EXTENDED REPORT

Selective laser trabeculoplasty: predictive value of early intraocular pressure measurements for success at 3 months

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Aim: To determine the predictive value of the 2 week post-selective laser trabeculoplasty (SLT) intraocular pressure (IOP) by comparing it to the 4 week and 3 month values.
Methods: A retrospective chart review of eyes that underwent SLT between 2001 and 2004 was performed. The primary outcome measure was IOP. Demographic and medical data were collected for correlational analysis.
Results: 132 eyes of 95 patients were identified, none was excluded. Of the eyes that exhibited a decrease in IOP of >1 mm Hg at 2 weeks postoperatively, 99.24% continued to show a lowered IOP at the 4 week and 3 month visits. For these patients, the Pearson's *r* value between 2 weeks and 4 weeks was 0.708 (p value = 0.01) while the *r* value between 2 weeks and 3 months was 0.513 (p value = 0.01).
Conclusions: The 2 week visit post-SLT predicted the 4 week and 3 month visits if the 2 week visit demonstrated a decrease in IOP. These findings suggest that those patients who had a decreased IOP at 2 weeks and are at their goal IOP may not need to be screened until 3 months postoperatively.

The American Academy of Ophthalmology practice pattern recommends follow up examinations after laser trabeculoplasty to occur within 30–120 minutes, 2–3 weeks, and 4–8 weeks after surgery.[1] All of these time points are listed as carrying the highest importance rating (''A'' or ''most important'') with the lowest strength of evidence ranking (''III'' or ''consensus of expert opinion in the absence of evidence that meets criteria II''). All references listed to support these follow up guidelines refer only to argon laser trabeculoplasty (ALT). Follow up guidelines for selective laser trabeculoplasty (SLT) are in evolution and are without consistency.[2 3]

The first report on the clinical effectiveness of SLT recommended follow up examinations at 1 hour, 2 hours, 1 day, 1 week, and 1 month postoperatively.[3] A later randomised clinical trial of SLT suggested a similar protocol but with an additional visit at 2 weeks.[2] At our institution, we have a variety of follow up protocols based on the literature and our personal experience. Our purpose was to investigate the predictive value of the 2 week intraocular pressure (IOP) measurement to help develop specific treatment guidelines.

METHODS

This is a retrospective study with IOP as the main outcome measurement. Secondary outcome measures include visual acuity (VA), presence or absence of an IOP spike (an elevation of IOP more than 5 mm Hg, or 10% of baseline) within 1 hour postoperatively, persistent inflammation (beyond 2 weeks), and specific symptoms which include change in VA, problems with drops, pain, discharge, and conjunctival erythema. Demographic data were collected, including age, sex, treated eye, self report of ethnic background, and a history of either hypertension or diabetes mellitus (table 1). Type of glaucoma, number of previous surgeries, and number of ocular hypotensive agents were also recorded.

Following approval of the institutional review board (#04-639E), a list of patients who had SLT between July 2001 and April 2004 by surgeons DJR and LJK was compiled. The aforementioned data were gathered from the 2 week, 4 week, and 3 month postoperative visits. Inclusion criteria included the recording of all data at all time points; the sole exclusion criterion was the absence of IOP data at any time point. All data were entered into a database using the Statistical Program for the Social Sciences (SPSS, Inc, Chicago, IL, USA). A two tailed Pearson's correlation was used to compare IOP at baseline and at 2 weeks, 4 weeks, and 3 months postoperatively to determine the predictive value of the 2 week IOP. Student *t* tests were used to compare group means. Increases in IOP were defined as IOP values >1 mm Hg of baseline; decreases as IOP values <1 mm Hg

Table 1 Baseline characteristics of sample (n = 132 eyes of 95 patients)

Characteristic	
Age (SD)	69.8 (11.7) years
Sex	62.1% women
Hypertension	41.7%
Diabetes	8.4%
Baseline IOP (SD) (mm Hg)	20.9 (5.0)
Baseline VA (SD)	0.24 (0.47)
Procedure parameters	
Average total energy (W) (SD)	62.66 (16.6)
Average number of shots (SD)	68.6 (15.8)
Glaucoma diagnoses eyes (no of patients)	
Primary open angle glaucoma	90 (63)
Low tension glaucoma	17 (13)
Pseudoexfoliation	15 (11)
Pigmentary glaucoma	5 (3)
Chronic angle closure glaucoma	3 (3)
Traumatic glaucoma	1 (1)
Uveitic glaucoma	1 (1)
Previous glaucoma procedures (no of patients)	
Group average	0.67 (1.04)
Argon laser trabeculoplasty	12 (12)
YAG peripheral iridectomy	12 (12)
Trabeculectomy	13 (13)
Tube shunt	1 (1)

