

Micropulse transscleral diode laser cyclophotocoagulation a safe treatment for recalcitrant glaucoma with good visual potential using different laser source on MicroPulse MP3 probe.

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Abstract

Glaucoma is a challenging ocular disease with different but limited treatment approaches. Diode laser through sclera is a traditional way to decrease IOP in advanced glaucomatous eyes, but with micropulse (microsecond pulsing) delivery system it became safer and more effective. In this study we retrospectively summarized IOP changes in eyes that had been treated by micropulse transscleral diode laser cyclophotocoagulation. we focused on glaucomatous eyes that had relatively good visual acuity and we used a new combination of two devices from two different companies which were infrared 810 nm laser source from (LIGHTMED CORPORATION, Tuscan, TAIWAN) with different delivery system the MicroPulse MP3 handpiece probe from (Iridex, Mountain View, CA, USA) in this way we decrease cost and showed a comparable effectivity .

Background

Glaucoma is one of the challenging diseases worldwide. It is a slowly progressive optic neuropathy. The number of patients with disease are estimated to increase by 2020 to 76 million and to 111.8 million by 2040(1).Researches are focusing on new treatment modalities with least side effects possible. The main goal of all medical, laser and surgical therapy is to decrease intraocular pressure (IOP) which is the main adjustable risk factor and decrease it slows down the progression of degenerative changes(2).

Medical management of glaucoma is still the most accessible initial therapy with comparable visual field result in 5 years follow up to initial surgical therapy (3).Medical therapy has compliance issue while surgical therapy has a high complication rate or high cost.

Laser therapy in glaucoma provides a remote access to the tissue of interest without surgically-induced tissue damage. Three types of laser have been used. The first is the Nd:YAG laser which used in selective laser trabeculoplasty (SLT). The second is the Argon laser which is primarily used in Argon laser trabeculoplasty (ALT) and the third is the diode laser which is used in cyclophotocoagulation (CPC)(4).

Transscleral cyclophotocoagulation (TSCPC) depends on diode laser (810 nm wavelength) and delivers laser through sclera. The laser beam is absorbed by melanin in the ciliary body which causes coagulation in affected tissue harboring melanin and the surrounding structures. This aggressive nature results in increasing complication rates like hypotony, loss of vision and phthisis bulbi. These serious complication limit the clinical application of TSCPC to late stage advanced glaucoma with low visual potential(5).

The micropulse (microsecond pulsing) laser was introduced to reduce these complications by distributing energy in less aggressive manner. It delivers energy in short pulses (microsecond) about 0.5ms energy is on and 1.1ms energy is off. The time of delivering energy of total treatment time would be called a "duty cycle " which is fixed on 31.3%.(6)

The mechanism of action in mTSCPC is depend on increasing uveoscleral outflow that could be inferred from increase in choroidal thickness after mTSCPC that has been demonstrated in Barac et al study

where all responsive patients had a thicker choroid one week after the laser treatment, while in non-responsive patients, the choroidal thickness remained the same postoperatively(11).

Murray Johnstone et al converted in their experimental study the total energy to Joules. Joules (J) = power in Watt (W) x total treatment duration in seconds (s) x ON cycle(31.3%). The ideal parameter ranged from 112 to 150 J (power is 2 w and the time ranged from 180 to 240 seconds(7)

Several studies had demonstrated safety and efficacy of mTSCPC in treating glaucomatous eyes in one study with short follow up(60 days) of 19 patients with advanced glaucoma showed 40% decrease in IOP (8).Another study with longer follow up (1.8 year) of 73 patients showed a 57% reduction in IOP and decrease in IOP-lowering medication(6)

In this non-comparative study we demonstrated outcomes of mTSCPC on long-term follow up in different types of glaucoma in patients with good visual potential but with complex glaucoma cases where there were no other treatment options or in which mTSCPC was a risk- free choice.

Methods

This is a retrospective non-comparative case series of 49 patients were diagnosed with glaucoma that resist conventional treatment at Safa eye Center, Damascus, Syria from January 2017 to April 2019.The micropulse (microsecond pulsing) infrared diode laser source were used in the study is (LIGHTMED CORPORATION, Tuscan,TAIWAN) on the other hand t,he delivery system was using MP3 probe (Iridex, Mountain View, CA, USA) (Figure 1). The power was 2 Watt and the time ranged from 150 to 200 seconds with fixed duty cycle 31.3% on with total energy between 93 and 125 J. The number of shots was 50 in each session each shot's duration was 3 seconds.

