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Comparison between 90-degree and 360-degree selective laser trabeculoplasty (SLT): A 2-year follow-up

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ABSTRACT.

Purpose: **To compare the effect of 90- and 360-degree selective laser trabeculoplasty (SLT) as primary or supplement therapy in patients with glaucoma and ocular hypertension (OHT).**

Methods: **Patients (>30 years old) with OHT, primary open-angle glaucoma (OAG), pigmentary glaucoma or pseudoexfoliative glaucoma were enrolled in a prospective randomized clinical trial. Patients were sequentially randomized to either 90- or 360-degree SLT. Their intraocular pressure (IOP) was monitored.**

Results: **The survival periods (in days) of the two extents (90 or 360 degrees) of treatment were not statistically significantly different ($p = 0.85$); only pretreatment IOP level could predict survival of treatment ($p = 0.02$).**

Conclusion: **The 90-degree SLT is as effective as 360-degree SLT. Further studies are warranted to confirm the findings. High baseline IOP could be a factor that predicts treatment success.**

Key words: Glaucoma – ocular hypertension – selective laser trabeculoplasty – SLT survival predictors

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Introduction

Glaucoma is a progressive optic neuropathy that is among the leading causes of blindness globally (Pascolini & Mariotti 2012). Reducing the intraocular pressure (IOP) is the only available treatment that can reduce the rate of visual and anatomical damage (CNTG-Study-Group 1998). Various therapeutic modalities including medical, laser and surgical treatment may reduce IOP among glaucoma patients. Intraocular pressure (IOP)-lowering eye drops are regarded as the first-line treatment, while laser and surgery are often considered second-line therapies.

In open-angle glaucoma (OAG), laser trabeculoplasty modalities such as argon laser trabeculoplasty (ALT) or selective laser trabeculoplasty (SLT) are considered non- or minimally invasive therapies with long-term IOP-lowering effects comparable to those of medication (Li et al. 2015; Wong et al. 2015). Selective laser trabeculoplasty (SLT) and argon laser trabeculoplasty (ALT) have similar efficacy and safety profiles (McAlinden 2014). Recently, SLT has been the focus of considerable research due to its potential as a first-line treatment (Schlote 2017). A meta-analysis of the effect of SLT in terms of IOP control has found that, in most trials, 360-degree SLT was comparable to medication and that there was no significant difference between 360- and 180-degree SLT (McAlinden 2014). However, the literature is inconclusive as to whether there is a difference between 360- or 180-degree and 90-degree SLT (McAlinden 2014). It is desirable to lower the IOP with minimal tissue alteration in the trabecular meshwork (TM). Consequently, further research comparing 90- with 360- or 180-degree SLT is necessary.

The current study compares the 2-year results of 90- versus 360-degree SLT treatment in terms of IOP control in patients with glaucoma and OHT.

Patients and Methods

Patients and examination

A prospective randomized clinical trial was conducted at two centres: the ophthalmology departments of Mälar Hospital (Eskilstuna, Sweden) and St. Erik Eye Hospital (Stockholm, Sweden). Patients who met inclusion criteria were sequentially randomized to either 360- or 90-degree SLT as primary or supplementary treatment between 2012 and 2014. Patients were blinded to the chosen treatment modality. If both eyes were to be treated with SLT, just one eye per patient was entered into the study analysis, that is, the right or left eye of participants with even or odd birth dates, respectively. The glaucoma medical therapy remained unchanged after SLT

treatment throughout the follow-up period. The type, dose and frequency of the glaucoma medication were recorded. Informed consent was obtained from the patients. The study adhered to the Declaration of Helsinki and was approved by the local research ethics committees.

Inclusion criteria were as follows: glaucoma (i.e., primary OAG, pigmentary glaucoma or pseudoexfoliative glaucoma) or ocular hypertension (OHT), age >30 years, IOP <40 mmHg, insufficient IOP reduction despite therapy, and adverse drug reactions and/or intolerance of medication. Exclusion criteria were: contact lens use, congenital glaucoma, any type of angle-closure glaucoma (ACG), diabetes mellitus (DM), keratitis or corneal scarring, history of previous anterior or posterior segment interventions (e.g., refractive surgery, previous laser or surgical glaucoma treatment, and intravitreal injections).

