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REVIEW

Selective laser trabeculoplasty (SLT) *vs* other treatment modalities for glaucoma: systematic review

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Abstract

Purpose **Systemic review to compare selective laser trabeculoplasty (SLT) to other glaucoma treatment options in terms of their intraocular pressure (IOP)-lowering effect.**
Methods **Searches of the following databases were performed: PubMed, Cochrane Central Register of Controlled Trials, Ovid, EMBASE, *meta*Register of Controlled Trials, and ClinicalTrials.gov. Only randomised controlled trials (RCTs) published in peer-reviewed journals comparing SLT to other glaucoma treatment options were considered. The main outcome measure was the change in IOP from baseline.**
Results **An initial search of PubMed identified 23 RCTs with 17 meeting the inclusion criteria. Nine RCTs compared 180° SLT to 180° argon laser trabeculoplasty (ALT) and one trial compared 360° SLT to 360° ALT, all reporting no difference in terms of IOP reduction from baseline. One RCT reported better outcomes with SLT at 1 year but this effect regressed at 2 years. Three trials compared 360° SLT to medical therapy and found no difference between the two treatment options. One trial found greater IOP reduction with latanoprost *vs* 90° and 180° SLT, and greater IOP reduction with 180° and 360° SLT versus 90° SLT, however no differences were found between 360° SLT versus latanoprost or 360° *vs* 180° SLT. Two trials compared 180° SLT to 360° SLT finding no difference in IOP reduction. Two trials compared 180° SLT to 90° SLT, one finding no significant difference and one finding greater IOP reduction with 180° SLT over 90° SLT. One trial compared excimer laser trabeculotomy (ELT) to 180° SLT, finding no differences in IOP reduction up to 3 months follow-up but greater IOP reduction with ELT at time intervals between 9 and 24 months. There were no RCTs identified that compared SLT to surgery.**
Conclusion **In terms of the IOP lowering effect, there is no difference between SLT and ALT. Three trials indicate no difference between 360° SLT and medical therapy, with one of the trials indicating greater IOP reduction with latanoprost over 90° and 180° SLT. Three trials indicate no difference between 180° SLT and 360° SLT. It is inconclusive whether 90° is less efficacious than 180° SLT. One trial reports greater IOP reduction with ELT over 180° SLT in the long term.**
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Keywords: glaucoma; selective laser trabeculoplasty; argon laser trabeculoplasty; excimer laser trabeculotomy

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Introduction

Glaucoma is a progressive optic neuropathy and accounts for 8% of global blindness.[1] It is principally characterised by changes in the appearance of the optic nerve head and visual field defects. The condition is frequently associated with raised intraocular pressure (IOP); however, glaucoma may present with IOP in the normal range. The normal IOP for 95% of Caucasians is within the range of 10–21 mm Hg.[2] The level of IOP that results in optic nerve damage depends on a variety of factors and will vary among patients. Glaucoma may be congenital or acquired and can be classified as either open-angle glaucoma (OAG) or closed angle glaucoma. The angle refers to the angle between the posterior cornea and anterior iris. Glaucoma may be further classified as primary where it occurs spontaneously or secondary where it is the result of another eye condition.[2]

Currently, IOP reduction remains the only treatment option for glaucoma, with options depending on many factors such as the type of glaucoma. Options include medical therapy (eg, beta blockers, alpha agonists, miotics, carbonic anhydrase inhibitors, and prostaglandin analogues), laser treatment (eg, argon laser trabeculoplasty (ALT), selective laser trabeculoplasty (SLT), neodymium-doped yttrium aluminium garnet (Nd:YAG) laser iridotomy, diode laser cycloablation, and laser iridoplasty), and surgery. Surgical procedures include iris procedures (eg, peripheral iridectomy), angle procedures (eg, goniotomy and trabeculotomy), filtration procedures (eg, trabeculectomy and artificial drainage tubes), and non-penetrating filtration procedures (eg, deep sclerectomy and viscocanalostomy). Drainage shunts include episcleral explants (eg, Molteno, Baerveldt, and Ahmed) or mini-shunts (eg, *ExPress Mini Shunt* and *iStent*).

SLT was developed following the introduction of selective photothermolysis in dermatology.[3] Selective photothermolysis refers to the confined thermal radiation of pigmented cells within a tissue.[4] SLT utilises a Q-switched, frequency-doubled, 532 nm Nd:YAG laser. With this laser, it is possible to selectively target the pigmented cells in the trabecular meshwork, as these cells exhibit greater optical absorbance to the laser than neighbouring cells, hence avoiding collateral damage. The mechanism by which this laser reduces IOP is unknown; however, the three main theories proposed by Van Buskirk *et al*,[5] which apply to both SLT and ALT, include a mechanical, biochemical, and cellular effect. Commercial SLT devices deliver 400 μm diameter laser spots in 3 ns, with typical power settings of 0.4–1.2 mJ. This low-power setting indicates that the energy delivered to the eye by SLT is significantly less than that of ALT, which results in less tissue damage to the trabecular meshwork.[6,7]

The purpose of this systematic review is to compare SLT to other treatment options in terms of their IOP-lowering effect. This will include only randomised controlled trials (RCTs) in which SLT has been compared to any other treatment options.

