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Repeat Selective Laser Trabeculoplasty

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Abstract

Purpose—To evaluate the efficacy of repeat 360° selective laser trabeculoplasty (SLT) in glaucoma patients with prior successful 360° SLT.

Design—Retrospective chart review

Methods—Forty-four eyes of 35 patients, ≥ 18 years of age, with open-angle glaucoma (primary open-angle, pseudoexfoliation or pigmentary glaucoma), uncontrolled on maximum tolerable medical therapy, underwent an initial 360° SLT (SLT1), which was successful for ≥ 6 months, but eventually lost efficacy and was followed by a repeat 360° SLT (SLT2). Patients with prior argon laser trabeculoplasty or other glaucoma surgery, before or during the study period, were excluded. Intraocular pressure (IOP) measurements were recorded before each procedure and 1–4 weeks, 1–3 months, and 5–8 months post-treatment, as well 15–21 weeks after the initial SLT.

Results—Reduction in IOP after SLT1 and SLT2 was significantly less with repeat treatment at 1–3 months, with average decreases of −5.0 and −2.9mmHg, respectively (p=.01); but there were no statistically significant differences between treatments at the other equivalent time points. Using a definition of "success" as ≥ 20% peak IOP reduction, success rates for SLT1 and SLT2 were not significantly different. There was also no significant difference in eyes that received SLT2 6–12 months after SLT1 compared to those that received SLT2 12 months or more after SLT1.

Conclusions—Our findings suggest that repeat 360° SLT may be safe and effective after an initially successful 360° SLT has failed. These results may be achieved as early as six months after the first treatment.

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Introduction

Selective laser trabeculoplasty (SLT) is becoming an increasingly popular alternative to argon laser trabeculoplasty (ALT) in the treatment of open-angle forms of glaucoma, primarily due to the lack of collateral thermal damage and trabecular meshwork scarring with SLT as compared to ALT.[1] However, prospective clinical trials have shown no significant difference between the two treatments with regard to safety and efficacy upon initial treatment.[2] A pressing question is whether repeating SLT, after an initially successful SLT has lost its efficacy, is associated with further clinically significant intraocular pressure (IOP) reduction, which has not been found to be the case with ALT.[3]

We report the results of a retrospective study in which a repeat 360° SLT was performed six months or more after an initially successful 360° SLT.

Methods

This is a retrospective chart review of patients treated in the offices of three of the authors (BA, JM and MW). Inclusion criteria were open-angle glaucoma patients (primary open-angle, pseudoexfoliation or pigmentary glaucoma), ≥ 18 years of age, who were uncontrolled on maximum tolerable medical therapy and underwent an initial 360° SLT (SLT1), which was successful for six months or more, but eventually lost efficacy and was followed by a repeat 360° SLT (SLT2). Exclusion criteria were prior ALT or other glaucoma surgery before or during the study period. The study was approved by the Human Investigation Committee of Yale University School of Medicine.

Data recorded for each patient included age, gender, type of glaucoma, glaucoma medications just before and during the study and the SLT protocol (number of spots and laser power setting). Baseline IOP for SLT1 was taken as the average of the last three readings before the treatment. The baseline IOP for SLT2 was the measurement on the day of the repeat treatment.

The SLT protocol consisted of pretreating with Apraclonidine and applying laser energy to all four quadrants of the trabecular meshwork. All eyes were treated with Bromfenac or Diclofenac b.i.d. for 4–7 days post-SLT. Follow-up IOP measurements were obtained at 1–4 weeks, 1–3 months and 5–8 months for both SLT1 and SLT2.

To evaluate the influence of time after SLT1 before the repeat procedure, the patients were divided into those who received SLT2 6–12 months after SLT1 (early repeats) and those in which the repeat was performed more than 12 months after SLT1 (late repeats). In addition to the three time points, the early and late repeat groups were compared at 15–21 months. The minimum follow-up time for all patients was six months after both SLT1 and SLT2.

The main outcome variables analyzed were the IOP-lowering effect of SLT2 compared to SLT1 at each time point and the IOP-lowering effect of SLT2 in the early repeat group as compared to that of the late repeat group. SLT1 and SLT2 were compared, using a definition of “success” as ≥ 20% IOP reduction in relation to respective pretreatment baselines. IOP increases above the aforementioned threshold of success were seen as loss of efficacy. In order to compare the efficacy from an equivalent time point relative to the respective procedures, the baseline for SLT2 is taken to be the IOP measurement directly prior to the second surgery. This provides a null hypothesis that the previous surgery does not affect the efficacy of repeat surgery. Baseline characteristic distributions were also compared between the early repeat and late repeat groups.

Student’s t-test was used to evaluate statistical significance in continuous variables in which there was a single measurement. In cases where the SLT1 baseline measurements were

compared, because there were three measurements, p-values were calculated using repeat measures analysis using ANOVA. Chi-square testing was used to calculate significance in categorical variables. All of these calculations were performed using Data Desk version 6.1 by Data Description, Inc.

Since we have 9 patients in whom both eyes were included, we first analyzed right and left eyes separately to avoid confounding of variables and pooled the data upon finding that the results were not significantly different.

