Selective Laser Trabeculoplasty (SLT): Predictors of Failure

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ABSTRACT

Purpose: SLT is widely used to control intraocular pressure (IOP) in glaucoma. We wished to determine predictive factors for long term success of SLT performed by full time faculty at a University Eye Clinic in Dallas.

Methods: Charts of patients with primary open angle glaucoma who underwent SLT between 2001 and 2011 were reviewed retrospectively. Those with follow up < 3 months, prior ALT/SLT, filtering procedure or inadequate data were excluded. The dependent variable was time to failure after ALT. Failure was defined as any additional medication, ALT/SLT or glaucoma filtering surgery. All patients were treated with 360° SLT. Logistic regression and receiver operating characteristic (ROC) analysis was performed to assess correlation between time to failure after ALT and age, pre-op IOP, C/D ratio, visual field defect (VFD), family history of glaucoma, refractive error, hypertension, diabetes, number of medications, laser energy used, central corneal thickness.

Results: Evaluable data was obtained on 189 patients; mean age 64, 44% male, 56% female, 49% white, 32% black, 12% Hispanic and 7 % others. 29.6% (56/189) were classified as SLT failures. Failure and non-failure patients had equal follow-up duration of median 2 yr. Age and laser energy were not significant predictors of SLT. In multivariable logistic regression models, statistically significant risk factors associated with SLT failure were family history of glaucoma (odds ratio (OR) = 1.7, 95% CI: 1.1-2.7, p=0.02), higher pre-op IOP (OR =1.1, 95%CI: 1.0-1.15, p=0.03), and moderate to severe VFD (OR =2.6, 95% CI: 1.3-5.2, p=0.006); ROC AUC = 0.71 (95% CI : 0.62-0.80).

Conclusions: SLT results were better in patients without family history of glaucoma and who had lower pre-op IOP and mild to moderate visual field defects.

INTRODUCTION

Glaucoma is a leading cause of blindness worldwide, and Primary open-angle glaucoma (POAG) is the most common type of glaucoma in the United States. POAG is a neuropathy characterized by progressive damage to the optic nerve and visual field loss leading to eventual blindness. Glaucoma is recognized as a complex and multifactorial disease that includes both systemic and ocular risk factors. Elevated intraocular pressure (IOP) is among the most significant predictive factors in POAG. IOP is the most treatable factor in POAG and is usually the focus of drug and surgical therapies.

Medication can successfully lower IOP. Common drug protocols include prostaglandin analogs, alpha agonists, beta agonists, miotic agents, and carbonic anhydrase inhibitors. Medications are usually applied topically in the form of eye drops. However, in severe and acute cases, more systemic drugs may be used. Compliance with drug protocols can be a challenge. Medications can be expensive and the side effects may be intolerable to some patients. As individual cases become more severe patients may struggle with the application of multiple medications. Often patients fail to maintain follow up appointments and prescription refills. Difficulties with medications have led to the exploration of early surgical interventions as alternative or combined therapy.

Laser trabeculoplasty is the most common and immediate surgical intervention for POAG. Argon laser trabeculoplasty (ALT) is a treatment that uses a thermal laser to open the trabecular meshwork. Selective laser trabeculoplasty (SLT) was developed as a nonthermal alternative using a Nd:YAG laser to stimulate the opening of the trabecular meshwork. The nonthermal nature of the laser allows the procedure to be repeated many times. Factors that predict the success or failure of (SLT) has become an important subject of glaucoma research as SLT has increasingly become the surgical intervention of choice in POAG. The objective of this project was to explore factors that predicted the long term success or failure of SLT. This and continued research on this subject will prove valuable in improving SLT outcomes and avoiding more drastic surgical interventions.

MATERIALS AND METHODS

After approval by the Institutional Review Board of the University of Texas Southwestern center, charts of patients with POAG who underwent SLT between 2001 and 2011 at the UT Southwestern James W. Aston Ambulatory Care Center were reviewed retrospectively. A database was designed to collect and store comprehensive data. All patients were treated with 360° SLT. Patients with treatment in multiple eyes had data for one eye selected at random. Patients with less than 3 months follow up, prior ALT/SLT, glaucoma surgery, or incomplete data were excluded.

Data collected included patient age, gender, race, history of hypertension, history of diabetes, family history of glaucoma, current type and number of glaucoma medications, cup to disc ratios, visual acuity, and central corneal thickness. Surgical parameters collected included power, energy, and number of spot applications.

