Efficacy of micropulse (subthreshold) argon laser trabeculoplasty in primary open angle glaucoma

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Efficacy of Micropulse (Subthreshold) Argon Laser Trabeculoplasty in Primary Open-angle Glaucoma

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Abstract

Background: Primary open-angle glaucoma (POAG) is an adult-onset, slowly progressing optic neuropathy characterized by the atrophy of the optic nerve and the death of retinal ganglion cells and their axons over time. The introduction of micro pulse laser trabeculoplasty (MLT) has allowed for the safe and effective treatment of several retinal maculopathies. This is achieved using a duty cycle algorithm that provides subthreshold therapy to ocular tissues without scar formation.

Objective: Evaluation of subthreshold MLT efficacy in primary open-angle glaucoma management.

Methods: We conduct a randomized prospective case series study of primary open-angle glaucoma cases. Including 40 eyes of patients with primary open-angle glaucoma. This research was carried out at Bab El-Sharea University Hospital’s Ophthalmology Department.

Results: This investigation comprised 40 patients’ eyes. Patients mean age was 55.50 ± 6.78 years. 12 patients were males and 28 females. Cup-disc ratio mean pretreatment was 0.56 ± 0.083 all the patients were on medications. Per-session, on average, 120 burns were administered. The average preintraocular pressure was 19.50 ± 2.26 and the postlaser intraocular pressure (IOP) at second hour postlaser, first day, first week, fourth week, 12th week, 24th week, 18.75, 18.70, 17.20, 16.15, 16.20, 15.90 mmHg, respectively. The mean reduction in IOP (%) at the first day, 1 week, 4 weeks, 12 weeks, and last follow-up was 4.1%, 12%, 17.2%, 16.9%, 18.5%. There is a clinically significant difference between mean the baseline IOP and the postlaser intraocular pressure at different follow-up times except after first day where there are no clinically significant differences.

Conclusion: Subthreshold micro pulse trabeculoplasty is a safe procedure has no eye complications. It is effective as an adjuvant treatment in patient with primary open-angle glaucoma. As MLT has no eye complications it can be repeated safely if the response is poor after three months or IOP got elevated later. It is effective as a first-line therapy for open-angle glaucoma, especially normal-tension glaucoma.

Keywords: Argon laser trabeculoplasty, Efficacy of micropulse, Primary open-angle glaucoma

1. Introduction

About 8% of all blindness is caused by glaucoma, making it the main cause of permanent blindness and the second greatest cause of blindness globally. Progressive optic neuropathy, acquired atrophy, and the death of retinal ganglion cells and their axons are all symptoms of the chronic condition known as primary open-angle glaucoma. By gonioscopy, an open anterior chamber angle is linked with this disease. The most important risk factor is elevated intraocular pressure.1

Retinal nerve fiber layer injury and visual field loss can be avoided if intraocular pressure (IOP) is reduced.2 Using topical antiglaucoma drugs prior to surgery can help reduce IOP and reduce the risk of complications.3 Wise and Witter, in 1979, documented the first laser trabeculoplasty using an argon laser.4 Selective laser trabeculoplasty (SLT) was first used by Latina and Park in 1995.5 After then, both became commonplace in the management of open-angle glaucoma (OAG), showing promise in lowering IOP and avoiding the negative effects of topical drugs.6 Multiple studies have demonstrated that the two methods are equivalent in their success rates. SLT, on the other hand, has the benefits of not scarring the trabeculum and being easily repeatable.7 Micro
pulse laser trabeculoplasty (MLT) is a relatively new technique used to treat a variety of retinal maculopathies. It employs a duty cycle algorithm to give subthreshold therapy to ocular tissues without scar formation, making it safe to put the laser even directly over the fovea.  
Inducing a biological reaction in the trabecular meshwork with minimum damage to the trabeculum in a shorter amount of time than would otherwise be possible due to the heat diffusion to surrounding tissues. Concerns remain about its effectiveness.  
So, our study aim was evaluation of subthreshold MLT efficacy in primary open-angle glaucoma management.

2. Patient and method

We conduct a randomized prospective case series study of primary open-angle glaucoma cases. Including 40 eyes of patients with primary open-angle glaucoma. This research was carried out at Bab El-Sharea University Hospital’s Ophthalmology Department.

2.1. Inclusion criteria

Individuals over the age of 20 who have been diagnosed with primary open-angle glaucoma and are receiving either the best medical therapy possible or no treatment at all are considered primary cases.

2.2. Exclusion criteria

Patients having a history of laser trabeculoplasty, cyclophotocoagulation, or other glaucoma operations, as well as those with secondary glaucomas: as congenital glaucoma, juvenile open-angle glaucoma, neovascular glaucoma, end stage glaucoma angle-closure glaucoma as well as Uveitic glaucoma.

(1) Complete ophthalmological examination before laser procedure including: Goldmann's applanation tonometry for intraocular pressure recording; Goldmann's 3-mirrors contact goniolens for angle examination (Fig. 1), best corrected visual acuity, retina and optic disc evaluation, visual field.