Results

Forty-four eyes of 35 patients met the inclusion-exclusion criteria and were included in the study. Patient demographics are shown in Table 1. Table 2 shows the mean IOP and mean IOP changes for SLT1 and SLT2 at the three time points for all 44 eyes. The only statistically significant difference was the mean change at 1–3 months, which was −5.0mmHg for SLT1 and −2.9mmHg for SLT2 (p=.01). Table 3 shows the percentage of eyes that qualified for the definition of success (≥ 20% IOP reduction) at each time point. At the 5–8 month time point, the success rate for SLT1 was 7% higher than that for SLT2, but the difference did not reach statistical significance. Eight patients (18.2%) had IOP greater than their SLT2 baselines 1–4 weeks after second treatment; of these patients, however, only one eye (2.3%) continued to have elevated IOP through the remainder of follow-up. With the exception of one patient, in whom brimonidine was discontinued due to dizziness, there were no changes in the glaucoma medication regimens throughout the study.

Mild anterior uveitis was documented in two eyes post-SLT1 and an IOP spike was noted in one eye (2.3%) after both SLT1 and SLT2. Conjunctival hyperemia was noted in 26 (59%) eyes post-SLT1 and 28 (64%) eyes post-SLT2. Post-treatment complications were not significantly different between the two surgeries.

The demographics for the early repeat and late repeat groups are also shown in Table 1. The only significant difference was the distribution of right and left eyes. The baseline mean IOPs, mean IOPs and mean change in IOPs at the four time points for the two groups are shown in Table 4. Although there was a statistically significant difference in baseline values, being higher in the early repeat group, the only significant difference in the post-treatment time periods was a lower mean IOP in the late repeat group at 5–8 months.

Discussion

Damji, et al studied SLT after ALT and reported beneficial IOP reduction with SLT in eyes that had been unresponsive to ALT.[2] Two groups (Mequio MJ, et al. IOVS 2007; 48: ARVO E-Abstract 3972 & Franco TC, et al. IOVS 2007; 48: ARVO E-Abstract 3981) recently described their experience with repeat SLT after prior SLT, although the initial SLTs were not all 360° and the repeat procedures were performed in some quadrants that had been previously treated and some that had not. To our knowledge, there has been no previous report in which a first 360° SLT, that was initially successful but eventually lost efficacy, was followed by a repeat 360° SLT.

There is much written in the literature as to the viability of repeat ALT. Early studies suggested that repeat 360° ALT in previously failed 360° ALT yielded encouraging results, with a 100% success rate at 3 months in one study[4] and up to 53% of retreated eyes achieving an IOP reduction at 12 weeks in another.[5] However, these numbers prove to be a bit misleading in that the former figure considers treatment to be successful if IOP is maintained below an absolute pressure of 21 mmHg for all eyes and the latter figure takes even the smallest IOP reductions into account.

In a study regarding repeat ALT in eyes that had a positive prolonged response to initial 180° and 360° ALT, Jorizzo, et al showed that 8 of 11 eyes had sustained reduction of IOP at >1 year follow-up.[6] Although this too is encouraging, we cannot be sure whether the IOP-lowering effect came from retreatment of previously treated regions or whether the apparent effect is skewed by the treatment of previously untreated regions (i.e.180° ALT1). It is appearing more and more likely that the therapeutic benefits of repeat ALT are limited[7] and that, although fairly safe, the likelihood of successful IOP reduction decreases significantly with each repeat ALT.[3]

On the other hand, SLT has been shown to be better tolerated, with less discomfort and postoperative anterior chamber inflammation,[8] and significantly less thermal damage to the trabecular meshwork as compared to ALT.[9]

We found that a repeat 360° SLT provided additional IOP reduction, which was not as marked as that with the first treatment, although the difference between the two was not statistically significant except at the 1–3 month time period. We also found that only one eye (2.3%) continued to have elevated IOP through the remainder of post-SLT2 follow-up.

We chose to be consistent with Damji, et al. in defining success as being a ≥20% reduction of pretreatment IOP.[2] Although our follow-up was not necessarily ≥1 year after each SLT application, we felt that this definition of success would not only make our results comparable to those of previous studies but also account for those IOP reductions closely approaching the average rather than only those IOP reductions greater than or equal to the average. With this definition of success, there was again no significant difference between the initial and repeat treatments. We also found that the time since the initial SLT did not influence the outcome of the repeat procedure.

Even though patients who had repeat SLT within 6–12 months of the initial treatment had a significantly higher baseline IOP than those whose repeat was after 12 months, the only significant difference between these two groups was a lower mean pressure in the late repeat group at the 5–8 month time period.