All patients underwent a full ophthalmic examination (by E.C. or K.T.), including IOP measurement (Goldmann applanation tonometry) and gonioscopy (openness and pigmentation were noted).

The IOP (average of three successive measurements made on each visit by the same trained ophthalmic nurse) was measured at baseline and post treatment, that is, after 1 hr, 1 week (±3 days), 1 and 3 months. Patients were thereafter monitored every 3 months for 2 years. Failure is defined as an IOP higher than 22 mmHg at any time during the follow-up period or an IOP-lowering effect of less than 20%. If a minimum of 20% reduction in IOP was not achieved or the pressure remained above 22 mmHg 1 month after treatment, the treatment was adjusted and the patient was then discharged from the study follow-up.

Laser techniques

Selective laser trabeculoplasty (SLT) was performed by one ophthalmologist at each centre (E.C. at St. Erik Eye Hospital; K.T. at Mälar Hospital). The Ellex SLT laser (SoloTM; Ellex Inc., Adelaide, SA, Australia) was focused on the TM through a Latina single-mirror goniolens. The initial laser energy was set to 0.8 mJ then adjusted in accordance with TM pigmentation by 0.1-mJ increments. If a cavitation bubble was not observed at the initial energy level, the energy was increased to the lowest possible level at which a bubble formed; conversely, if a bubble was initially observed, the energy was reduced to the lowest level at which a bubble formed. During laser treatment, bubble formation was monitored during each laser pulse and was adjusted as above. In the 90-degree treatment group, 25 non-overlapping spots were treated from the 3 to 6 o'clock positions. In the 360-degree treatment group, the entire meshwork was treated with 100 non-overlapping spots. The total number of pulses and total amount of energy delivered were recorded. No topical steroids were used after SLT treatment. A single 1% Apraclonidine (Iopidine; Alcon, Camberley, UK) drop was prescribed after treatment and IOP was checked 1 hr after treatment to detect any possible IOP surge.

Statistics and analysis

Statistical analysis was performed using IBM SPSS statistical software (Version 23; SPSS Inc., Chicago, IL, USA). The survival functions were estimated using the Kaplan–Meier method with three tests, that is, the log rank (Mantel–Cox), Breslow (generalized Wilcoxon), and Tarone–Ware tests. Cox regression analysis was performed to determine the parameters associated with treatment survival, including the following factors: 90- or 360-degree treatment, baseline IOP, right or left eye, exfoliation, age, sex and responsible clinic. Statistical significance was defined as $p < 0.05$.

Results

A total of 67 eyes of 67 patients, all Caucasians, were enrolled. Thirty-two (48.8%) and 35 (52.2%) patients received 90-degree and 360-degree SLT, respectively.

The characteristics of each group are summarized in Table 1. Both groups were statistically comparable in terms of number of cases, age, sex, baseline IOP, prevalence of exfoliation, follow-up duration and efficacy of treatment.

The distributions of survival times for the two treatment extents were not statistically significantly different ($p = 0.85$). The mean survival of the treatment effect was similar in the 90-degree (mean 365 ± 48 days, 95% CI 270–459) and 360-degree (mean 355 ± 48 days, 95% CI 261–448) SLT groups. Kaplan–Meier test results were not statistically different, that is, log rank $p = 0.85$, Breslow $p = 0.71$ and Tarone–Ware $p = 0.89$. Seven (21.9%) and 11 (31.4%) cases in the 90- and 360-degree groups, respectively, were censored due to study closure. Fig. 1 shows the survival plots of the treatment groups.

A Cox regression was run to predict the survival of treatment based on age, sex, exfoliation, baseline IOP and extent of treatment (i.e., 90 degrees or 360 degrees). Only higher baseline IOP could significantly predict a longer survival period of treatment ($p = 0.02$). The other factors were not significant predictors, that is, age ($p = 0.36$), sex ($p = 0.82$), exfoliation ($p = 0.85$), treating ophthalmologist ($p = 0.15$) and medication ($p = 0.86$).