Methods

Studies included

Only RCTs published in peer-reviewed journals comparing SLT to other treatment options in humans were considered in this review. RCTs comparing different modalities of SLT were also considered. RCTs in progress, unpublished, or conference abstracts were not considered. The main outcome measure was the change in IOP from baseline. Other outcomes such as complications or side effects of treatments were not considered.

Electronic searches

The following databases were searched: PubMed, the Cochrane Central Register of Controlled Trials, Ovid, EMBASE, the *meta*Register of Controlled Trials, and ClinicalTrials.gov. There were no date or language restrictions and the databases were last searched on 24 March 2013. Table 1 indicates the search terms used. PubMed was searched first and then the remaining databases were searched to find any additional relevant RCTs.

In cases where it was not clear from the methodology whether randomisation was performed, the authors were contacted by e-mail for clarification.

Results

An initial search of PubMed was conducted that identified 23 possible RCTs. After the full text of each study was obtained and reviewed, 17 studies met the inclusion criteria and six were excluded.[8–13] A flowchart of the searches is displayed in Figure 1, and Table 2 illustrates the six excluded studies and the reasons for their exclusion. No additional RCTs were identified by the experts contacted. One study was in German[14] and another in Polish,[15] and both were translated to English.

Table 1 User search terms and query translation (including Medical Subject Headings (MeSH)) in PubMed

User search	'selective laser trabeculoplasty' OR 'Nd:YAG laser trabeculoplasty' OR 'YAG laser trabeculoplasty' OR 'SLT AND glaucoma'
Query translation	'selective laser trabeculoplasty'[all fields] OR (('lasers, solid-state'[MeSH terms] OR ('lasers'[all fields] AND 'solid-state'[all fields]) OR 'solid-state lasers'[all fields] OR ('nd'[all fields] AND 'yag'[all fields] AND 'laser'[all fields]) OR 'nd yag laser'[all fields]) AND ('trabeculectomy'[MeSH terms] OR 'trabeculectomy'[all fields] OR 'trabeculoplasty'[all fields])) OR 'YAG laser trabeculoplasty'[all fields] OR (SLT[all fields] AND ('glaucoma'[MeSH terms] OR 'glaucoma'[all fields]))

