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Comparison of the efficacy of micropulse diode laser transscleral cyclophotocoagulation using different energy protocols

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Abstract:

PURPOSE: This study aimed to explore the safety and efficacy of laser treatment settings of micropulse transscleral cyclophotocoagulation treatment in glaucoma patients and to evaluate the relationship between intraocular pressure (IOP) reduction and different treatment parameters.

MATERIALS AND METHODS: A total of 74 eyes in 64 glaucoma patients with IOP over 21 mmHg or under 20 mmHg with visual field progression who underwent micropulse transscleral cyclophotocoagulation treatment were included. Patients were divided into success and failure groups based on criteria of 20% IOP reduction rate. The predictive factors of IOP reduction between success and failure groups and the IOP reduction rates in the different treatment duration groups were evaluated. Predictive factors for IOP reduction were analyzed using univariate and multivariate regression models.

RESULTS: Patients in the success group had significantly higher baseline IOP (median: 28.0 vs. 23.0 mmHg; $P = 0.016$) and longer treatment times (median: 240 vs. 160 s; $P = 0.001$). Treatment duration range between 200 and 240 s achieved significantly higher intraocular pressure reduction rates (47.8 ± 17.4%) than durations under 140 s (23.1 ± 14.2%). Univariate analysis showed that baseline IOP and treatment duration were significant contributing factors in IOP reduction. Multivariable analysis further demonstrated that treatment duration over 200 s was the significant predictive factor for IOP reduction.

CONCLUSION: Treatment duration settings were the most significant factor of IOP reduction rates in micropulse cyclophotocoagulation. Customized therapy according to the target IOP reduction rate can be applied with different treatment duration settings to achieve optimal outcomes.

Keywords:

Diode laser, glaucoma, intraocular pressure, micropulse transscleral cyclophotocoagulation, treatment duration

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Introduction

Continuous-wave transscleral cyclophotocoagulation (TSCPC) has been used for treating refractory glaucoma for more than 20 years. Traditional TSCPC is a cyclodestructive procedure that provides a continuous diode laser to the targeted ciliary body, which reduces the production of aqueous humor for the reduction of intraocular pressure (IOP).[1] The traditional TSCPC has long provided good efficacy for IOP reduction in patients with refractory glaucoma. However, serious complications, including uveitis, vision loss, chronic hypotony, rarely phthisis bulbi, and sympathetic ophthalmia, have been observed in continuous-wave TSCPC.[2]

Micropulse TSCPC is a new diode laser system that delivers diode laser in micropulse mode using the Cyclo G6 system (Iridex, Mountain

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View, CA, USA), which is considered to be a novel and relatively safe treatment for glaucoma treatment. It provides an efficacious and nonincisional solution for treating uncontrolled IOP with maximal medications with only rare sight-threatening complications. Aquino *et al*.[3] discovered that continuous-wave TSCPC and micropulse CPC had similar efficacy in reducing IOP; however, micropulse CPC had a lower rate of complications. Regular energy setting parameters were suggested by the manufacturing company, such as setting the duty cycle to 31.3%, setting power to 2W, and the treatment duration to 80 s in each hemisphere. However, the regular parameters could not effectively reduce IOP in patients who had a high preoperative IOP. Only a few articles have reported the suitable intensity of laser energy for different IOP levels,[4,5] and therefore, consensus has not been reached. Higher energy may have better therapeutic effects; however, more side effects may occur after treatment, including the risk of hypotony, long periods of inflammation, and cystoid macular edema (CME). In contrast, lower laser energy reduces the side effects; however, elevated IOP may recur, and repeat treatment will be needed.

This study evaluated the safety and efficacy of micropulse TSCPC and compared different energy protocols to determine the correlation between energy settings and IOP reduction. We also observed possible side effects, such as visual acuity reduction and complications of the participants after the treatment.

Materials and Methods

This retrospective study included 74 eyes in 64 patients diagnosed with glaucoma who underwent micropulse TSCPC treatment by Dr. SHL Chang in Foresight Eye Clinic, New Taipei City, Taiwan, between November 2018 and March 2022. The study was conducted according to the Declaration of Helsinki and approved by the Institutional Review Board for Human Research of Keelung Chang Gung Memorial Hospital (202300788B0), and the patient consent was waived by the IRB. Patients who met the following criteria were included: patients with IOP >21 mmHg under maximal medication who could not reach target IOP, and patients with visual field progression with IOP within 10–20 mmHg. All patients had completed a thorough physical examination to understand their clinical condition before the procedure. IOP measurement with applanation tonometry, slit-lamp biomicroscopy, and fundus examination were performed preoperatively and at each follow-up visit.

