RESEARCH ARTICLE

pISSN: 0126-074X | eISSN: 2338-6223
https://doi.org/10.15395/mkb.v54n3.2648
Majalah Kedokteran Bandung. 2022;54(3):166–171

Majalah Kedokteran Bandung (MKB)

Received: January 26, 2022
Accepted: July 4, 2022
Available online: September 30, 2022

Efficacy and Safety of Micropulse Transscleral Cyclophotocoagulation Use in Refractory Glaucoma Patients

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Abstract

Glaucoma is the leading cause of irreversible blindness worldwide. Micropulse Transscleral Cyclophotocoagulation (MP-TSCPC) is a new method for treatment for refractory glaucoma with lesser complications than coventional TSCPC. This study aimed to evaluate the effectiveness and safety of MP-TSCPC (IRIDEX IQ810 Laser systems, CA) for refractory glaucoma treatment. This was a retrospective study using data obtained from the medical records of patients who underwent a MP-TSCPC procedure at Cicendo National Eye Hospital from July 2018 to September 2019. The outcomes measured were success rate (IOP decreased ≥30% from baseline with or without anti glaucoma medication at first month follow up) and post-operative complications. Fifty-seven eyes from 56 patients with a mean age of 57 years old underwent MP-TSCPC with 3 month follow up. The mean pre-operative intraocular pressure (IOP) dropped from 51.8 mmHg to 36.0 mmHg at 1 month follow up and 36.8 mmHg at the final follow up, representing an IOP decrease of 31% (1 month) and 28% (3 month). There was also a decrease of anti glaucoma medication usage from 2.51 to 2.16. The overall success rate at 1 month follow up was 49% and only 5% complication were found in this study. MP-TSCPC is safe and effective for lowering IOP and decreasing the need of anti glaucoma -medications in refractory glaucoma case. Further long-term evaluation and comparison to conventional TSCPC are still necessary.

Keywords: Glaucoma, laser, micropulse transscleral cyclophotocoagulation

Introduction

Glaucoma is the most common cause of irreversible blindness in the world. The prevalence of blindness in Indonesia in the population aged over 50 years old based on the Rapid Assessment of Avoidable Blindness (RAAB) in 2014–2016 is around 3%, with glaucoma being the second most common cause of blindness, which is around 1.8%. Open-angle glaucoma is common in African and European populations whereas angle-closure glaucoma is common in Asian populations. Glaucoma treatment aims to maintain visual function and reduce intraocular pressure (IOP). This can be achieved by increasing the excretion of aqueous humor such as through surgical filtration or decreasing the production of aqueous humor by cyclodestructive procedure.. [1-3]

Transscleral cyclophotocoagulation (TSCPC) is a cyclodestructive procedure that targets a diode laser on the ciliary body to reduce the production of aqueous humor. Continuous wave TSCPC (CW-TSCPC) is a conventional TSCPC that is often associated with serious complications including uveitis, hypotony, and blindness to phthisis bulbs. This is the reason why TSCPC is generally the final choice for refractory glaucoma or palliative therapy for painful eyes with poor visual prognosis. [3-6]

In the last decade, micropulse TSCPC has been introduced. This mode produces short but repetitive serial energies. It aims to reduce extensive tissue damage by shooting the tissue more selectively. This observational study aims to assess the effectiveness and safety of using micropulse transcleral cyclophoto-coagulation (MP-TSCPC) in refractory glaucom.[7-9]

Methods

This study was conducted retrospectively from the medical record data of patients who had MP-

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TSCPC procedures performed at the National Eye Center of the Cicendo Eye Hospital (PMN RSMC) from July 2018 to September 2019. The inclusion criteria in this study were as follows:

First, patients with refractory glaucoma defined as intraocular pressure (IOP) >21 mmHg with maximal tolerable medical therapy, with or without a history of previous glaucoma surgery; (2) perform routine control for at least 1 month after the laser. Exclusion criteria in this study were patients who were experiencing ocular infection or inflammation.

The MP-TSCPC procedure was performed in monitoring anesthesia care (MAC) and peribulbar block using a combination of 0.5% bupivacaine and 2% lignocaine hydrochloride 100 mg/5 mL in 3–5 mL. The laser machine used was Micropulse P3 (IRIDEX IQ810 Laser system, Mountain View, CA, USA). The 810 nm infrared diode laser will be transmitted using the micropulse method, which is 0.5 ms on phase and 1.1 ms off phase (31.3% duty cycle).

