

# Micropulse laser trabeculoplasty and reduction of intraocular pressure: A preliminary study

Ryan Phan<sup>1</sup>, Kevin Bubel<sup>1</sup>, Joshua Fogel<sup>2</sup>, Aaron Brown<sup>3</sup>, Henry Perry<sup>1</sup>, Marcelle Morcos<sup>1</sup>

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## Abstract:

**PURPOSE:** The purpose of the study was to measure the change in intraocular pressure (IOP) after micropulse laser trabeculoplasty (MLT) and to evaluate subgroups based on initial IOP and severity of glaucoma.

**METHODS:** This was a retrospective study of 34 eyes that were treated with MLT. Follow-up measurements were obtained at 3 months. Paired *t*-tests compared baseline to follow-up.

**RESULTS:** IOP reduction approached significance ( $P = 0.055$ ) for lower mean IOP from pre- to post-treatment. In the subset of those with baseline IOP  $>16$ , mean IOP was significantly lower ( $P = 0.001$ ) from pretreatment (mean = 19.43, standard deviation [SD] = 2.48) to posttreatment (mean = 16.91, SD = 3.37). There were 34.8% (8/23) with a 20% reduction from baseline IOP. For patients with no glaucoma/early glaucoma, mean IOP was significantly lower ( $P = 0.003$ ) from pretreatment (mean = 19.62, SD = 3.36) to posttreatment (mean = 16.62, SD = 3.01). In the subset of those with moderate/advanced glaucoma, there were no significant changes for mean IOP from pretreatment to posttreatment.

**CONCLUSION:** Patients with higher initial IOP and in the early stages of glaucoma were more likely to benefit from MLT in lowering IOP. A randomized clinical trial is necessary to confirm these preliminary findings. We recommend that clinicians should consider MLT in the management of early glaucoma and among those with IOP  $>16$  mmHg.

## Keywords:

Glaucoma, intraocular pressure, laser therapy

## INTRODUCTION

Primary open angle glaucoma (POAG) has an overall prevalence in the United States of approximately 1.86%.<sup>[1]</sup> Topical drug treatment for POAG includes prostaglandin analogs, beta-blockers, carbonic anhydrase inhibitors, alpha agonist, parasympathetic mimetics, and trabecular meshwork relaxing signaling molecules.<sup>[2]</sup> Laser therapy for POAG includes argon laser trabeculoplasty (ALT), selective laser trabeculoplasty (SLT), and most recently micropulse laser trabeculoplasty (MLT).<sup>[3]</sup> Laser therapy offers many advantages over topical drugs including eliminating the concern of adherence to eye drop prescriptions and an improved side effect profile.<sup>[4]</sup>

The first laser technology used to treat POAG was ALT. ALT was effective as topical intraocular pressure (IOP) lowering medications. However, ALT use was frequently complicated by significant tissue disruption, loss of trabecular architecture, loss of cell integrity, and tissue destruction with crater formation.<sup>[3]</sup> SLT has less collateral damage and trabecular scarring than ALT for POAG treatment.<sup>[5]</sup> MicroPulse technology was incorporated into laser trabeculoplasty, delivering energy in microsecond pulses followed by rest periods allowing for increased thermal relaxation time and less dissipation of heat. MLT does not destroy pigmented cells or cause posttreatment inflammation.<sup>[6,7]</sup> For these reasons, MLT may be safer than SLT, especially in patients with highly pigmented trabecular meshwork who are at higher risk for postlaser pressure spikes.<sup>[8]</sup>

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<sup>1</sup>Department of Ophthalmology, Nassau University Medical Center, East Meadow, <sup>2</sup>Department of Business Management, Brooklyn College, Brooklyn, NY, USA, <sup>3</sup>Department of Clinical Sciences, American University of the Caribbean School of Medicine, Cupecoy, Sint Maarten

**Address for correspondence:** Dr. Ryan Phan, Department of Ophthalmology, Nassau University Medical Center, 2201 Hempstead Turnpike, East Meadow, NY 11554, USA. E-mail: rphan@gmail.com  
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There are a few studies that show that MLT has been successfully used to treat POAG with findings of reduced IOP after MLT treatment.<sup>[3,6,9]</sup> Baseline IOP is a known predictor for treatment response with SLT therapy.<sup>[10]</sup> We are not aware of any study with MLT that analyzes subgroups based on glaucoma severity. We divide patient into subgroups of baseline high IOP, low IOP, no glaucoma/early glaucoma, and moderate/advanced glaucoma to determine if MLT has any impact on IOP over 3 months in these subgroups.

## METHODS

### Setting

This was a retrospective review of 19 consecutive patients that consisted of 34 eyes that were treated with MLT between February 2017 and January 2018 at a suburban New York City community hospital outpatient center. Inclusion criteria were open-angle glaucoma patients and ocular hypertension (OHTN) patients who were available for follow-up at 3 months. The diagnosis was confirmed by rotating glaucoma trained subspecialists before each procedure. Exclusion criteria were diagnosis of closed-angle glaucoma, history of prior incisional glaucoma surgery, and change in number of medications or ocular surgery immediately before the procedure or during the 3-month follow-up period. This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the hospital Institutional Review Board.