Micropulse TSCPC was performed by Dr. SHL Chang in the operating room at the outpatient clinic. Peribulbar injection of 4 ml 2% lidocaine was given before the procedure. The laser power setting was 2000 mW in micropulse mode, with variable treatment duration (range: 140–320 s) for different individuals. The P-probe was applied with firm pressure in a continuous sliding arc route over the sclera. The total duration of treatment was divided into four quadrant applications, such as total 240 s, each quadrant 60 s, with 3 and 9 o'clock spared. In addition, locations with previously performed trabeculectomy or implanted Ahmed tube were also spared.

Postoperatively, subtenon injection of triamcinolone 0.5 mg was performed, topical steroid and pressure bandage was applied for about 4 h, and then, ice packs and analgesics were also given to relieve pain. Topical steroid eye drops were used for 1 week or longer until the inflammation was controlled. Antiglaucoma medication was continued after the operation, which may be tapered when IOP is reduced. Ocular findings were recorded at 1 day, 1 week, 2 weeks, 1 month, 2 months, 3 months, 9 months, and 12 months after the operation and at the last visit. The recorded data included visual acuity, IOP, number of antiglaucoma medications, anterior chamber reaction, changes in the optic disc and macula, and any vision-threatening complications postoperatively. Optical coherence tomography for the macula was performed to determine if macula edema was present when patients experienced changes in visual acuity.

Patients were divided into success and failure groups. Treatment success was defined as an IOP reduction of more than 20% at 12 months after operation. Postoperative conditions included: IOP reduction <20% within 12 months, and repeat TSCPC within 12 months. Trabeculectomy or bleb needling revision performed within 12 months was defined as treatment failure. Patients with repeated micropulse CPC treatment were also included in this study, and IOP data at the last visit were evaluated. For the repeated cases, the follow-up data involved monitoring the IOP subsequent to their latest micropulse CPC treatment. Therefore, we analyzed the relationship between treatment duration and success or IOP reduction between treatment duration groups. For some patients requiring micropulse CPC treatments on both eyes, the operations were conducted on separate days with varying treatment durations determined by the baseline IOP of each eye. Therefore, the follow-up of the IOP reduction rate of each eye was recorded separately.

Statistical analysis

Continuous data are presented as mean ± standard deviation and performed as the Student's *t*-test or presented as medians (interquartile range: 25th–75th percentile, IQR) and performed as the Wilcoxon rank-sum test. The Shapiro–Wilk test was performed for normal distribution. Categorical data are presented as *n* (%) and performed by

Fisher's exact test. The Kruskal–Wallis test was performed for the treatment duration group, and Steel–Dwass–Critchlow–Fligner pair-wise ranking nonparametric method was performed for *post hoc* multiple comparisons. Logistic regression models were used to evaluate the effects of treatment duration for IOP reduction success 12 months after surgery using odds ratios (ORs) and 95% confidence intervals (CIs). The step-wise selection method was used to identify the predictive factors for IOP reduction success, which specifies the significance level of entering an effect into the model and staying in the model = 0.1. Finally, we simultaneously plotted receiver operating characteristic curves (ROCs) and calculated the area under the ROCs curve (AUC) to assess the predictive ability of related factors for IOP reduction success, with a higher AUC indicating higher predictive performance. All statistics were two-sided and performed using SAS statistical software (version 9.4; SAS Institute, Inc., Cary, NC, USA).

Results

A total of 74 eyes in 64 Chinese patients were included in this study. The male: female ratio was 3:1. The mean age was 54.8 ± 15.0 years (range 11–90 years). Patients' baseline and clinical data and outcomes by group are shown in Table 1. Primary open-angle glaucoma was the most common diagnosis. The second-most common diagnosis was glaucoma associated with inflammation. The mean total follow-up period after receiving micropulse CPC was 21.7 ± 8.9 months. In total, 19 eyes in the study received more than one micropulse CPC treatment, and 10 patients received micropulse CPC treatment in both eyes. Figure 1 illustrates the mean IOP of all participants at various time points, both before and after undergoing micropulse CPC treatment. The overall mean baseline IOP in this study was 29.06 ± 9.05 mmHg. The mean IOP declined to 17.85 ± 7.23 mmHg 1 day after receiving the operation. At the 12th month postoperatively, the mean IOP was maintained at 16.5 ± 5.86 mmHg.