The engine power on the IRIDEX IQ810 and the duration of each quadrant are adjusted based on the IOP of the preoperative patient, namely power 2,000 milliwatts (mW) for 50 seconds for IOP 20–30 mmHg, power 2000 mW for 60 seconds for IOP 30–40 mmHg, power 2,100 mW for duration 60 seconds for IOP 40–50 mmHg, power 2,200 mW duration 60 seconds for IOP 50–60 mmHg, and power 2200 mW duration 70-90 seconds for IOP >60 mmHg. Laser power is recorded in milliwatts, duration is in seconds, and the total laser energy in joules is calculated using the formula power (W) x total duration (s) x on cycles (31.3%). The total energy is classified into 3 groups, namely the low energy group (≤ 100 Joule), medium (101–200 Joule), and high energy group (>200 Joule).

The probe presses against the sclera-like pencil pressure during the writing and is moved continuously along the limbus from 9.30 to 2.30 and vice versa in the superior quadrant and from 3.30 to 8.30 and vice versa in the inferior quadrant. Post-laser patients were given topical 1% prednisolone acetate as much as 4x1 drops for the first week, then tapered off periodically and given oral paracetamol 3x500 mg as an analgesic. The use of anti-glaucoma drugs was adjusted to post-laser IOP at the time of control.

Periodic control was carried out on the first day, 1 week, 1 month, and 3 months after the laser treatment. Data collected from patient medical records were age, gender, IOP, basic uncorrected visual acuity, glaucoma type, lens status, previous glaucoma surgery history, number of antiglaucoma drugs used, power, duration, and total laser energy used, and complications. and post-laser pain. Basic visual acuity at pre- and post-laser was measured using the Snellen chart. Intraocular pressure was measured using a Goldmann applanation tonometer in mmHg and the average value of 2 measurements with a distance of 5 minutes was taken.

The criteria for success in this study included achieving an IOP reduction of 30% from baseline IOP with or without glaucoma medications at 1-month post-laser. All data were presented descriptively using univariate analysis and presented in the form of Tables and Figure.

Results

From July 2018 to September 2019, 57 eyes were obtained from 56 patients that filled the inclusion and exclusion criteria in this study. A total of 5 patients only visited the doctor for less than 1 month so they were excluded from this study.

In general, the clinical characteristics of patients can be seen in Table 1. In Table 1, 42% of patients are male and 58% of patients are female. The mean age of the patients was 57.2 (±12.8) years. The most common case was neovascular glaucoma with 38 eyes (66%) and followed by chronic angle closure glaucoma in 5 eyes (9%).

In total, only 34 eyes (59.6%) underwent routine control up to 3 months post-laser treatment. A total of 12 eyes had not reached the control period of 3 months, 10 eyes have only visited the doctor for 1 month after the laser, and 1 eye had evisceration in the second month after the laser due to severe pain. The average laser power used in this study is 2108.7 mW with an average duration of 69.3 seconds for each quadrant. The most used total energy was the

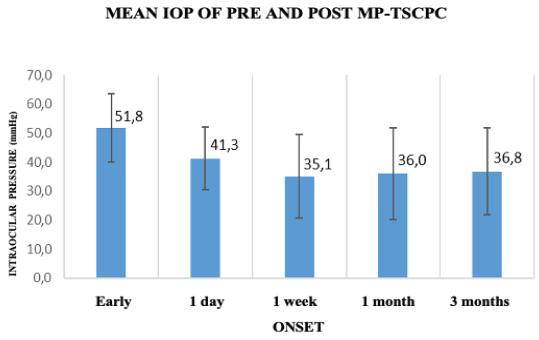

Figure 1 Mean IOP of Pre and Post MP-TSCPC

Table 1 Clinical Characteristics of Patients

Variable	Total (n=57)	Percentage (%)
Gender		
Male	33	42
Female	24	58
Age (years)		
≤40	3	5
>40	54	95
Mean ± SD	57.2	±12.8
Laterality		
Unilateral	55	96.5
Bilateral	2	3.5
Visual acuity		
≥6/18	1	2
6/60–6/18	1	2
3/60–6/60	0	0
1/60–3/60	1	2
LP-1/60	7	12
NLP	47	82
Diagnosis		
POAG	1	2
JOAG	2	3
PACG	3	5
CACG	5	9
NVG	38	66
Secondary Glaucoma		
Aphacic	1	2
Pseudophacic	1	2
Uveitic	1	2
Steroid induced	1	2
Angle recess	1	2
Others	3	5
Lens Status		
Phacia	40	70
Pseudophacia	15	27
Aphacia	2	3
History of Previous Glaucoma Surgery		
None	46	78
Trabeculectomy		
Conventional	3	5
Antimetabolit	1	2
Phacotrabeculectomy	0	0
SICS-trabeculectomy	1	2
GDD implant	1	2
Phacoemulsification-GDD	1	2
Conventional TSCPC	6	9