Severity was determined by extrapolation of visual field data and categorized as mild, moderate or severe. Visual fields with a mean deviation index (MD) of -6 dB and less that 25% point depression were categorized as mild POAG. Visual fields with a MD of -6 dB to -12 dB and 25% to 50% point depression were categorized as moderate POAG. Visual fields with a MD greater than -12dB and 50% point depression were categorized as severe POAG.

IOP data was collected from patient charts immediately prior to SLT and immediately after. IOP data was collected as available at one week, one month and 3 months after SLT. IOP data continued to be collected as available in patient charts at approximately every 6 months until failure or loss to follow up.

The dependent variable was time to failure after SLT. Failure was defined as any new glaucoma medication, additional SLT, or any additional glaucoma surgery. Time to failure was calculated from date of SLT and date of failure or last IOP measurement.

Logistic regression and receiver operating characteristic (ROC) analysis was performed to assess correlation between time to failure after ALT and age, pre-op IOP, C/D ratio, visual field defect (VFD), family history of glaucoma, refractive error, hypertension, diabetes, number of medications, laser energy used, and central corneal thickness.

***Table 1*. Gender Demographics**

	M	F	Total
Frequency	83	106	189
Percent	44%	56%	

***Table 2*. Racial Demographics**

	White	Black	Hispanic	Asian	East Indian	Total
Frequency	93	61	22	6	7	189
Percent	49%	32%	12%	3%	4%	

Figure 1. **Racial Demographics**

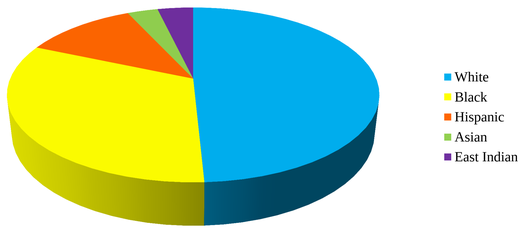

Table 1 & 2 and Figure 1. Break down of patient racial and gender demographics. Demographics were found to have no significant effect on SLT outcomes.

***Table 3*. Baseline IOP**

	n	Mean	SD	Minimum	Maximum
Non-failure	132	20.33	5.22	12	45
Failure	56	21.84	5.78	12	36
Odds Ratio, 1.1; 95% Confident Interval, 1.0-1.15; p = 0.03					

***Table 4*. Visual Field Defect**

	Normal	Mild	Moderate	Severe	Total
Non-failure	31	39	23	35	128
Failure	5	15	21	14	55
Odds Ratio, 2.6; 95% Confident Interval, 1.3-5.2; p = 0.006					

***Table 5*. Family History of Glaucoma**

		No FHG	FHG	Total
Non-failure	n	74	59	133
	Total %	39%	31%	70%
	Row %	56%	44%	
	Col %	76%	65%	
Failure	n	24	32	56
	Total %	13%	17%	30%
	Row %	43%	57%	
	Col %	24%	35%	
Odds Ratio, 1.7; 95% Confident Interval, 1.1-2.7; p = 0.02				

Table 3, 4, & 5. Statistical analysis of significant findings with odds ratios, confident intervals, and p-values: high baseline IOP, moderate-severe VFD, and family history of glaucoma.

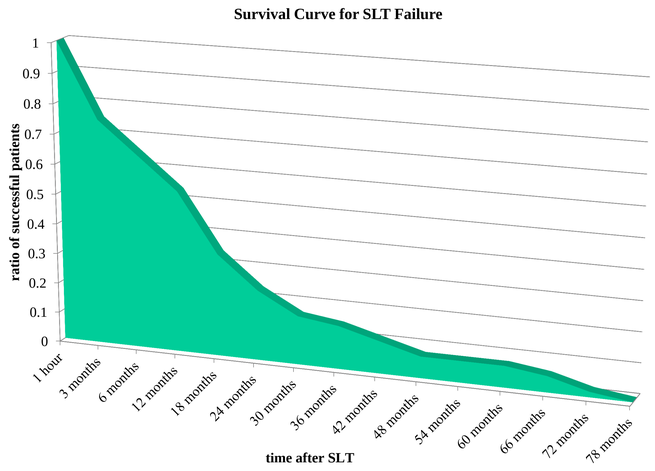

Figure 2. This is the survival curve for all patients who eventually failed SLT. Mean time to failure was 25.2 months, n = 56. The ratio of patients who have not yet failed is plotted against time after SLT. At time immediately following SLT all patients are considered successful. The last patient failed after 78 months.