Discussion

Previous studies found no difference between 90- and 180-degree SLT (Chen et al. 2004) or between 180- and 360-degree SLT (Gracner et al. 2006; Goyal et al. 2010; Woo et al. 2015). However, some researchers found that the success rate was greater with 180- and 360-degree than 90-degree SLT (Nagar et al. 2005). The current study demonstrated that there is no difference between 90- and 360-degree SLT in terms of survival, probably due to differences between this treated patient population and those previously studied. Further studies are needed to confirm the present findings.

It is well established that pre-SLT IOP is the strongest predictor of SLT survival period (Pillunat et al. 2016), and our finding that a higher baseline IOP predicts a longer survival period confirms previous findings. Our results indicated that age, sex and exfoliation were not predictors of survival of treatment, in agreement with previous studies that also studied other variables. Ethnicity, type of glaucoma, family history of glaucoma, history of previous ALT, myopia, systemic disease (e.g., high blood pressure and DM), simultaneous eye drops (e.g., prostaglandins), visual function, pigmentation of TM, angle grade, phakic/pseudophakic state of lens and central corneal thickness were not found to be significant predictors either (Martow et al. 2011; Leahy & White 2015; Chun et al. 2016).

Table 1. Characteristics of studied groups.

Characteristics	90-degree SLT	360-degree SLT	p-value
Number of cases (%)	32 (48.8)	35 (52.2)	
Sex, Female/Male	18/14	20/15	0.06
Mean age (standard deviation), year	68.9 (9.5)	71.6 (7.1)	0.1
Exfoliation (%)	16 (50)	22 (62.8)	0.1
Baseline IOP (standard deviation), mmHg	24.9 (3.6)	24.8 (4.2)	0.3
Survival (standard deviation), days	365 (48)	355 (48)	0.1

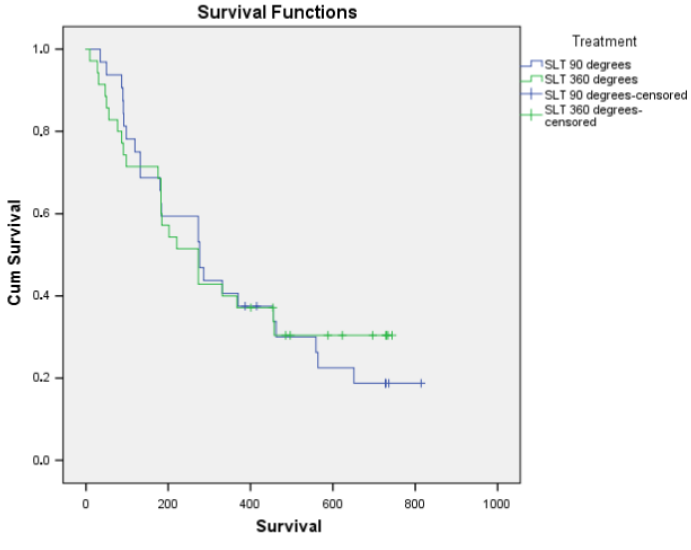

Fig. 1. Kaplan–Meier survival analysis on selective laser trabeculoplasty (SLT)-treatment.

Transient adverse effects, such as ocular discomfort, uveitis and IOP spike during the first week after SLT treatment, are more common after 360- than 90-degree SLT (Nagar et al. 2005). Furthermore, there is still concern over possible side effects such as peripheral anterior synechia formation or corneal oedema (Martow et al. 2011; Song 2016). Consequently, 90-degree SLT is preferable to 360-degree SLT if both therapies have comparable efficacy. A few small inconclusive studies have investigated treatment survival in 90- versus 360-degree SLT. The importance of this study is that it supplements current literature regarding the efficacy of 90- versus 360-degree SLT (McAlinden 2014). However, the small number of cases and the lack of a double-blind design limit the generalizability of results the current study.

In conclusion, 90-degree SLT was found to be as effective as 360-degree treatment. Larger studies are warranted to confirm our results. High pre-SLT IOP was found to be the only predictor of treatment success.

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