Abbreviations: ALT, argon laser trabeculoplasty; IOP, intraocular pressure; SLT, selective laser trabeculoplasty; TM, trabecular meshwork; VA, visual acuity

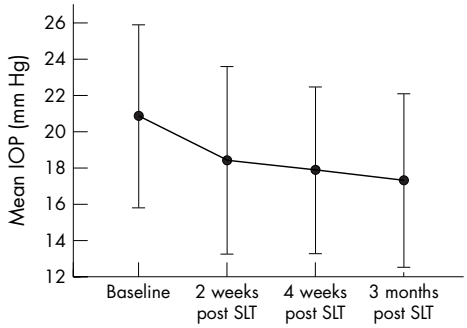

Figure 1 Change in IOP over time. The average decrease in IOP was 2.77 (4.77) mm Hg from baseline to 2 weeks (9.2% of baseline) ($p<0.001$). The average decrease in IOP from baseline to 4 weeks was 3.26 (4.11) mm Hg (10.8% of baseline)) ($p>0.05$) and from baseline to 3 months was 3.74 (4.58) mm Hg (12.4% of baseline) ($p>0.05$). The average lowering in IOP from 2 weeks to 4 weeks was 0.73 (4.96) mm Hg ($p=0.201$). The average decrease in IOP from 2 weeks to 3 months was 1.28 (5.11) mm Hg ($p=0.063$).

of baseline. No change in IOP was recorded for the remaining eyes.

The laser procedure was performed in a standard fashion in all cases. An initial power setting between 0.8 W and 1.2 W was selected and the energy was subsequently titrated (0.3–1.4 mJ) until the desired clinical end point of ''champagne bubbles'' was achieved. The procedure was then completed for 360 degrees. The intended number of spots was between 55 and 70. Patients received a topical α agonist (either apraclonidine 0.5% or brimonidine 0.2%) and prednisolone acetate immediately before the procedure. Patients were treated with topical loteprednol 0.5% (Lotemax; Bausch and Lomb) four times per day for 2 days to 1 week following the procedure.

RESULTS

In all, 132 eyes of 95 patients were identified during the defined time period. None was excluded. The age and sex were consistent with a glaucomatous population (table 1). Primary open angle glaucoma comprised the primary indication for the procedure (68.1%).

The average decrease in IOP from baseline to 2 weeks was 2.77 (4.77) mm Hg (9.2% of baseline) ($p<0.001$). The average IOP and percentage of baseline IOP continued to decrease between 2 weeks, 4 weeks, and 3 months postoperatively (fig 1 and table 2). There was no change in visual acuity after the procedure ($r=0.949$, $p<0.01$). At 4 weeks, 16% of patients had an increase in IOP above baseline whereas at 3 months 14% of patients had an increase in IOP above baseline (table 2).

Of the eyes that exhibited a decrease of IOP at 2 weeks postoperatively (n = 96; 72.7%), all but one continued to show a reduced IOP at the 4 week and 3 month visits. For this subgroup of patients, the Pearson's r value between 2 weeks and 4 weeks was 0.708 (p value 0.01) while the r value between 2 weeks and 3 months was 0.513 (p value 0.01).

Of the eyes that did not change in IOP at 2 weeks (n = 20; 15.1%) nine showed a decrease in IOP at 4 weeks, while the remaining 11 did not change from baseline. None experienced a subsequent elevation of IOP.

Of the eyes that exhibited an increase in IOP of >1 mm Hg at the 2 weeks postoperative visit (n = 16 12.1%) eight returned to within 10% of baseline IOP; five of these eight eyes returned to baseline by the 4 week postoperative visit (that is, 2 weeks after the elevated reading) and three eyes returned to baseline by the 3 month postoperative visit (that is, 10 weeks after the elevated reading); in these eight eyes, SLT did not have a significant effect on their IOP control. Six of the remaining eight eyes ultimately experienced a decrease in IOP >10% of baseline; all six reached this level by the 4 week visit. The remaining two eyes ultimately had an increase in IOP >10% of baseline; both of these procedures were in different eyes of the same patient.

An IOP reduction at 2 weeks ($r=0.308$, $p<0.05$) and at 3 months ($r=0.287$, $p<0.05$) correlated with number of shots given during the procedure. An IOP reduction also correlated with average energy at 3 months ($r=0.278$, $p<0.01$). Eyes with baseline IOP values ⩽21 mm Hg had an average IOP reduction of 4.8% (0.74 mm Hg) at 2 weeks. Patients with baseline IOP values >21 mm Hg had an average IOP reduction of 20.4% (5.80 mm Hg) at 2 weeks.

An IOP reduction did not correlate with age, sex, race, and type of glaucoma (p values were 0.355, 0.530, 0.525, and 0.669, respectively).