MLT was performed using an Iridex IQ 532,<sup>[11]</sup> with MicroPulse technology at 532 nm. The settings were standardized and used by all operating physicians. The standardized settings were 300 micron spot size, 300 ms duration, 1000 milliWatt power, duty cycle of 15% duty and 85% rest, and 360° of treatment aimed at the trabecular meshwork.

### Variables

The main variables were measured IOP on the date of the procedure (baseline) and at 3-month follow-up. IOP was measured by Goldmann applanation tonometry. Patient demographic variables collected were age (years), gender (male/female), race/ethnicity (Caucasian, Hispanic, and African-American), and eye (right/left). Diagnoses consisted of POAG, OHTN, normal-tension glaucoma (NTG), and narrow-angle. Patients were diagnosed with POAG if they had IOP >21 and had glaucomatous nerve damage on examination or Humphrey visual field (HVF) changes consistent with glaucoma. Patients were diagnosed with OHTN if they had IOP >21 with no other evidence of glaucomatous optic neuropathy by clinical examination or on HVF testing. Patients were diagnosed with NTG if IOP was lower than 21 before initiation of therapy. Patients were diagnosed with narrow-angle glaucoma if the angles were identified as narrow based on gonioscopy by the Schaffer or Spaeth grading scale. Glaucoma severity was based on HVF changes that were graded by two independent researchers with at least 1 year of ophthalmology training and categorized as early, moderate, or advanced based on the Hoddap-Parish Anderson grading

scale or no glaucoma if there were no changes on HVF consistent with glaucoma. Any discrepancies in severity were agreed on by consensus between the two researchers. Patients were categorized as either no glaucoma/early glaucoma or moderate/advanced glaucoma. Mean number of IOP-lowering medications was recorded. Adverse events were recorded at the first follow-up visit after MLT treatment. Patients were categorized as high or low baseline IOP as >16 or <16, respectively, based on the median of the accepted range of normal IOP.<sup>[12]</sup>

### Statistical analysis

Mean and standard deviation were used to describe the continuous variables. Frequency and percentage were used to describe the categorical variables. Paired *t*-tests compared initial IOP to IOP after 3 months. IBM SPSS Statistics Version 25 (IBM Corporation, Armonk, New York, USA) was used for all analyses.<sup>[13]</sup> All *P* values were two tailed.

## RESULTS

Table 1 shows the sample characteristics. The mean age was above 63 years and almost three-quarters were female. There was high minority representation with half African-American and almost half Hispanic. Eyes were half left and half right. More than two-thirds had a diagnosis of primary open-angle glaucoma. Mean IOP was 17.4 mmHg. More than half had either moderate or advanced glaucoma. The mean number of medications was 2.2. There were no reported adverse events.

Table 2 shows comparisons for mean IOP from pretreatment to posttreatment at 3 months. IOP approached significance ( $P = 0.055$ ) for lower mean IOP from pre- to post-treatment. There were 32.4% (11/34) with a reduction of 20% from initial IOP. In the subset of those with initial IOP <16, there were no significant changes for mean IOP from pre- to posttreatment. There were 27.3% (3/11) with a reduction of 20% from initial IOP. In the subset of those with initial IOP >16, mean IOP was significantly lower ( $P = 0.001$ ) from pre- to posttreatment. There were 34.8% (8/23) with a reduction of 20% from initial IOP. In the subset of those with no glaucoma/early glaucoma, mean IOP was significantly lower ( $P = 0.003$ ) from pre-to posttreatment. There were 30.8% (4/13) with a reduction of 20% from initial IOP. In the subset of those with moderate/advanced glaucoma, there were no significant changes for mean IOP from pre- to post-treatment. There were 38.9% (7/18) with a reduction of 20% from initial IOP.

## DISCUSSION

This preliminary study shows promising results for MLT as a viable treatment for POAG. We found that MLT treatment was associated with a reduction in IOP that approached statistical significance across all participants. MLT treatment was associated with statistically significant reduction in IOP in patients with higher initial IOP and also in those in the early stages of glaucoma.

**Table 1: Characteristics of the sample**

Variable	Mean (SD) or, n (%)
Age (years), mean	63.2 (10.1)
Gender (female)	25 (73.5)
Race/ethnicity	
Caucasian	2 (10.5)
Hispanic	8 (42.1)
African American	9 (47.4)
Eye	
Right	17 (50.0)
Left	17 (50.0)
Diagnosis	
POAG	23 (67.6)
OHTN	2 (5.9)
NTG	5 (14.7)
Narrow-angle	4 (11.8)
Glaucoma severity	
None	9 (26.5)
Early	4 (11.8)
Moderate	7 (20.6)
Advanced	11 (32.4)
Indeterminate	3 (8.8)
Medications (n), mean	2.2 (1.3)
Adverse events (yes)	0