RESULTS

Evaluable data was obtained on 189 patients from the UT Southwestern James W. Aston Ambulatory Care Center. Demographic data showed that patients were 44% male and 56% female. Racial and ethnic demographics revealed that patients were 49% white, 32% black, 12% Hispanic and 7 % others. Mean patient age was 64. No demographic categorization including age had a significant effect on SLT outcomes. Table 1 and Figure 1 present demographic data.

29.6% (56/189) of patients were classified as SLT failures as described in methods. Failure and non-failure patients had an equal follow-up duration median of approximately 2 years. SLT parameters including laser energy were not significant predictors of SLT outcomes. Figure 2 presents the survival curve for SLT failures.

In multivariable logistic regression models, statistically significant risk factors associated with SLT failure were family history of glaucoma (odds ratio (OR) = 1.7, 95% CI: 1.1-2.7, p=0.02), high baseline IOP (OR =1.1, 95%CI: 1.0-1.15, p=0.03), and moderate to severe VFD (OR =2.6, 95% CI: 1.3-5.2, p=0.006); ROC AUC = 0.71 (95% CI : 0.62-0.80). Table 3, Table 4, and Table 5 present significant results.

Odds ratio (OR) was used to measure the association of two binary variables. By definition, OR compares the odds of the "YES" proportion for one group to the odds of the "YES" proportion for a second group. When OR is 1, there is no association between the variables. When OR is greater than 1, group 1 is more likely than group 2 to have the "YES" response. When OR is less than 1, group 1 is less likely than group 2 to have the "YES" response. These values can then be used to calculate p-values for confident intervals.

A 95% confident interval means there is at least 95% confidence that OR for a group will lie between a certain OR range. In our example for patients with a family history of glaucoma, we have at least 95% confidence that an OR of 1.7 will be between 1.1 and 2.7. In other words, patients with a family history of glaucoma were 1.7 times more likely than patients without a family history of glaucoma to reach failure after SLT treatment.

DISCUSSION

SLT has long proven a safe and effective means of controlling IOP. However there are limitations to its effectiveness. Gracner et al. reported that SLT effect diminishes over time.[1] Zanetti and Ravinet found that SLT can effectively manage IOP for many years without a change in topical medications.[2] However, it cannot completely separate treatment from medications. Therefore, predictors for success and failure must be examined to increase selectivity for SLT.

There have been many prior studies that have investigated and found various predictors of success or failure. Gracner et al. previously reported that the absence of diabetes mellitus was a predictor of success.[3] Shazly et al. found that patients with thinner corneas have greater short term and long term success following SLT.[4] Ayala and Chen showed that younger patients respond better to SLT. They also found that an increase in total laser energy improved response to SLT. [5] Our study examined all these relationships without significant findings.

High baseline IOP is the best documented predictor of success for IOP as documented by Ayala and Chen, Bruen et al., and Mao et al.[5-7] Similarly Almeida et al. reported that a greater initial reduction in IOP following SLT is a reliable predictor of midterm success.[8] This is completely logical since higher starting IOP allows for the most dramatic decreases in IOP. Our own study found that higher baseline IOP actually hastens time to failure. This is not necessarily a finding in discord with previous findings. Studies naming higher baseline IOP as a predictor of success focus exclusively on the immediate effects on IOP. Furthermore, Ayala and Chen in examining the long term effects of SLT found that higher baseline IOP decreases the time to failure.[5]

To the Authors' knowledge, no previous studies have found family history of glaucoma as a significant predictive factor of SLT outcomes. Gracner et al. found family history to be insignificant in a clinical study of 122 eyes. That study also found baseline IOP to be insignificant.[3] Since glaucoma has complex multifactorial inheritance it is not surprising that family history is a sporadic factor, especially in different areas of the world. Additionally, if genetics indicates a predisposition to glaucoma, it is not surprising that laser therapy might ultimately be less effective in preventing the eventual progression of the disease.

The authors know of no studies that have associated severity of visual field defects with SLT outcomes. Again, it may be a logical conclusion that more advanced cases of glaucoma will ultimately be less responsive to any type of intervention. Glaucoma treatments are not restorative. They are preventative. SLT and medications are best used to preserve an already patent visual field and stave off further deterioration. A plausible and important implication of this finding is that it may be better to intervene sooner rather than later with SLT. We believe SLT treatment will continue to benefit from similar studies that reveal and review predictive factors in SLT.

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