No IOP spikes of more than 5 mm Hg or >10% of baseline occurred 1 hour after the laser. In the 3 months following SLT, five patients experienced problems with drops (3.79%), five experienced discharge (3.79%), 13 experienced pain (9.85%), 16 experienced conjunctival erythema (12.12%), and 17 experienced subjective change in visual acuity (12.88%). None of these symptoms was noted by the examining ophthalmologist to be a direct result of SLT.

DISCUSSION

Selective photothermolysis takes place when thermal damage is confined to the target, melanin, by using a specific laser wavelength with a laser exposure time (3 ns) equal to or shorter than the thermal reaction time of melanin. Thus, pulsed lasers with low threshold radiant exposures can selectively target pigmented trabecular meshwork (TM) cells and avoid collateral thermal damage to adjacent non-pigmented cells.[4] SLT is performed using a frequency doubled (532 nm) q-switched Nd:YAG laser which creates a spot size of 400 μm.[5] Histologically, SLT has not been reported to result in coagulative damage to the TM.[6 7]

The literature has shown variable rates of the short and long term efficacy of SLT, with mean reductions in IOP

Table 2 Change in IOP at 2 weeks, 4 weeks, and 3 months as percentage of baseline

Change in IOP	2 Weeks	4 Weeks	3 Months
>30% decrease	19%	15%	24%
21–30% decrease	18%	19%	10%
11–20% decrease	22%	20%	34%
1–10% decrease	14%	24%	8%
No change	6%	6%	10%
1–10% increase	9%	2%	8%
11–20% increase	6%	7%	2%
21–30% increase	2%	6%	2%
>30% increase	4%	1%	2%

Values in the table represent percentages of the patient population.

ranging from 2–14 mm Hg at 1 month, 3–6 mm Hg at 3 months, and 5–7 mm Hg at 6 months.[5 8–11] Our study shows SLT to be a safe and effective procedure with continued average IOP lowering over 3 months consistent with these studies. Similar to other investigators, we found that those that had a baseline IOP >21 mm Hg were more likely to have a greater absolute value of IOP reduction.[12 13] An IOP reduction correlated with number of shots and average energy delivered, indicating that those eyes which received greater total amounts of energy had greater reductions in IOP. These factors influenced whether or not each eye had an IOP reduction, however, the 2 week visit predicted the subsequent course of IOP in those eyes that had a reduction of IOP, regardless of baseline or procedural factors.

In our sample, if an eye had a decrease in IOP 2 weeks after SLT, the patient had a 99.24% chance to maintain IOP values below baseline for at least 3 months. Only in one case (0.76%) was there an initial decrease in IOP followed by an increase above baseline. The baseline, 2 week, 4 week, and 3 month IOP values of this eye were 15, 9, 12.5, and 17 mm Hg, respectively. It was the left eye of a 58 year old African-American male with primary open angle glaucoma. At baseline, he was taking three ocular hypotensive agents without previous intraocular surgery. The eye received 59 shots with an average energy of 1.1 W. The patient experienced erythema postoperatively.

Thus, the 2 week visit post-SLT predicted the 4 week and 3 month visits if the 2 week visit demonstrated a decrease in IOP, which is reflected in the *r* values between the 2 week and 4 week visit (0.706) and between the 2 week and 3 month visit (0.512) for eyes that showed an initial decrease in IOP. The correlation was not perfect because the mean IOP continued to decrease beyond 2 weeks (0.73 mm Hg decrease between 2 weeks and 4 weeks postoperatively; 1.28 mm Hg decrease between 2 weeks and 3 months postoperatively).

If the 2 week visit showed an increase in IOP, more variability in subsequent IOP values was seen. In some cases the IOP remained elevated, while in others it decreased. In these patients, subsequent visits must be employed to determine whether the patient's IOP will decrease to below baseline, return to baseline, or remain elevated.

In the literature, potential complications include a 67% chance of conjunctival redness and injection within 1 day after the procedure. One hour after selective laser trabeculoplasty, there is an 11% chance of an increase in IOP of more than 5 mm Hg, and a 7% chance of an increase in IOP between 2 mm Hg and 5 mm Hg.[5] Our patient population reported ocular symptoms, but none was attributed to the SLT procedure.

Our findings suggest that those patients who had a decreased IOP at 2 weeks and are at their goal IOP are likely to remain at that IOP level and may not need to be checked again until 3 months postoperatively. For patients with mild to moderate glaucoma, the 4 week postoperative visit may be unnecessary unless the patient did not reach their goal IOP by the 2 week visit. Those who had a decreased IOP at 2 weeks but are not yet at their goal should be seen again at 4 weeks. Patients who had an elevated IOP or no change in IOP at 2 weeks should also be be monitored closely. The situation in certain patients, such as the presence of advanced disease, threat to central fixation, or concomitant ocular pathology, may lead the physician to choose to follow the patient more closely. Further research is needed to generate specific criteria for these exceptions.

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