The mean treatment durations and the IOP reduction rates were compared between the success and failure groups. A total of 59 eyes were in the success group and 15 eyes in the failure group. As shown in Table 1, significant differences were found in baseline IOP and

Table 1: Patients' baseline and clinical data and outcomes by group

	Total (*n*=74)	Success (*n*=59)	Failure (*n*=15)	*P*
Age	54.8±15.0	55.1±14.5	53.7±16.8	0.748
Gender				
Female	18 (24.3)	16 (27.1)	2 (13.3)	0.333
Male	56 (75.7)	43 (72.9)	13 (86.7)	
Diagnosis				
POAG	52 (70.3)	40 (67.8)	12 (80.0)	0.935
Secondary	1 (1.4)	1 (1.7)	0	
Inflammation related	9 (12.2)	8 (13.6)	1 (6.7)	
NVG	3 (4.0)	2 (3.4)	1 (6.7)	
ICE syndrome	2 (2.7)	2 (3.4)	0	
Post-PK glaucoma	1 (1.4)	1 (1.7)	0	
PACG	6 (8.0)	5 (8.5)	1 (6.7)	
Baseline IOP (mmHg)	27.0 (22.7–33.0)	28.0 (24.3–36.7)	23.0 (15.0–31.0)	**0.016**
Treatment				
Medication use before surgery	4 (4–5)	4 (4–5)	4 (3–4)	0.060
Treatment duration (s)	240 (180–240)	240 (200–280)	160 (140–200)	**0.001**
Outcomes				
Repeat treatment				
Yes	19 (25.7)	13 (22.0)	6 (40.0)	0.190
No	55 (74.3)	46 (78.0)	9 (60.0)	
Repeat treatment interval (months)	15.9±8.8	19.5±7.8	8.1±4.7	**0.004**
After surgery 12 months[a]				
IOP (mmHg)	15.0 (12.3–20.0)	14.3 (2.0–19.7)	20.0 (14.0–23.3)	**0.026**
Reduce rate (%)	42 (27–52)	45 (31–53)	10 (3–16)	**<0.001**
Final				
IOP (mmHg)	16.0 (13.7–19.7)	15.3 (12.3–18.7)	19.7 (15.7–27.0)	**0.004**
Reduce rate (%)	40±30	40±20	3±20	**<0.001**
Follow-up period (months)	21.7±8.9	22.2±8.0	19.8±12.0	0.464

[a]There are five patients missing the information. Continuous data with normal distribution were presented as mean±SD; data without normal distribution were presented as medians (IQR). Categorical data are presented as *n* (%) and performed by Fisher's exact test. Significance values are in bold. POAG=Primary open-angle glaucoma, NVG=Neovascular glaucoma, Post-PK glaucoma=Postpenetrating keratoplasty glaucoma, PACG=Primary angle-closure glaucoma, IOP=Intraocular pressure, SD=Standard deviation, IQR=Interquartile range

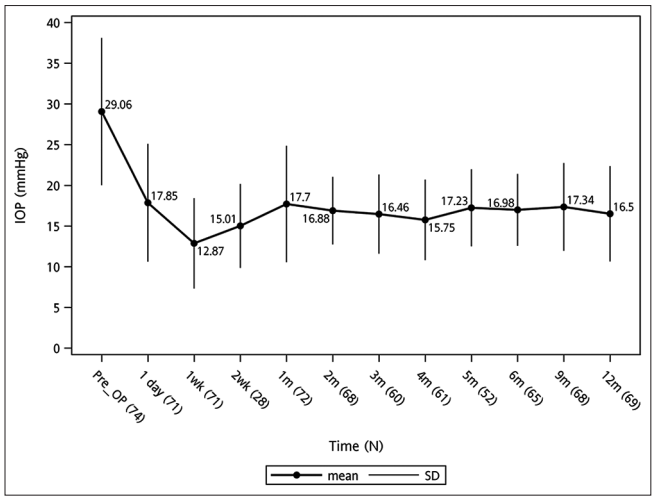

Figure 1: Intraocular pressure before and after micropulse transscleral cyclophotocoagulation