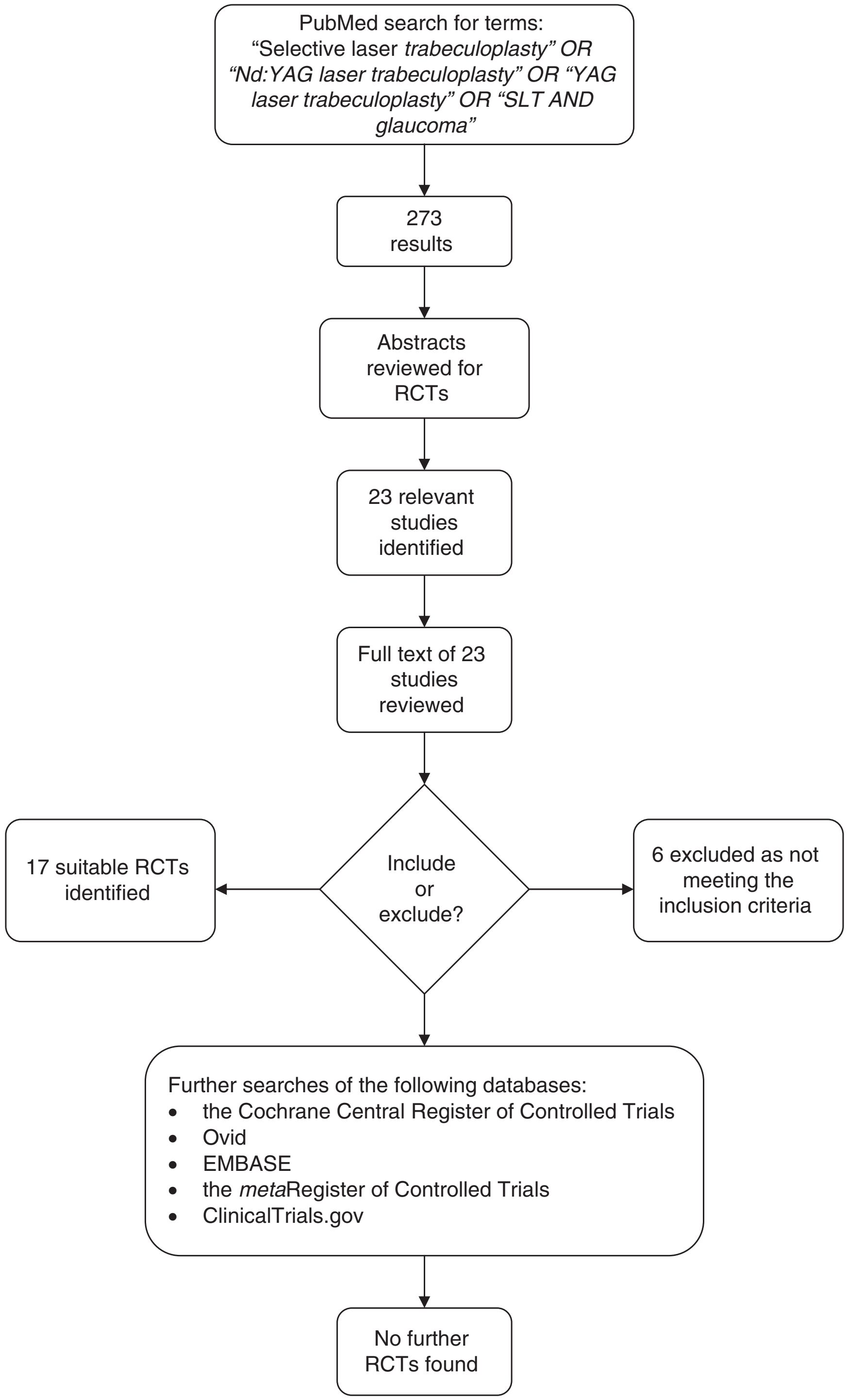

Figure 1 Flowchart indicating the search and selection of relevant studies.

In two studies, it was unclear whether patients were randomised and the corresponding authors were contacted for clarification.[16,17] It was not possible to combine any of the 17 RCTs in a meta-analysis because of the significant differences in the study designs. There were no RCTs identified that compared SLT to surgery.

Sources of bias

The design of this systematic review is at risk of publication bias as it is only considering published RCTs in peer-reviewed journals. There is also the risk of generalised publication bias where study investigators

Table 2 The six excluded studies and the reasons for their exclusion.[8–13]

- Bozhurt *et al*[8] (2011): Case series
- Realini *et al*[9] (2010): Not comparing SLT to another treatment
- Hodge *et al*[10] (2005): Sub-analysis of an RCT looking at predictive factors of SLT success
- Gracner[11] (2002): Not comparing SLT to another treatment; compared SLT in two types of glaucoma
- Cellini *et al*[12] (2008): Assessed changes in metalloproteinases and tissue inhibitor of metalloproteinases following SLT
- Agarwal[13] (2006): Only involved partial randomisation and results presented included non-randomised patients

may not have published trials in peer-reviewed journals. In studies with long follow-up periods, selection bias is common because of the loss of follow-up. Some studies used an intention to treat analysis to help minimise bias. Information bias in terms of measurement error must be considered in all these trials because of the nature of tonometry (IOP measurement). A further consideration is bias when two eyes of one patient are used as there is a greater intra-correlation between the two eyes of one patient compared with the inter-correlation between the two eyes of two different patients.[18] Specific bias issues including small sample sizes (power calculation) and confounding factors are discussed below in the review of each trial.

Randomisation and masking

The method of randomisation was largely appropriate in most studies, although some studies did not mention the randomisation method.[16,17] Owing to the nature of the treatment, in many studies it was not possible to mask the doctor or patient from the treatment (eg, laser *vs* drops); however, in some studies comparing different SLT treatment modalities (eg, 90 *vs* 180) the patient was masked.[16] Some studies masked the doctor performing tonometry.[19–21]

Discussion

SLT vs ALT

In 1999, Damji *et al*[22] in Canada conducted an RCT to compare SLT and ALT in patients with OAG (including pigmentary and pseudoexfoliation (PXF) glaucoma). Patients were recruited with uncontrolled IOP defined as >16 mm Hg on maximal medical therapy or previously failed 180/360° ALT. Neither clinicians nor patients were masked to the treatment allocation. Standard 180° SLT and 180° ALT were performed. ALT settings were as follows: 50 applications, 50 μm spot size, 0.1 s duration, and power ranging from 400 to 600 mW. SLT settings were as follows: 50 applications, 400 μm spot size, and 3 ns duration. The initial energy was 0.8 mJ and was increased or decreased until bubble formation appeared and was then decreased by 0.1 mJ for the remainder of the treatment. Patients were kept on the same glaucoma medications prescribed at the study inception for the duration of the study. A total of 17 eyes were in the SLT group and 18 eyes in the ALT group. There were no statistically significant differences in the baseline IOP between the two groups of patients. At 6 months following treatment, the mean ($\pm$ SD) IOP reductions in the SLT and ALT groups were 4.8 ± 4.6 and 4.7 ± 3.3 mm Hg, respectively. This difference was not statistically significant ($P = 0.97$). When the eyes that had previous ALT were removed from the statistical analysis, the differences between the SLT and ALT groups were not statistically significant. Considering the 15 eyes that had previous ALT, seven were in the SLT group and eight in the ALT group, and the mean IOP reduction was 6.8 ± 2.4 and 3.6 ± 1.8 mm Hg, respectively, which was statistically significant ($P = 0.01$). One of the main limitations of this study is the small sample size. In addition, there is a confounding factor in that patients continued on a variety of medical therapies, which may also contribute to IOP lowering.