(2) Informed consent the patients signed a consent for procedure including, advantages, disadvantages and risks of possible complications.

(3) Procedure technique and follow-up of MLT conducted with the IRIS Medical Oculight SLx 532 IQ Argon Laser System (IRIDEX Corporation, Mountain View, CA, USA). Immediately before to the MLT procedure, the patient's eyes were numbed with two drops of topical anesthetic (0.4% benoxinate). Patients sat at the slit-lamp, and an inner face guide and a specific MLT lens were used to accurately fire 10 confluent laser pulses into the eye every hour. The MLT Mode selected a spot size of 300 m, a power of 1000 mW, a duration of 300 ms, and a duty cycle of 15% (Fig. 2).

Careful attention was paid to directing the laser beam onto the anterior trabecular meshwork, where 120 laser dots were uniformly spaced out over the whole trabecular meshwork. Diclofenac 0.1% eye drops were used immediately after the procedure and for the next five days, three times a day. The patients continued taking the medications they were taking before therapy. After the second hour, first day, 1
week, 4 weeks, 12 weeks and 24 weeks following MLT, intraocular pressure readings were taken.

2.3. Statistical analysis

SPSS (Statistical Package for the Social Sciences) version 22 for Windows was used to enter codes, process data, and generate results (IBM SPSS Inc, Chicago, IL, USA). The Shapiro–Wilk test was used to check if the data followed a normal distribution. Quantitative information was shown as percentages and frequencies. The $\chi^2$ test is used to compare the differences between two or more sets of qualitative data. Calculations were done using a mean and standard deviation format for quantitative data (Standard deviation). Two sets of normally distributed data were compared using the independent samples $t$-test (parametric data). When the probability level was less than 0.05, it was judged to be statistically significant.

3. Results

Table 1 showed the base line demographic characteristics. This investigation comprised 40 patients’ eyes. The mean age of the patients was $55.50 \pm 6.78$ years. 12 patients were males and 28 females. Cup–disc ratio mean pretreatment was $0.56 \pm 0.083$ all the patients were on medications. Persession, on average, 120 burns were administered. The average preintraocular pressure was $19.50 \pm 2.26$ and the postlaser IOP at second hour postlaser, first day, first week, fourth week, 12th week, 24th week. $18.75, 18.70, 17.20, 16.15, 16.20, 15.90$ mmHg, respectively (Table 1).

Regarding IOP(%) mean reduction at the first day, 1 week, 4 weeks, 12 weeks, and last follow-up was $4.1\%, 12\%, 17.2\%, 16.9\%, 18.5\%$ (Table 2).

There was a clinically significant difference between mean the base line IOP and the postlaser intraocular pressure at different follow-up times except after first day where there is no clinically significant differences (Table 3 and Fig. 3).

Table 1. Baseline demographic characteristics ($n = 40$).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>$55.50 \pm 6.78$</td>
</tr>
<tr>
<td>Cup/disc ratio</td>
<td>$0.56 \pm 0.083$</td>
</tr>
<tr>
<td>Follow-up</td>
<td>24 weeks</td>
</tr>
<tr>
<td>Sex</td>
<td>Male 12 (30%), Female 28 (70%)</td>
</tr>
<tr>
<td>Lens</td>
<td>Clear 14 (35%), NS 14 (35%), N II 6 (15%), AC.PC 6 (15%)</td>
</tr>
<tr>
<td>Medical treatment</td>
<td>Xalatan 12 (30%), Twinzole 12 (30%), Alpha Nova 16 (40%)</td>
</tr>
<tr>
<td>IOP (mmHg)</td>
<td>Preoperative 19.50 ± 2.26</td>
</tr>
<tr>
<td>IOP (mmHg)</td>
<td>Postoperative 18.75 ± 2.31</td>
</tr>
<tr>
<td></td>
<td>1st day 18.70 ± 3.31</td>
</tr>
<tr>
<td></td>
<td>1st week 17.20 ± 2.26</td>
</tr>
<tr>
<td></td>
<td>4 weeks 16.15 ± 2.01</td>
</tr>
<tr>
<td></td>
<td>12 week 16.20 ± 2.02</td>
</tr>
<tr>
<td></td>
<td>24 week 15.90 ± 1.92</td>
</tr>
</tbody>
</table>
The mean IOP at the beginning of the study was significantly related to the mean IOP at subsequent time points. No adjustments were made to the patients’ medication schedules from before therapy began. At the subsequent follow-up, no patients showed any signs of a serious inflammatory response. The pressure never suddenly increased. When we last checked in with our patients, none of them had developed peripheral anterior synechiae. All eyes maintained the same levels of visual acuity (Table 4).