treatment duration between the two groups. Patients in the success group had significantly higher baseline IOP (median: 28.0 vs. 23.0 mmHg; $P = 0.016$) than the failure group. Treatment durations (median: 240 vs. 160 s; $P = 0.001$) were also longer than those of the failure group. In addition, the difference in medication use before surgery was not statistically significant between the success and failure groups ($P = 0.06$).

Postoperative IOP values were recorded regularly for 12 months and until the final visit in the follow-up period. The mean follow-up period was 21.7 ± 8.9 months. There were no differences between the two groups. The IOP reduction rate was also determined at 12 months postoperatively and the final visit in the follow-up period. The mean IOP reduction rates in the 12th month after the operation were significantly different between the two groups ($P < 0.001$). Among the outcomes 12 months postoperatively, the success group had a lower average IOP (median: 14.3 vs. 20.0 mmHg; $P = 0.026$) and a higher IOP reduction rate (45 vs. 10%; $P < 0.001$). No significant differences were found between groups in percentages of repeated treatments. However, the repeat treatment interval of the success group was obviously longer than that of the failure group patients with repeated treatment (mean: 19.5 vs. 8.1 months; $P = 0.004$). The average IO*P* values and IOP reduction rates at the final visit and 12 months were similar. Hence, the factors that contributed to reducing IOP consisted of the baseline IOP and the duration of treatment.

To analyze the relationship between IOP reduction rates and the treatment durations [Table 2], participants were divided into five groups based on the treatment duration they received. The five groups were respectively <140, 140–160, 160–200, 200–240, and above 240 s. The purpose of the grouping was to figure out the IOP reduction rate in each group and the most effective treatment group. Table 2 shows the correlations between treatment duration and IOP reduction rates. The overall success rate was 79.7%, and the overall IOP reduction rate at the 12th month after the surgery was 38.5 ± 25.8%. Among the five groups, treatment duration between 210 and 240 s showed the highest success rate (100%). The overall 12-month IOP reduction rates of the treatment duration groups were not significantly different ($P = 0.097$); however, 200 ~ 240 s duration had a significantly higher median reduction rate than that of the ≤ 140 s duration group (45.0% vs. 18.0%, *post-hoc* comparison $P = 0.049$). Moreover, the overall final IOP reduction rate was significantly different between the treatment duration groups ($P = 0.002$), whereas the 200–240 s duration group also had the highest IOP reduction rate (median: 48.5%), followed by that of the > 240 s duration group (median: 47.0%), and ≤ 140 s duration group was the lowest (median: 4.5%). Furthermore, *post-hoc* multiple comparisons revealed that pair-wise significant differences were found at > 240 s, 160–200 s, and 200–240 s versus ≤ 140 s (*post-hoc* comparison $P = 0.010$, 0.021 and 0.002).

Table 3 shows the effects of treatment duration for IOP reduction success at 12 months after surgery. In the univariate model, two factors affected the success of IOP reduction, including baseline IOP (OR = 1.14, 95% CI: 1.03–1.25, $P = 0.010$) and treatment duration (>200 s vs. ≤140 s; OR = 24.67, 95% CI: 3.13–194.55, $P = 0.002$). According to the multivariable model enrolling baseline IOP and treatment duration groups, the baseline IOP had a borderline probability of influencing effects on IOP reduction. However, compared with the treatment duration under 140 s, over 200 s significantly increased the success of IOP reduction (adjusted OR = 11.21, 95% CI: 1.22–103.37, $P = 0.033$). Treatment duration also played a key role in reducing IOP successfully. When applying the treatment duration over 200 s, the surgery significantly increased the success rate ($P = 0.002$), and the ORs were as high as 24.67 (95% CI = 3.13–194.55).