In 2006, Damji *et al*[23] published longer-term results to the study in 1999, and it consisted of a larger sample size. The inclusion and exclusion criteria were the same, as well as the same laser treatment parameters. The sample size was calculated at 90% power using the previous trial data, and 176 eyes were included in this trial. Among exposure variables and covariates, P-values <0.10 or when a difference $>25\%$ was found between the two treatment groups, 1-year IOP values were used in a multivariate generalized linear model as the primary outcome. Simple and clustered multivariate analyses were performed and the correlation between eyes was accounted for. In total, 176 eyes of 152 patients were enrolled and were randomised into the ALT and SLT groups, with 87 receiving ALT and 89 receiving SLT. In the ALT group, 12 patients were lost to follow-up (selection bias), 48 eyes achieved an IOP reduction $\geq 20\%$, and 27 received an IOP reduction $<20\%$. In the SLT group, 11 patients were lost to follow-up, 43 eyes achieved an IOP reduction $\geq 20\%$, and 35 received an IOP reduction $<20\%$. Kaplan–Meier survival curves revealed no significant difference in the success rates between the two groups ($P = 0.907$). The mean baseline IOP was 23.48 ± 4.21 mm Hg in the ALT group and 23.84 ± 4.88 mm Hg in the SLT group ($P = 0.601$). At 1 year, the mean IOP was 17.88 ± 3.92 mm Hg in the ALT group and 17.97 ± 4.74 mm Hg in the SLT group ($P = 0.896$). The IOP was also measured at post-treatment intervals of 1 h, 1 week, 1 month, 3 months, and 6 months. At all these time intervals, there were no statistically significant differences in the IOP between groups. The mean reduction in IOP at the various time points between the two groups was not statistically significant. In addition, multivariate analyses using previous ALT treatment as a covariate indicated no significant differences in the mean IOP between the ALT group and the SLT group at 1 year or at any of the other post-treatment intervals.

The authors conducted a number of sub-analyses, although this resulted in considerably smaller sample sizes. In eyes with PXF, the IOP reduction was similar to the overall group with IOP decreasing by a mean of 5.4 mm Hg in the ALT group ($n = 23$) and 5.7 mm Hg in the SLT group ($n = 16$) at 1 year. In eyes with pigmentary glaucoma, there was a mean reduction in IOP by 3.4 mm Hg in the ALT group ($n = 3$) and by 5.6 mm Hg in the SLT group ($n = 5$) at 1 year. In light of the small sample sizes in these sub-analyses, the authors did not assess statistical significance. A sub-analysis was also conducted to assess the effect of SLT and ALT on patients who had previous ALT treatment (either 180° or 360°). In the SLT group, at 1 year, the mean IOP reduction in eyes that had previous 180° ALT ($n = 10$) was 4.8 mm Hg and the mean IOP reduction in eyes that had previous 360° ALT ($n = 9$) was 7.1 mm Hg. This difference was just outside statistical significance with a P-value of 0.061. However, in eyes that had no previous ALT treatment, the mean reduction in IOP was 5.7 mm Hg and when compared to previous ALT-treated eyes, a statistically significant difference was found with P-values of 0.018 and 0.003 for previous 180° and 360° ALT, respectively. Interestingly, in the ALT group, at 1 year, the mean IOP reduction in eyes that had previous 180° ALT ($n = 22$) was 7.0 mm Hg and the mean IOP reduction in eyes that had previous 360° ALT ($n = 11$) was 4.5 mm Hg. This difference was statistically significant with a P-value of 0.001, indicating better IOP outcomes when ALT is performed in eyes that have had previous 180° ALT compared with 360° ALT. In eyes that had no previous ALT treatment, the mean reduction in IOP was 6.0 mm Hg and again, when compared with previous ALT-treated eyes, a statistically significant difference was found with P-values of 0.001 for previous 180° and 360° ALT. These results should be interpreted with caution because of the small sample sizes.

Recently, this research group published the long-term results of this trial.[24] Data were available for 142 eyes at 3 years, 134 eyes at 4 years, and 120 eyes at 5 years. Lowering of IOP was similar at 3 years (SLT −6.7 ± 7.1 *vs* ALT −6.1 ± 5.1 mm Hg); 4 years (SLT 7.0 ± 7.7 *vs* ALT −6.3 ± 5.0 mm Hg); and 5 years (SLT −7.4 ± 7.3 *vs* ALT −6.7 ± 6.6 mm Hg). There was no statistically significant change in IOP in either of the two groups, and medication changes were equivalent in each group.