LP: light perception; NLP: no light perception; POAG: primary open angle glaucoma; JOAG: juvenile open angle glaucoma; PACG: primary angle closure glaucoma; CACG: chronic angle closure glaucoma; SICS: small incision cataract surgery; GDD: glaucoma drainage device

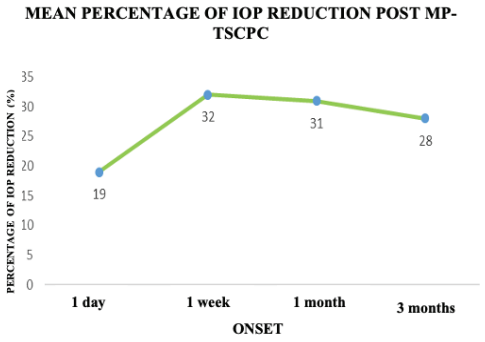

Figure 2 Mean Percentage of IOP Reduction Post MP-TSCPC

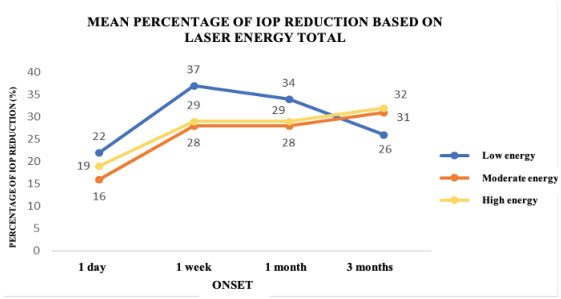

Figure 3 IOP Reduction based on Energy Total

low total energy group with 28 cases (49%).

Refer to figure 1 shows a decrease in the mean IOP from baseline to 3 months post-laser. Figure 2 shows an increase in the percentage of post-laser IOP reduction. Figure 3 compares the post-laser IOP reduction in each laser energy group.

Table 2 shows that there were 13 eyes (35%) that experienced a decrease in the number of post-laser anti-glaucoma drugs from an average of 2.51 to 2.16.

Table 3 shows that only 3 cases (5%) of post-laser complications were found, namely decreased post-laser vision, hyphema, and keratopathy. Post-laser complications and pain were assessed from control 1 week to 3

Table 2 Number of Post-Laser Anti Glaucoma Drugs

Variable	Total (n=57)
Number of Post-Laser Anti Glaucoma Drugs (mean±SD)	
Pre laser	2.51± 0.57
Post laser	2.16 ±0.59

Table 3 Postlaser Complication

Variable	Total (n=57)
Postlaser Complication (%)	
Decreased Visual Acuity Posterior	1 (2%)
Synechiae	0 (0%)
Hyphema	1 (2%)
Persisten iritis	0 (0%)
Keratopathy	1 (2%)
Hypotonia	0 (0%)
Supracoroidal Hemorrhage Retinal Detachment	0 (0%)
Choroidal effusion	0 (0%)

months post-laser. There are 7 eyes (12%) still experienced pain for up to 3 months after the laser. The effectiveness of MP-TSCPC in the first month reached 49% of cases (28 eyes), but only 19% of cases (11 eyes) were able to achieve IOP <21 mmHg.

Discussion

The use of cyclodestructive lasers for the treatment of glaucoma has been growing continuously in the medical community. In the last decade, MP-TSCPC was introduced which is stated to have superiority over conventional TSCPC (CW-TSCPC). One of the advantages of MP-TSCPC over conventional TSCPC is to gain rapid decrease of IOP effect that can be seen 1 day after laser treatment was conducted. The rapid fall in IOP may be due to increased uveoscleral flow due to post-laser inflammation and reduced aqueous humor production. Schubert et al and Liu et al also reported an increase in outflow in eyes lasered by the MP-TSCPC method.[10–12]