4. Discussion

Invisible, repeating, brief laser pulses are applied to the trabecular meshwork by the subthreshold micropulse laser technology. Each one of these pulses is separated by a substantial period of rest. Micropulse trabeculoplasty uses 15% duty cycle instead of a continuous 100% duty cycle laser wave, so that targeted tissue maintain temperature and remains viable. Also, Trabeculoplasty using micropulse technology does not lead to a coagulative reaction, intraocular pressure spikes, pigment dispersion, or significant inflammatory response.9

This prospective case series study set out to see if MLT might successfully reduce pressure in eyes being treated for POAG. The average decrease in IOP from baseline to follow-up in this investigation was 18.5%, which is similar to the results published by Ingvolstad and colleagues9 (18.3% reduction in IOP) and greater than the results of prior studies, by Detry-Morel and colleagues10 with Micropulse diode laser trabeculoplasty (MDLT) showing 12.2% decreases in IOP by the third month. Gossage11 revealed that at 4 months, the patient’s IOP had decreased by 18%, which was the target.

Some studies obtain higher IOP reduction after MPLT, Foa and colleagues12 performed Micropulse diode laser trabeculoplasty on a group of 20 patients with a 12-month follow-up period; IOP decreased by 21.3%; IOP decreased by greater than 20% in 10/15 eyes (66.7%) as compared with previous research wherein only 35.7% of patients had success with similar reductions. Other researchers, like as Lee and colleagues,8 found a similar decrease in IOP of 19.5% after 6 months, with 72.9% (n = 35) of patients seeing an IOP reduction of 20% or more in the first month.

Recently, Ahmed13 reported their experience in using MLT with 532 nm wavelength in patients with open-angle glaucoma. The identical spot size (300 m), duration (300 ms), and duty cycle (15%) were employed for all treatments. Nonetheless, they contrasted the results of employing various

<table>
<thead>
<tr>
<th>Variables</th>
<th>Paired Differences</th>
<th>95% Confidence interval of the difference</th>
<th>t</th>
<th>Significance</th>
</tr>
</thead>
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<tr>
<td>Mean</td>
<td>Std. deviation</td>
<td>Std. error mean</td>
<td></td>
<td></td>
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<tr>
<td>Base line IOP – 2nd hour</td>
<td>0.750</td>
<td>0.638</td>
<td>0.143</td>
<td>0.451 - 1.049</td>
</tr>
<tr>
<td>Base line IOP – 1st day</td>
<td>0.800</td>
<td>2.375</td>
<td>0.531</td>
<td>–0.312 - 1.912</td>
</tr>
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<td>Base line IOP – 1st week</td>
<td>2.300</td>
<td>0.656</td>
<td>0.147</td>
<td>1.993 - 2.608</td>
</tr>
<tr>
<td>Base line IOP – 4th week</td>
<td>3.350</td>
<td>0.875</td>
<td>0.196</td>
<td>2.940 - 3.759</td>
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<tr>
<td>Base line IOP – 12th week</td>
<td>3.300</td>
<td>0.470</td>
<td>0.105</td>
<td>3.079 - 3.520</td>
</tr>
<tr>
<td>Base line IOP – 24th week</td>
<td>3.600</td>
<td>0.502</td>
<td>0.112</td>
<td>3.365 - 3.835</td>
</tr>
</tbody>
</table>
power levels: 13 eyes of 13 patients at 300 mW; 14 eyes of 14 patients at 700 mW; and 15 eyes of 15 patients at 1000 mW (18 eyes of 18 Patients) IOP was shown to be most effectively reduced at 1 and 4 months with a power level of 1000 mW. They thought that the greater force would have a more permanent impact.

4.1. Conclusion

In conclusion, subthreshold micro pulse trabecuoplasty is a safe procedure has no eye complications. It is effective as an adjuvant treatment in patient with primary open-angle glaucoma. As MLT has no eye complications it can be repeated safely if the response is poor after three months or IOP got elevated later. It can be used as primary treatment for open-angle glaucoma particularly normal-tension glaucoma.

We recommend larger number of subjects and follow-up for a longer period of time (years) is required to proof the effect of MLT over time. We need randomize controlled trials to show the response of primary cases without previous medical treatment (virgin eyes) and compare MTP with antiglaucoma medications, ALT or SLT.

Author contribution

Authors contributed equally in the study.

References


Table 4. Correlations.

<table>
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<th>Variables</th>
<th>N</th>
<th>Correlation</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Base line IOP &amp; _2nd h</td>
<td>40</td>
<td>0.961</td>
<td>0.000</td>
</tr>
<tr>
<td>Mean Base line IOP &amp; 1st day</td>
<td>40</td>
<td>0.697</td>
<td>0.001</td>
</tr>
<tr>
<td>Mean Base line IOP &amp; 1st week</td>
<td>40</td>
<td>0.958</td>
<td>0.000</td>
</tr>
<tr>
<td>Mean Base line IOP &amp; 4th week</td>
<td>40</td>
<td>0.923</td>
<td>0.000</td>
</tr>
<tr>
<td>Mean Base line IOP &amp; 12th week</td>
<td>40</td>
<td>0.982</td>
<td>0.000</td>
</tr>
<tr>
<td>Mean Base line IOP &amp; 24th week</td>
<td>40</td>
<td>0.984</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Fig. 3. There was a significant correlation between the mean base line IOP and the mean IOP at different follow-up times.

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Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Conflicts of interest

There are no conflicts of interest.