Best *et al*[14] in Germany conducted an RCT to compare 360° SLT (using two different laser systems (Otello and Selecta II)) to the 360° ALT (Argus laser system) for the treatment of ocular hypertension (OHT) and medically uncontrolled OAG.[12] There were marked differences in the sample size of each group with the final analysis including 106 eyes in the SLT Otello group, 110 eyes in the SLT Selecta II group, and 32 eyes in the ALT group. Identical SLT treatments were performed with the two laser systems (532 nm, 400 μm, and 3 ns). One year after treatment, the mean IOP reduction was 1.7 mm Hg with the Otello SLT system, 1.8 mm Hg with the Selecta II SLT system, and 2.1 mm Hg with the Argus ALT system. Two years after treatment, the mean IOP reduction was 1.7 mm Hg with the Otello and Selecta II SLT systems and 2.0 mm Hg with the Argus ALT system. Statistical comparisons of these differences were not reported. In addition, neither patients nor observers performing tonometry were masked to the treatments. Confounding factors in this study included the continued use of medication and both eyes of some patients being included in the analysis.

Birt[25] in Canada conducted an RCT as part of a larger study comparing 180° SLT to 180° ALT in eyes with OAG (primary, pigmentary, or PXF) who were unable to reach their clinically determined target IOP while taking medications, were unable to tolerate the medications that were keeping the IOP at an adequate target level, or were noncompliant with medication. If both eyes were eligible for inclusion in the analysis, the first eye treated was chosen. The analysis included 30 patients randomised to SLT and 39 patients to ALT. The mean baseline IOP was 22.9 ± 4.2 and 22.0 ± 5.3 mm Hg for the SLT and ALT groups, respectively. At 4.5 months post treatment, the IOP in the two groups was 17.6 ± 3.8 and 18.1 ± 4.2 mm Hg, and at 1 year it was 17.7 ± 4.0 and 16.4 ± 3.6 mm Hg, respectively. Statistical testing indicated no significant differences ($P > 0.05$) at baseline and at the two post-treatment time intervals in both groups. The main limitation of this study was the small sample size and no masking employed.

Russo *et al*[19] conducted an RCT at the University of Foggia in Italy comparing 360° SLT to 360° ALT in uncontrollable OAG on maximally medication treatment. A total of 120 eyes of 120 patients were included—60 randomised to SLT and 60 randomised to ALT. The randomisation was a simple even/odd number allocation. Thirty-six eyes had received previous SLT ($n=17$) or ALT ($n=19$) treatments, and the results of retreated eyes and virgin eyes were analysed separately. The observer performing tonometry was masked to the treatment. In virgin eyes, 43 eyes underwent SLT and 41 underwent ALT. Both groups achieved a statistically significant drop in IOP following treatment, with no significant differences in IOP between the groups at baseline, 1 month, 3 months, 6 months, and 12 months. At 12 months, the mean IOP in the ALT group was 16.9 ± 1.9 mm Hg compared with 16.7 ± 1.7 mm Hg in the SLT group ($P>0.05$). In patients who had previous SLT/ALT treatments, IOP values for patients having SLT were significantly lower at all post-treatment time intervals ($P<0.05$). At 12 months, the mean IOP reduction in SLT compared with ALT was 6.24 and 4.65 mm Hg, respectively ($P<0.05$). Other than the values presented here, the authors of this paper have not reported the absolute IOP values at each time point nor the mean reduction at each post-treatment time interval. This study has a number of limitations, the most significant being the confounding factors in the randomisation of patients to SLT or ALT having had previous SLT or ALT. There are four possible combinations of outcomes and the authors have not taken this into account in the statistical analysis. In addition, the sample size is small and a simplistic randomisation was used.

Rosenfeld *et al*[26] in Israel recently compared 180° SLT to 180° ALT in a small sample of pseudophakic patients with OAG uncontrolled IOP (>20 mm Hg) on maximal medical therapy. Fifty-two eyes of 52 patients were randomised to SLT or ALT. Fifteen patients were excluded (12 in the ALT group and three in the SLT group) because of an unsatisfactory outcome. This resulted in 18 eyes in the ALT group and 19 in the SLT group. The baseline IOP was 25.11 ± 2.16 mm Hg in the ALT group and 25.36 ± 1.83 mm Hg in the SLT group. At 12 months post treatment, the IOP in the two groups was 21.88 ± 2.05 and 21.06 ± 2.11 mm Hg, respectively. There was no statistically significant differences between groups ($P>0.05$). This study had the advantage of a single eye analysis per patient but was limited by a small sample and no masking used.