Table 4 indicates that the predictive ability of the multivariable model was the highest (AUC = 0.81 95% CI: 0.68–0.95). Compared with the multivariable model, no significant differences in AUCs were found in the predictability of either baseline IOP or treatment duration, whereas treatment duration was closer to the model with a mean AUC difference of 0.05 [Table 4 and Figure 2]. Therefore, the multivariable model showed that the treatment duration was the most important predictor for IOP reduction success. The sensitivity (76.3%) and specificity (80.0%) were further calculated for the Youden index by observing the success rate of each participant. The optimal treatment threshold was determined by the Youden index. Table 4 shows that the optimal treatment duration threshold was 220.46 s.

Table 2: Correlation between treatment duration and intraocular pressure reduction rate

Treatment duration (s)	*n*	Success rate (%)	IOP reduction rate after surgery 12 months (%)	Final IOP reduction rate (%)
Continuous	74	79.7	38.5±25.8[a]	35.8±25.7
>240	18	88.9	41.8±17.4; 43.9 (25.4–51.9)[b]	42.5±21.8; 47.0 (24.6–59.7)
>200, ≤240	21	100.0	47.8±17.4; 45.0 (30.7–61.9)	46.9±16.9; 48.5 (38.3–56.1)
>160, ≤200	18	72.2	34.0±30.5; 40.3 (30.2–49.6)[b]	30.4±22.4; 32.6 (23.9–47.6)
>140, ≤160	10	60.0	31.6±43.6; 39.4 (12.0–60.2)[c]	36.5±32.3; 39.0 (7.1–67.4)
≤140	7	42.9	23.1±14.2; 18.0 (11.2–33.7)	−1.91±21.4; 4.5 (−1.8–2.1)
Overall (*P*)			0.097	**0.002**
P-value of the *post hoc* multiple comparison			**0.049** (≤140 vs. >200, ≤240)	**0.010** (>240 vs. ≤140) **0.021** (>160, ≤200 vs. ≤140) **0.002** (>200, ≤240 vs. ≤140)

[a]Missing *n*=5, [b]Missing *n*=2, [c]Missing *n*=1. Data were presented as mean±SD and median (IQR). Significance values are in bold. IOP=Intraocular pressure, SD=Standard deviation, IQR=Interquartile range

Table 3: The effect of treatment duration for intraocular pressure reduction success after surgery 12 months

	Univariate		Multivariable[a]	
	OR (95% CI)	*P*	AOR (95% CI)	*P*
Age	1.01 (0.97–1.05)	0.744		
Gender				
Female	Reference			
Male	0.41 (0.08–2.04)	0.278		
Diagnosis				
POAG	Reference			
Other	1.90 (0.48–7.54)	0.361		
Baseline IOP (mmHg)	1.14 (1.03–1.25)	0.010	1.11 (0.99–1.24)	0.068
Treatment				
Medication use before surgery	1.71 (0.89–3.29)	0.109		
Duration (s)				
≤140	Reference		Reference	
>140, ≤160	2.00 (0.28–14.20)	0.488	0.83 (0.09–8.02)	0.875
>160, ≤200	3.47 (0.56–21.35)	0.180	3.33 (0.50–22.30)	0.215
>200	24.67 (3.13– 194.55)	0.002	11.21 (1.22–103.37)	0.033

[a]Using the step-wise selection method specifies the significance level of entering an effect into the model and staying in the model=0.1. POAG=Primary open-angle glaucoma, OR=Odds ratio, AOR=Adjusted OR, IOP=Intraocular pressure

Table 4: The area under the receiver operating characteristic curve of related factors and multivariable model for intraocular pressure reduction success

Variables	AUC (95% CI)	Difference (95% CI)[a]	Optimal threshold[b]	Sensitivity (%)	Specificity (%)	Youden index (%)
Treatment duration (s)	0.76 (0.62–0.91)	−0.05 (−0.11–0.02)	220.46	63.0	86.7	49.0
Baseline IOP (mmHg)	0.70 (0.54–0.87)	−0.11 (−0.23–0.01)	20.01	96.6	40.0	36.6
Multivariate model[c]	0.81 (0.68–0.95)	-	0.77	76.3	80.0	56.3

[a]Difference: Means difference of the AUC between variables and the multivariable model, [b]The optimal threshold is the cutoff point on the corresponding receiver operating characteristic curve with Youden's index: (sensitivity + specificity) – 1, [c]Enrolled related factors, including treatment duration (categorical) and baseline IOP. IOP=Intraocular pressure, AUC=Area under the receiver operating characteristic curve, CI=Confidence interval