In this study, the mean percentage of IOP reduction in the low-energy laser group experienced a gradual decrease in effectiveness when entering the third month. This was different from the other 2 laser groups where there was a constant increase in effectiveness at the end of the third month. This is supported by the study of Sanchez et al.[14] where the use of energy 100 J will require repetition of the action more than 1x to maintain long-term effects. This is mentioned because of the pilocarpine-like effect as the main effect arising from micropulse lasers compared to photocoagulation in pigmented ciliary epithelium. The relaxation of the ciliary muscle, scleral spur, and trabecular meshwork that results from a micro pulse laser mimics that of pilocarpine. This effect is said to have a persistent effect when the total laser energy used is 150 J.[10,12-13]

The mean IOP reduction of patients in this study was 31% at 1-month post-laser. This is to previous studies. Aquino et al.[16] stated that the percentage decrease in the average IOP was around 39%, while Chew et al.[17] reported a decrease of 35.9% in the first month. Slightly higher results were obtained in the studies of Kuchar et al.[15] and Nguyen et al.[11] namely 40% at the first 2 months and 44% at 1-month post-laser treatment. However, in this study, the average IOP percentage decreased to 28% in the third month. This may be because the use of average total energy below 150 J only has a temporary decreasing effect.[14]

The success rate in this study was around 49%. The difference in the definition of success in this study from previous studies is due to differences in the initial IOP in the sample population. Another study by Nguyen et al.,[11] Lee et al.[19] and Sarrafpour et al.,[20] had a mean pre-laser IOP of 25–30 mmHg. Only one other study by Aquino and Chew[16] found that the mean pre-laser IOP was 43.3 mmHg. The mean initial IOP in this study was 51.8 mmHg so more than 1 repeat laser treatment was needed to achieve the target IOP of <21mmHg. This has an impact on the success rate of MP-TSCPC in this study which is lower than other studies, which is around 60–75%. On average, other studies carried out laser procedures more than once and also had a longer study duration. This difference in results may also be because several previous studies still used a decrease in IOP of 20% as a reference for success.

Sarrafpour et al.[20] said that as many as 43.2% of cases experienced a reduction in the use of anti-glaucoma drugs of at least 1 type during the first 1 year after the laser. The decrease in the mean number of anti-glaucoma drugs in this study was less than in previous studies. This may be since although the percent reduction in IOP is 30%, the IOP target has not reached <21 mmHg in some patients so the number of anti-glaucoma drugs cannot be reduced after laser surgery. Reducing the number of anti-glaucoma drugs themselves will provide benefits for patients because it reduces the risk of drug side effects and reduces patient treatment costs.[7,15,16]

In this study, 88% of patients did not experience post-laser back pain and only 5% had complications, namely decreased vision,

hyphema, and keratopathy. This is following the research of Aquino et al. which showed that the MP-TSCPC procedure had a lower complication rate than conventional TSCPC. This is due to the on and off cycle mode on MP-TSCPC compared to conventional TSCPC which still uses continuous energy. The existence of this mode causes a coagulative phase (on) in pigmented uveal tissue and provides cooling time (off) for the surrounding non-pigmented uveal tissue, thereby reducing unwanted tissue damage.[5, 21-24]

Kuchar et al.[15] reported a decrease in visual acuity of at least 1 line in 4 out of a total of 19 eyes treated with MP-TSCPC whereas 4 eyes experienced an increase in visual acuity. Another study by William et al.[21] also stated that as many as 17% of patients experienced a decrease in vision of 2 lines or more in the first 3 months. Slightly different results were found in this study, namely that 1 patient (2%) had decreased vision of more than 2 lines and 2 patients (4%) experienced an increase in the vision of at least 1 line. This is probably because the sample population in this study is dominated by NLP vision, making it difficult to validly assess post-laser visual impairment.[9]

The limitation of this study is that it is a descriptive study with small sample size and short follow-up duration. Further research is needed to analyze the effectiveness of MP-TSCPC laser therapy in the long term, the possible number of repeats of laser procedures in patients with very high initial IOP, the ideal power setting based on IOP, the relationship of total laser energy with complications that can arise and analysis of possible applications. MP-TSCPC in the eye still has visual potential. An additional suggestion for further research, it can be considered the use of total laser energy of 150 J to provide a persistent effect.

Based on this study, MP-TSCPC provides a good success rate in the treatment of refractory glaucoma patients. MP-TSCPC is relatively safe and effective for lowering IOP and reducing the frequency of post-laser drug usage. Repeat laser procedures may be required in patients with very high initial IOP.

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