In a study by Martinez-de-la-Casa *et al*[17] in Spain, 180° SLT was compared to 180° ALT in a group of 40 OAG subjects with poor IOP control (>21 mm Hg) with medical treatment and had no previous laser or filtering surgery. Twenty eyes of 20 patients had 180° SLT and 20 eyes of 20 patients had 180° ALT. The baseline IOP was 24 ± 4.7 and 23.6 ± 3.8 mm Hg in the SLT and ALT groups, respectively, with no significant difference between groups ($P=0.75$). At the final follow-up at 6 months, the IOP had reduced in both groups to 18.6 ± 4.2 and 19 ± 3.2 mm Hg, respectively, and the differences between groups were not significant ($P=0.81$).

Liu and Birt[27] in Canada compared the effectiveness of 180° ALT and 180° SLT in lowering IOP in a younger cohort of patients (<60 years). Forty-two patients (42 eyes) were included in the study, with 22 randomised to ALT and 20 randomised to SLT. The types of glaucoma included were as follows: POAG ($n=19$), juvenile OAG ($n=10$), OHT ($n=8$), PXF ($n=2$), mixed mechanism ($n=1$), low-tension ($n=1$), and pigment dispersion syndrome (PDS) ($n=1$). There was no difference ($P>0.05$) in the baseline IOP between groups, which was 21.9 mm Hg in the ALT group and 19.1 mm Hg in the SLT group. At 2 years following treatment, there was a statistically significant decrease in IOP of 11.1% after ALT ($P=0.01$) and 7.7% after SLT ($P=0.01$), with no statistical difference between the lasers ($P>0.05$). However, at 1 year following treatment the IOP in the SLT group was significantly lower ($P=0.03$) than that in the ALT (15.4 *vs* 19.2 mm Hg) group. At 2 years, the IOP in the SLT group increased to 17.3 mm Hg, suggesting that the effect of SLT may decrease with time and the differences between groups may become nonsignificant. The main limitation of this study was the small sample size (power = 19%); however, to achieve a power of 80%, close to 500 subjects would have been required for each group.

In 2000, Popiela *et al*[15] in Poland compared 180° SLT with 180° ALT in 27 OAG patients who had deteriorating visual field defects despite maximal topical therapy. This was a randomised contralateral eye study in that one eye underwent 180° SLT and the other underwent 180° ALT. At baseline, the IOP in the SLT group was 21.26 ± 4.82 mm Hg, which was significantly higher ($P=0.037$) than the baseline IOP in the ALT group (20.26 ± 4.01 mm Hg). However, at 3 months post treatment, there was no difference in the IOP between groups ($P=0.26$) with the mean values of 18.41 ± 3.15 and 17.63 ± 3.43 mm Hg, respectively. The mean reduction in each group was 2.85 ± 4.62 and 2.63 ± 3.60 mm Hg, respectively, and the difference was not significant ($P=0.84$).

In conclusion, from the evidence presented there appears to be no difference in terms of IOP reduction from baseline following SLT or ALT. Nine RCTs compared 180° SLT with 180° ALT, and one trial compared 360° SLT with 360° ALT. One RCT reported better outcomes with SLT at 1 year; however, this effect regressed at 2 years perhaps suggesting that the effect of SLT may decrease with time.

SLT vs medical therapy

Lai *et al*[28] conducted a contralateral eye RCT comparing 360° SLT to medical therapy in a group of 29 Chinese patients (58 eyes) with POAG (17 subjects) and OHT (12 subjects). Subjects had an IOP >21 mm Hg in both eyes without antiglaucomatous medications prior to the trial. One eye of each patient was randomised to receive SLT and the fellow eye received medical treatment. Medical treatment consisted of topical beta blockers, pilocarpine, dorzolamide or latanoprost, or various combinations. The mean baseline IOP was 26.8 ± 5.6 mm Hg in the SLT group and 26.2 ± 4.2 mm Hg in the medical therapy group ($P = 0.62$). The mean IOP reduction was 8.6 ± 6.7 mm Hg (32.1%) in the SLT group and 8.7 ± 6.6 mm Hg (33.2%) in the medical therapy group at the 5-year follow-up ($P = 0.95$). There was no significant difference in the mean IOP reductions between the two groups from day 1 to the last follow-up at 5 years. In the SLT group, eight eyes (27.6%) required additional medical therapy to control the IOP to below 21 mm Hg. The mean number of medications required for IOP control remained significantly lower in the SLT group than in the medical treatment group up at 5 years ($P < 0.001$). Five eyes (17.2%) in the SLT group and eight eyes (27.6%) in the medical therapy group had an IOP >21 mm Hg despite maximal medications and required filtration surgery. Despite the authors concluding that there was no difference between the SLT group and the medical treatment group, comparisons made do not compare the two treatment modalities directly. Some patients had additional topical medication following SLT and some had glaucoma filtration surgery. Although this perhaps provides a more realistic representation of glaucoma management, from a scientific perspective, there are flaws when concluding that there is no difference between the two treatment modalities. The paper does also not report at what stage these further interventions were initiated. Hence, the 5-year SLT outcomes are not reporting the IOP reduction of SLT alone but SLT plus the additional treatments. Moreover, patients in the medical treatment group had various topical antiglaucoma medication or combinations; hence, each comparison is different. An additional flaw in this study is the evaluation of the effects of SLT and medications on the same patient (contralateral eye study). Previous research has also indicated a significant effect of topical beta-adrenergic in the contralateral eye.[14]