Our study is limited by its retrospective design. The decision to repeat SLT was made by the treating physician, based on the overall status of each patient. The sample size is also fairly small, so larger, prospective studies are needed to confirm our findings. In addition, because 360° repeat SLT has been so rare to date, it was necessary to accept using multiple eyes from the same subjects in order to gain proper power for this retrospective trial. While not ideal, there were not differences between the two eyes of those repeated subjects, nor between the demographics of them and those subjects who had repeat SLT in only one eye. Another measure that allowed for increased power was the fact that three measurements were taken prior to SLT1. Because the IOP prior to SLT1 was in steady state, three measurements were taken in order to better calculate the baseline; however, between the first and second surgeries, at the time of SLT2 baseline, the IOP was in a state of flux so repeat measure would have been misleading. The repeated measures were not significantly different from each other as judged by ANOVA with ID and order as factors ($p=.54$).

Nevertheless, our preliminary findings are encouraging, suggesting that 360° SLT may be repeated after an initially successful 360° SLT has failed, with IOP reduction that suggests only slightly diminishing returns. Our findings also suggest that these results may be achieved as early as six months after the first treatment. If prospective, randomized trials also show that SLT can be repeated in a safe and effective manner, it may be possible to claim an advantage for the use of SLT over ALT, and the former may assume an increasingly important role in our management of glaucoma.

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Table 1

Initial Demographics: Mean (95% CI*) or Number (Percentage) of all Glaucomatous Eyes and Two Treatment Groups (Selective Laser Trabeculoplasty repeated at 6–12 months and ≥12 months)

	Total	6–12 months	≥12 months	
Gender (M:F)	15:29 (34:66)	7:13 (35:65)	8:16 (33:67)	p=.91
Age	73.2 (69.7,76.9)	73.6 (67.9,79.3)	72.99 (68.3,77.7)	p=.45
Type of Glaucoma (POAG: PXG: PG) †	35:8:1 (80,18,12)	17:2:1 (85:10:5)	18:6:0 (75:25:0)	p=.26
Eye (OD:OS) ‡	25:19 (57:43)	14:6 (70:30)	11:13 (46:54)	p=.006
Number of Spots	102.1 (98.1,106.0)	102.4 (96.3,108.5)	101.8(96.5,107.1)	p=.88
Power Setting (mJ)	88.1 (84.7, 91.5)	87.8 (82.3,93.3)	88.4 (84.2,92.6)	p=.87

*Confidence interval

†Primary Open-Angle: Pseudoexfoliative: Pigmentary Glaucoma

‡Right Eye:Left Eye

TABLE 2

Intraocular Pressures at Equivalent Time Points after Initial Application of Selective Laser Trabeculoplasty (SLT1) and after Repeat Application (SLT2) in the Treatment of Open-Angle Glaucoma and change in from pre-procedure baseline IOP (pre- SLT2 IOP for SLT2 measurements) (n=44)

		SLT1	SLT2	
IOP	Baseline	20.1(18.8,21.3)	19.5(17.7,21.3)	p=.49
	1–4 Weeks	16.9(15.7,18.2)	16.9(15.1,18.6)	p=.94
	1–3 Months	15.0(14.2,15.8)	16.6(15.2,18.0)	p=.04
	5–8 Months	16.2(14.9,17.4)	16.7(14.9,18.4)	p=.60
IOP Change	1–4 Weeks	−3.1(−4.6,−1.7)	−2.6(−4.1,−1.1)	p=.61
	1–3 Months	−5.0(−6.2,−3.9)	−2.9(−4.0,−1.8)	p=.002
	5–8 Months	−4.0(−5.3,−2.7)	−2.9(−4.2,−1.5)	p=.16

TABLE 3

Percentage of Glaucomatous Eyes that reach ≥ 20% decrease in Intraocular Pressure after Initial Application of Selective Laser Trabeculoplasty (SLT1) and after Repeat Application (SLT2)

	1–4 weeks	**1–3 months**	**5–8 months**
SLT 1	29.5% (n=13)	54.5% (n=24)	50% (n=22)
SLT 2	40.9% (n=18)	36.3% (n=16)	43.2% (n=19)
	p=.26	p=.09	p=.52

TABLE 4

Comparison of Intraocular Pressure Reduction with Repeat Selective Laser Trabeculoplasty (SLT2) 6–12 Months and ≥12 Months after SLT1 in the Treatment of Open-Angle Glaucoma

		6–12 Mo SLT2	**≥12 Mo SLT2**	
IOP	Pre-op	21.7(19.4,24.0)	18.7(17.7,19.76)	p=.01
	1–4 Week	17.4(15.7,19.0)	16.6(14.8,18.4)	p=.55
	1–3 Month	15.5(14.3,16.6)	14.7(13.6,15.7)	p=.33
	5–8 Month	17.5(15.6,19.4)	15.0(13.6,16.5)	p=.02
	15–21 Month	18.1(14.7,21.4)	17.0(15.7,18.4)	p=.56
IOP Change	1–4 Week	−4.3(−6.7,−2.0)	−2.1(−3.9,−0.4)	p=.15
	1–3 Month	−6.2(−8.1,−4.3)	−4.1(−5.5,−2.7)	p=.07
	5–8 Month	−4.2(−6.3,−2.1)	−3.9(−5.6,−2.2)	p=.41
	15–21 Month	−3.6(−7.0,−0.2)	−1.7(−3.3,−0.1)	p=.29

* Confidence interval