Inclusion criteria are recalcitrant glaucoma which defined as:

IOP>21 mmHg with maximal medical therapy

Eyes with recurrent glaucoma after maximal surgical therapy

A minimum follow-up 2 months

The procedure was performed by a single surgeon(AA) in the outpatient setting. General sedation was given.180 degree avoiding the nasal and temporal clock hours and also the region with previous filtration surgeries (trabeculectomy)

Types of glaucoma were: POAG, NVG, Congenital glaucoma, trauma induced, silicon induce.

The IOP was measured using Keeler Non-contact Tonometer Tonocare (Keeler ophthalmic instrument, UK) and Topcon Non-contact Tonometer CT-80 (Topcon, Japan).

Relative success was defined as IOP 6–21 or 25% or more reduction from baseline with or without IOP lowering medication with stopping oral carbonic anhydrase inhibitor.

The outcomes were: success rate, retreatment rate, time of follow up.

The study followed the tenants of the Declaration of Helsinki and was approved by the affiliated Safa eye center's ethics review committee with collaboration with Higher Commission For Scientific Research.

Results

We treated 49 eyes of 39 patients, 10 patients had glaucoma in both eyes. The main characteristics of study group were summarized in table 1. Mean age was 46 ± 23.4 . Gender was distributed as 40.8% (n 20) male and 59.2% (n 29) female. The sample was categorized according to glaucoma type as following:: primary open angle glaucoma (POAG) 30 (61%), neovascular glaucoma (NVG) 8 (16.4), congenital glaucoma (n) 8 (16.4), traumatic induced glaucoma 2 (4%), silicon oil induced glaucoma 1 (2%)

9 eyes have had previous glaucoma surgery (trabeculectomy, Ahmad valve). one eye had Ozurdex implant, 4 eye had previous vitrectomy /silicon oil, and one eye had corneal transplant.

35 (71%) eyes had good visual acuity 0.05 or more (on Tumble E chart) which considered a good visual potential. 10 (20%) eyes their patients were incorporated, 2 (4%) was NLP (no light perception), 2 (4%) was LP/HM (light perception / hand motion). At end of follow up the visual acuity was remained stable in all patients' eyes without decline and without any report of vision loss.

The mean pre-operative IOP was 38.2 ± 11.4 mm Hg. The mean post-operative IOP at 1 week was 25.3 ± 8.4 mm Hg and at the end point was 18.7 ± 7.5 mm Hg ($P = 0.000$). Average IOP at end point was reduced by 19.5 mm Hg (51 %)

The mean follow up was 6.5 months (max 20 and min 2), the mean number of sessions needed was 2.38 (max 6 and min 1).

The success rate was defined as 25% reduction. The patients were monitored after one week, one month, two months, three months, six months, and 12 months. Retreatment sessions were secluded at any point the IOP was more than 21 mm Hg.

24 (49%) patients were followed for less than 6 months. 25 (51%) were followed form 6 months to 20 months. The mean IOP reduction according to follow up were summarized in the table2.

28.6% of treated eyes needed only one session while 70.4% needed more than one session. The mean IOP reduction according to treatment session was summarized in Table 3.

IOP reduction rate were similar in different glaucoma type (Table 4,Figure 2). Also, the mean follow-up periods were close to each other in all types (Table 5).One eye had hypotony which was transient and

improved after one week.