Nagar *et al*[21] compared 90°, 180°, and 360° SLT with medical treatment using 0.005% latanoprost (prostaglandin analogue) in an RCT for the control of IOP in OAG and OHT at two centres in the United Kingdom.[15] Both eyes of each patient received identical treatments; however, only one eye of each patient was entered into the study, either the eye with the highest IOP measurement at baseline examination or, if the pressures were identical, the right eye was chosen. Owing to an apparent lack of efficacy with 90° SLT, after 9 months the 90° group was discontinued at one of the centres. Patients were recruited at the time of diagnosis or with established primary or secondary OAG controlled on medical therapy. Before treatment, all patients who had been receiving antiglaucomatous medications underwent a minimum of a 5-week 'washout' period and the baseline data were obtained for each patient before the initiation of treatment. One hundred and sixty-seven patients (167 eyes) with OHT (85 eyes) or OAG (82 eyes) were randomised, with 39 randomised to latanoprost, 35 eyes to 90° SLT, 49 eyes to 180° SLT, and 44 eyes to 360° SLT. In patients receiving 90° SLT, 25–30 non-overlapping laser spots were applied to 3 clock hours of the inferonasal or inferotemporal trabecular meshwork. For 180° treatments, 48–53 spots were applied over the inferior 6 clock hours, and with 360° procedures the entire meshwork was treated with 93–102 non-overlapping spots. Standard SLT laser setting were used. Thirty-six patients (22%) were either of African or Afro-Caribbean origin and 131 patients (78%) were white. In the 82 eyes (49%) with OAG, 76 had POAG, four had secondary OAG to PDS, and two secondary to PXF. There were no differences between the four treatment groups in terms of age, sex, race, and aetiology of raised IOP. The mean baseline IOP of the 167 eyes was 29.3 mm Hg (range 22–50 mm Hg, median 28 mm Hg). There were no differences in the baseline IOP for the different groups for the exception of the 90° SLT group, which was lower. Success was defined both as a ≥20% reduction in IOP from baseline and also as a ≥30% IOP reduction from baseline, with no additional antiglaucomatous interventions. Results indicated that in the latanoprost group, 35 eyes (90%) achieved >20% IOP reduction and 28 eyes received (78%) >30% IOP reduction from the baseline measurements without further intervention. In the 90° SLT group, 12 eyes (34%) achieved >20% IOP reduction and four eyes achieved >30% IOP reduction. In the 180° SLT group, 32 eyes (65%) achieved >20% IOP reduction and 21 eyes received (48%) >30% reduction. Finally, in the 360° SLT group, 36 eyes (82%) achieved >20% IOP reduction and 26 eyes received (59%) >30% reduction. Statistically, success rates were better with latanoprost than 90° and 180° SLT, and better with 180° and 360° SLT than 90° SLT. There was no statistically significant difference in the success rate of latanoprost compared with 360° SLT and no statistically significant difference in the success rate of 360° SLT to 180° SLT. A comparison of demographic and treatment parameters in eyes with successful outcomes following 180° and 360° SLT indicated no differences between age, sex, race, pretreatment IOP, OHT *vs* OAG, laser power settings, and total laser energy delivered. In the six eyes with OAG secondary to PDS or PXE, four eyes failed to respond to 180° and 360° SLT, with one eye responding but failing to reach a target pressure of <22 mm Hg.[29]

Nagar *et al*[21] compared 360° SLT to latanoprost 0.005% (one drop at night) in a RCT involving 40 patients with OHT and OAG. Twenty were randomised to receive SLT and 20 to latanoprost. The mean baseline IOP for the SLT group was 26.1 ± 4.0 mm Hg and was significantly lower ($P = 0.017$) in the latanoprost group at 22.8 ± 4.5 mm Hg. SLT induced a mean reduction across all follow-up visits of 4.7 mm Hg (95% CI 3.6–5.7, $P < 0.01$). The treatment caused a similar reduction in IOP in both groups at all post-treatment intervals except at 1 month. At 1 month, the mean reduction was 7.0 mm Hg in the latanoprost group *vs* 3.2 mm Hg in the SLT group ($P < 0.05$). However, at 4–6 months, there was no statistically significant difference in the IOP reduction, with an absolute reduction of 6.2 mm Hg in the SLT group compared with 7.8 mm Hg in the latanoprost group. The observers responsible for follow-up, data collection, and analysis were masked to the treatment. This study used the Ellex Tango ophthalmic laser system (Ellex, Adelaide, South Australia, Australia) and the authors mentioned a 400 mm spot size; however, it is assumed to be an error and should read 400 μm.

