLT IOP. As for the type of antiglaucoma medication used, previous reports have demonstrated that prostaglandin eye drops can potentially hinder the effects of SLT.[4] The positive association of carbonic anhydrase inhibitor use with SLT success has not been reported before. We postulate that it may not be the direct use of a topical carbonic anhydrase inhibitor that enhances SLT success but perhaps the use of this drug in place of a prostaglandin that accounts for this phenomenon, since prostaglandins can potentially counteract the action of metalloproteinase and macrophages in the trabecular meshwork following SLT.[4]

Older age was found to be a significant predictor for success (OR: 1.11; P=0.0003). This is contrary to the majority of reports in the literature that have found no significant association between age and SLT success.[8–10] Our finding was in agreement with that of Ahmed et al who also reported that age ≥60 years was associated with greater success.[11]

Having a greater degree of spherical equivalent or more refractive error was also a predictor of SLT success (OR: 1.19; P=0.02). This association has not been reported before in the literature. This observation may be related to the association of myopia with POAG and the greater prevalence of myopia in our population compared to the Caucasian population.[12,13] We postulate that those with more refractive errors (most likely myopia since the mean spherical equivalent in our population was −3.54±4.05 diopters) were more likely to have deeper anterior chamber angles and theoretically, more areas of trabecular meshwork that were open and visible for treatment. While angle status was not found to influence SLT success in the Western population where an open angle configuration is the norm,[14] this situation may be different in a Chinese population with a higher prevalence of anatomically narrower angles.[15] Thus, those with a deeper anterior chamber may have better trabecular meshwork exposure for SLT, as it has been reported that treatment to 360° of the trabecular meshwork is far more superior to 180° treatment, which in turn is still more superior to only 90° of angle treatment.[16]

Our study had its limitations. Firstly, the 1-month IOP was used for the calculation of IOP response. A longer period following SLT would have been more ideal, but the decision was based on the following rationale: 1) patients were maintained on the same antiglaucoma medication regimen up to 1 month after SLT, hence the changes in IOP during this time would solely represent the effect of SLT, and 2) based on previous reports in the literature, the IOP-lowering effects of SLT at 2 weeks was predictive of the IOP results at 3 months after laser.[17]

Secondly, topical antiglaucoma medications were not washed out prior to SLT. The investigators felt that it would be unethical to stop antiglaucoma medication in the POAG group prior to laser as this would result in certain patients having a period of elevated IOP without medication. This decision was also based on previous reports in the literature confirming that eye drops use did not seem to influence SLT success significantly.[6]

Conclusion

Nevertheless, this is one of the few studies in the literature reporting the predictors of SLT success for a Chinese POAG population. It is also one of the first to report a positive association between SLT and the use of carbonic anhydrase inhibitor or a greater degree of spherical equivalent. In summary, SLT was successful in close to 50% of a sample of Chinese POAG patients. A higher pre-SLT IOP, using four types of antiglaucoma eye drops, use of a topical carbonic anhydrase inhibitor, older age, and higher refractive errors were predictors for SLT success.

Disclosure

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