Discussion

The study had several limitations, but it added innovative idea to the literature. Retrospective nature of the study and loss of follow up beside small number of the sample were some of its limitations. The most important idea in this study was we were able to use a new combination of two devices from two different companies which was infrared 810 nm diode laser (LIGHTMED CORPORATION, Tuscan, TAIWAN) with the MicroPulse MP3 handpiece probe (Iridex, Mountain View, CA, USA). MP3 probe was used without any limit. The mTSCPC provided a safe and least aggressive procedure to glaucomatous eyes with good visual potential and where other procedures carried some risk of losing eye. This new way was effective in decreasing IOP the mean pre-operative IOP was 38.2 ± 11.4 mm Hg, While the mean post-operative IOP at the end point was 18.7 ± 7.5 mm Hg ($P = 0.000$) and the mean follow up was 6.5 months (max 20 and min 2). In Sarrafpour et al study that showed that the average initial IOP was 25.5 ± 9.4 , and at 1 year, average IOP was 13.8 ± 7.0 (6). In Kuchar et al study 19 patients underwent mTSCPC the mean IOP decreased from 37.9 mmHg preoperatively to 22.7 mmHg at with mean follow-up of 60.3 days (8). In Tan F et al study showed that mean IOP was significantly reduced from the preoperative mean of 40.1 ± 11.6 mmHg to 24.6 ± 9.6 at final follow-up and the mean follow-up period was 16.3 ± 4.5 months (9). In Nguyen et al study the mean pre-operative IOP was 25.1 ± 5.3 mm Hg and the mean post-operative IOP at 12 months was 17.5 ± 5.1 mm Hg (10). In Emanuel et al 's retrospective study on 84 eyes with a mean follow-up time of 4.3 months the mean IOP was 27.7 mm Hg preoperatively and the mean postoperative IOP at months 1, 3, 6, and 12 were lowered to 16.3, 14.6, 13.0, and 11.1 mm Hg (12).

Micropulse diode laser proved that it is safe. In Kuchar et al study (8) no patient lost light perception vision and one case out of 19 developed hypotony. In Sarrafpour et al study (6) with long term follow up no patient developed macular edema or phthisis. 10% of patients with light perception to count finger vision progressed to no light perception after 1 year of follow up which could be due to glaucoma progression. In our study visual acuity of 35 (71%) eyes was 0.05 or more (on Tumble E chart) which considered a good visual potential. The visual acuity was stable at the end of the study.

The ideal parameter for mTSCPC was discussed in detail in one study (7) which showed that a total energy that ranged between 112 and 150 J allowed a moderate IOP lowering effect of around 30% with few/no complications. In our study the power was 2 watt and the time ranged from 150 to 200 seconds with fixed duty cycle 31.3% on, with total energy between 93 and 125 J. The number of shots was 50 in each session each shot's duration was 3 seconds.

A new approach for complex glaucoma cases like NVG or glaucoma after PK where the eye had good visual acuity and the surgeon needed a least invasive intervention without any risk of losing the eye.

Conclusion

The most important in our study was that we designed a new low-cost and effective method in applying mTSCPC and we proved the affectivity and safety of mTSCPC in lowering IOP in glaucoma patients with good visual potential.

Abbreviations

mTSCPC: Micropulse transscleral diode laser cyclophotocoagulation

MP3 MicroPulse

TSCPC Transscleral cyclophotocoagulation

IOPintraocular pressure

Nd:YAG laser neodymium-doped yttrium aluminum garnet; Nd

SLT selective laser trabeculoplasty

ALT Argon laser trabeculoplasty

CPC cyclophotocoagulation

TSCPC Transscleral cyclophotocoagulation

NLP no light perception

PK Pentrating Keratoplasty

POAG primary open angle glaucoma

NVG Neovascular glaucoma

Declarations

Ethics approval and consent to participate

Written informed consent was obtained from all participants prior to data collection. The study was approved by Safa eye center ethics committee with collaboration with Higher Commission For Scientific Research

Consent to publish

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during this study are available from the corresponding author on any request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

AA contributed to the conception, design, the procedure, patient's follow up, revising the manuscript critically. AH contributed to data collection, statistical analysis, data interpretation, drafting the article and in preparing the manuscript. Both authors revised the final version of the manuscript and approved it for publication.

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Tables

Table 1

Mean	Variable
±23.4 46	Age
(40.8%) 20	Male
(59.2%) 29	Female
(51%) 25	Diabetes Meletus
(months(max 20 and min 2 6.5	Follow up period
(max 6 and min 1)2.38	Session number
Glaucoma type	
(61%) 30	(Primary open angle glaucoma (POAG
(16.4%) 8	Congenital glaucoma
(16.4) 8	(Neovascular glaucoma (NVG
(2%) 1	Silicon induced glaucoma
(4%) 2	Traumatic induce glaucoma

Table 2

Total reduction % in OP	End of follow up IOP	1week post-op IOP	Pre-op IOP	Follow up periods
(47.5%) 18.2	± 8.5 20.12	26.25 $8.5 \pm$	38.33 ± 10.7	Less than 6 months
(54.3%) 20.7	± 6.1 17.4	± 8.5 24.56	38.12 ± 12.2	From 6 months to 20 months