Katz *et al*[30] published the results of a multicentre RCT in the United States comparing 360° SLT to prostaglandin eye drops in a group of patients with POAG or OHT. Patients underwent a 'washout' period for 4 weeks. Sixty-nine patients underwent treatment but only 54 (100 eyes) reached 9- to 12-month follow-up (selection bias). In cases where the target IOP was not attained, additional 180° SLT was performed in the SLT group or additional medical therapy in the prostaglandin group. Twenty-nine eyes underwent SLT and 25 had medical therapy. In the SLT group, the mean baseline IOP was 24.5 mm Hg and the IOP at the last follow-up was 18.2 mm Hg (6.3 mm Hg reduction), with 11% requiring further SLT treatment. In the medical therapy group, the mean baseline IOP was 24.7 mm Hg and the IOP at the last follow-up was 17.7 mm Hg (7.0 mm Hg reduction), with 27% requiring additional medical therapy. There were no statistically significant differences between the two groups.

In conclusion, with regards to IOP reduction, three trials compared 360° SLT to medical therapy and found no difference between the two treatment options. One trial found greater IOP reduction with latanoprost *vs* 90° and 180° SLT and greater IOP reduction with 180° and 360° SLT *vs* 90° SLT; however, no differences were found between 360° SLT *vs* latanoprost or 360° *vs* 180° SLT.

180° vs 360° SLT

Goyal *et al*[20] conducted an RCT comparing 180° with 360° SLT in patients with untreated POAG or OHT both with IOP >21–35 mm Hg. Eighteen eyes underwent 180° SLT, 19 eyes underwent 360° SLT, and eight eyes were untreated as controls. In the case of both eyes requiring treatment, only one eye was entered into the trial to avoid bias. Observers performing tonometry were masked from the treatment group allocation. IOP decreased significantly following the 180° and 360° SLT groups from baseline. The mean pre-180° and pre-360° SLT IOPs were 26 and 25.54 mm Hg ($P = 0.76$), respectively, and the mean decreases were 6.9 and 8.2 mm Hg in the two groups, respectively ($P = 0.35$), at 1 month. This indicates that in the short term (1 month), no significant differences were found between the two groups. As described above, Nagar *et al*[29] compared 180° with 360°, finding no difference at the 12-month follow-up.

90° vs 180° SLT

Chen *et al*[16] in Sweden compared 180° with 90° SLT in a group of 64 patients with 32 eyes randomised to 180° SLT and 32 to 90° SLT. Patients were masked as to which treatment they received. The baseline IOPs in the 180° and 90° SLT groups were 26.06 ± 1.73 and 25.44 ± 1.41 mm Hg, respectively, with no significant difference between the groups ($P = 0.59$). There were also no significant differences between the two groups at post-treatment time intervals of 1, 4, and 7 months. The IOPs at 7 months in the two groups were 19.90 ± 1.59 and 18.43 ± 1.34 mm Hg, respectively ($P = 0.21$), although 13 patients in the 180° SLT group and 15 patients in the 90° group were excluded from the 7-month analysis, as these patients required further treatment because of an inadequate IOP reduction. As described above, Nagar *et al*[29] found a greater IOP reduction with 180° SLT compared with 90° SLT.

SLT vs excimer laser trabeculotomy (ELT)

ELT is a laser therapy with an emission wavelength of 308 nm, 200 μm spot size, 80 ns pulse duration, and pulse energy of 1.2 mJ. It was developed to improve the aqueous outflow by creating holes through the anterior meshwork of the inner wall of Schlemm's canal with minimal thermal or necrotic effects on the trabecular meshwork.[31–33] Babighian *et al*[33] compared 2-year IOP outcomes of ELT and 180° SLT in an RCT for patients with POAG refractory to medical therapy. Eyes treated with ELT resulted in a mean IOP reduction from 25.0 ± 1.9 mm Hg at baseline to 17.6 ± 2.2 mm Hg at 24 months. Similarly, in the SLT group a significant decrease in the mean IOP occurred, from 23.9 ± 0.9 mm Hg at baseline to 19.1 ± 1.8 mm Hg at 24 months. There were no differences in IOP between groups at baseline, 1 day, 1 week, 1 month, and 3 months. At 9, 12, 18, and 24 months post treatment, the IOP was statistically lower in the ELT group than in the SLT group. Confounding factors in this study include various medical therapies used before and after the laser treatment by patients in each group. A further limitation includes the small sample size of only 30 subjects; however, the improved efficacy with ELT found warrants further investigation.

Conflict of interest

The author declares no conflict of interest.

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