The race/ethnicity is (n=19) while all other variables are based upon (n=34) eyes. SD=Standard deviation; POAG=Primary open-angle glaucoma; OHTN=Ocular hypertension; NTG=Normal-tension glaucoma

**Table 2: Intraocular pressure comparisons from pre- to post-treatment**

Variable	Mean (SD)		P
	IOP initial	IOP 3-month	
Entire sample (n=34)	17.47 (3.59)	16.15 (3.75)	0.055
IOP<16 (n=11)	13.36 (1.29)	14.55 (4.16)	0.38
IOP≥16 (n=23)	19.43 (2.48)	16.91 (3.37)	0.001
No glaucoma/early glaucoma (n=13)	19.62 (3.36)	16.62 (3.01)	0.003
Moderate/advanced glaucoma (n=18)	15.61 (3.03)	15.22 (3.96)	0.71

There were 3 participants with indeterminate glaucoma that were not included in the glaucoma subgroups. SD=Standard deviation; IOP=Intraocular pressure

Reduction of IOP approached significance ( $P = 0.055$ ) in the whole sample from pre- to posttreatment. There was a mean 7.6% mmHg reduction in IOP. This is lower than prior studies of MLT which show a 12.2% to 22.1% mean mmHg reduction from pre- to posttreatment of IOP.<sup>[3,6,7,9]</sup> A possible reason for the difference is that the eligibility criteria for prior MLT studies tended to be more selective and only included participants with initial IOP >21 mmHg,<sup>[6,9]</sup> or those that had failed maximal medical therapy,<sup>[14]</sup> whereas our study included all patients with POAG or OHTN. Furthermore, the mean initial IOP among our patients was lower than that of many prior studies.<sup>[3,6,7,9]</sup> We suggest that our results for the whole sample do not show as large mmHg reductions because of our broader inclusion criteria. Across all participants, we had a success rate of 32.4% (11/34) for reduction of 20% from

baseline IOP. Previous research with MLT reports a wide range of 2.5%–72.9% for 20% reduction from baseline IOP.<sup>[3,7,15,16]</sup> Our findings are within that range and confirm the utility of MLT as an important therapeutic modality in the management of glaucoma.

In the subset of those with baseline IOP <16, there were no significant changes for mean IOP from pre- to post-treatment. In the subset of those with baseline IOP >16, mean IOP was significantly lower ( $P = 0.001$ ) from pre- to post-treatment. This included a mean change of 13.0% mmHg from baseline IOP to follow-up. There were 34.8% (8/23) with a reduction of 20% from initial IOP. Higher baseline IOP is a known factor impacting the reduction of IOP after SLT treatment,<sup>[10,17-20]</sup> but to our knowledge, no studies have evaluated the role of baseline IOP in MLT. Our findings extend what is known about SLT treatment for IOP reduction to MLT treatment and indicate the potential role for MLT in the management of patients with higher baseline IOP. The mechanism that drives the reduction in IOP is likely due to the pressure gradient from the anterior chamber to Schlemm's canal and collecting channels.<sup>[21,22]</sup>

In the subset of those with no glaucoma/early glaucoma, the reduction in mean IOP was significantly greater ( $P = 0.003$ ) from pre- to post-treatment. This included a mean change of 15.3% mmHg from baseline IOP to follow-up. There are studies that show the viability of laser trabeculoplasty as an initial treatment for POAG.<sup>[23,24]</sup> A few studies have specifically compared the impact of laser trabeculoplasty in early as compared to advanced glaucoma among those with ALT and SLT.<sup>[24,25]</sup> To our knowledge, there are no studies that specifically looked at the impact of MLT among those with no glaucoma/early glaucoma and moderate/advanced glaucoma. Our results for MLT are consistent with a previous study that found that patients with early glaucoma had greater reduction in IOP after SLT.<sup>[25]</sup> In the subset of those with moderate/advanced glaucoma, there was no statistically significant change in the mean IOP from pre- to post-treatment. However, there were 38.9% (7/18) with a reduction of 20% from initial IOP. Although the mean IOP did not achieve a significant reduction, MLT did seem to be useful in a subset of these advanced glaucoma patients. This may indicate that there is some other factor impacting MLT, even in those patients with advanced disease. It is possible that the morphologic changes in the trabecular meshwork of patients with advanced glaucoma confer a resistance to the impact of MLT.<sup>[26-29]</sup>

This study has several limitations. First, this a preliminary study of just 34 eyes. Future research is needed to replicate these findings with a clinical trial. Second, we did not record the number of laser pulses for each treatment. It is possible that pulse number is associated with IOP outcomes. Third, as this was a retrospective study, we could not standardize the number of laser pulses for each treatment regimen. Fourth, IOP was not standardized to a single Goldmann applanator device, physician, or time of day which possibly can lead to increased variability of results.

## CONCLUSION

We found that patients with higher baseline IOP and in the early stages of glaucoma were more likely to benefit from MLT in lowering IOP. A randomized clinical trial is necessary to confirm the preliminary results seen in this study. We recommend that clinicians should consider MLT in the management of early glaucoma and among those with IOP >16 mmHg.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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