Table 3

P value	IOP reduction rate	End of follow up IOP	Pre-op IOP	Number of patients	Treatment sessions
0.000	45.9%	18.5	43.7	(53.1%) 26	One to two session
0.000	46.8%	18.6	37.1	(46.9%) 23	Three to six session

Table 4

P-value	IOP reduction rate	End of follow up IOP	pe-op IOP	Number of eyes	Glaucoma type
0.000	(19.5)51%	18.7 ± 7.4	38.2 ± 12.9	(61%) 30	Primary open angle glaucoma ((POAG
0.004	(18.9)55.3%	15.3 ± 5.7	34.2 ± 9.8	(16.4%) 8	Congenital glaucoma
0.001	(22.4)51.3%	21.3 ± 9.2	43.7 ± 8.4	(16.4) 8	(Neovascular glaucoma (NVG
0.467	(20.1)51.9%	19 ± 12.7	39.5 ± 13.4	(4%) 2	Traumatic induce glaucoma
0.465	(9.2)31.1%	21 ± 1.2	30.5 ± 10.6	(2%) 1	Silicon induced glaucoma

Table 5

Mean number of sessions	Mean follow up periods	Glaucoma type
2.4	6.6	(Primary open angle glaucoma (POAG
2.8	7.5	Congenital glaucoma
2	6.3	(Neovascular glaucoma (NVG
2	2.5	Traumatic induce glaucoma
1.5	7	Silicon induced glaucoma

Figures



Figure 1

Truscan laser source settings with MP3 probe from Iridex

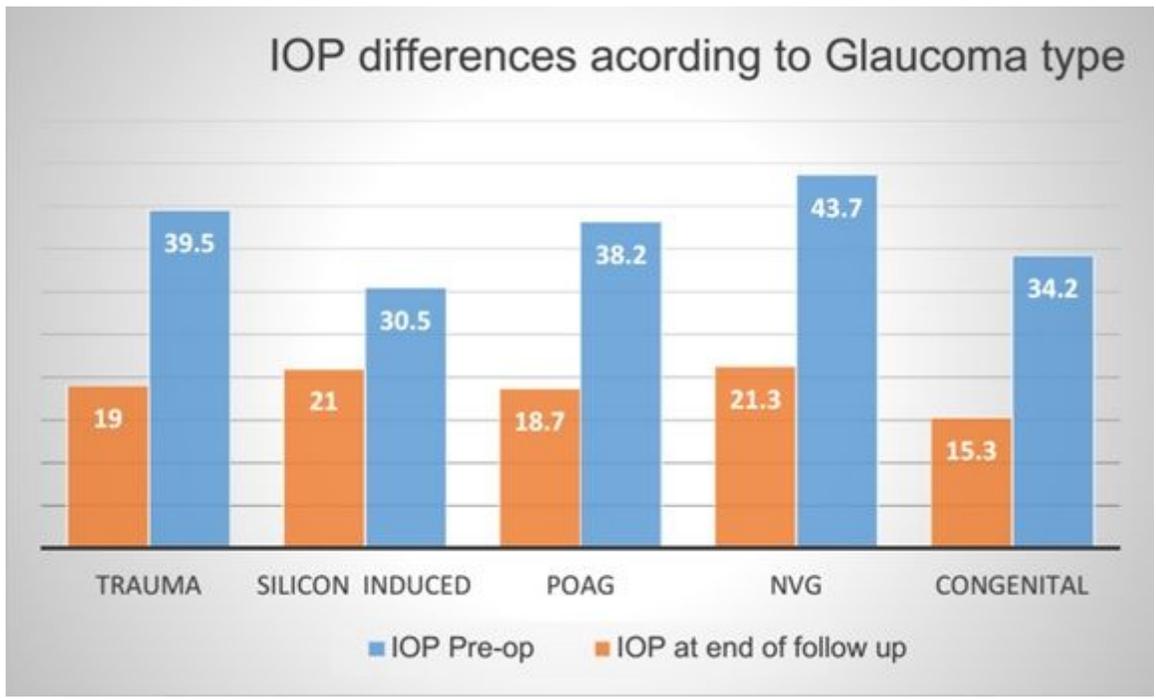


Figure 2