The average numbers of glaucoma medications used after receiving micropulse CPC are shown in Figure 3. Before undergoing the operation, the mean amount of medications used was 3.99 ± 0.85 (referring to bottles). The number of medications at 1 week, 1 month, 3 months, 6 months, and 12 months was 2.93 ± 1.3, 2.46 ± 1.33, 2.56 ± 1.41, 2.82 ± 1.46, and 2.91 ± 1.42, respectively. A significant decline in medications was noted from the 1st week after performing micropulse CPC, and the reduction of glaucoma medications lasted 12 months postoperatively. The average reduction in the number of medications was 1.08 at 12 months postoperatively.

Table 5 indicates other outcomes distribution, including final visual acuity and complications. Improvements for final visual acuity were found in 32.4% of patients. However, the visual acuity in 37 (50%) eyes was reduced after the operation. The vision in 13 (17.6%) eyes did not change before and after the treatment. Complications after the treatment included mydriasis in 17 (22.9%) eyes, cystoid macula edema in 4 (5.5%) eyes, and subretinal fluid recurrence in 1 (0.9%) eye. Mydriasis was the most frequently observed complication, affecting 22.9% of the patients. One patient showed a long-lasting inflammatory reaction after the surgery.

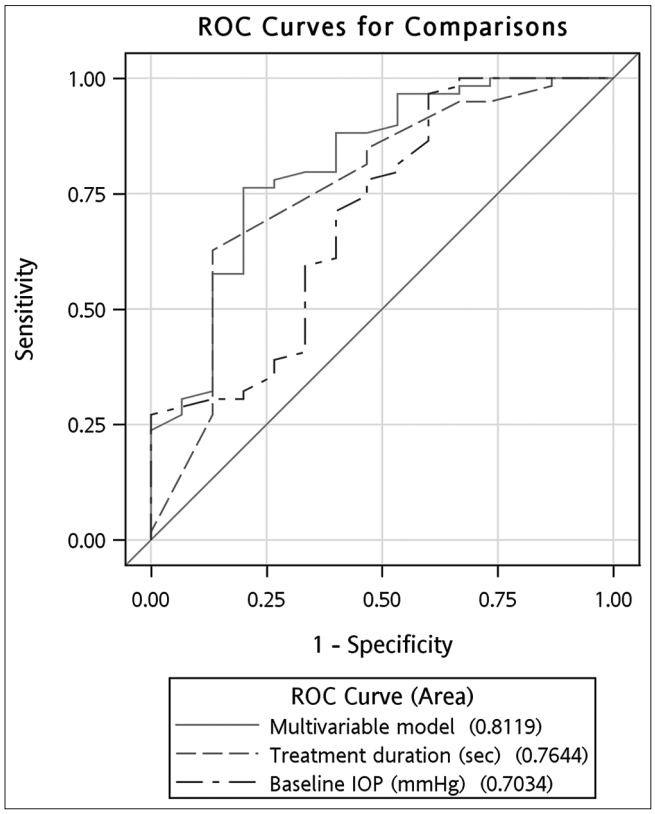

Figure 2: Receiver operating characteristic curves of related factors and multivariable model for transscleral cyclophotocoagulation success

Table 5: Other outcomes distribution

	Total (*n*=74), *n* (%)
Final VA	
Improved	24 (32.4)
Reduction	37 (50.0)
Same	13 (17.6)
Complication*	
Mydriasis	17 (22.9)
Inflammation	1 (0.9)
CME	4 (5.5)
Subretinal fluid recurrence	1 (0.9)
Glaucoma	1 (0.9)

*There were 50 cases without complication after TSCPC. CME=Cystoid macular edema, VA=Visual acuity, TSCPC=Transscleral cyclophotocoagulation

Discussion

This is the first study to retrospectively study the efficacy of micropulse TSCPC in decreasing IOP reduction rates based on using different energy levels. The primary goal of this study was to establish a protocol to determine the optimal treatment duration for the desired IOP reduction rate we aimed to achieve. Therefore, the desired IOP reduction for each patient could be achieved based on their preoperative IOP and the target IOP.

In the present study, we found that the IOP reduction rate is significantly associated with the settings for

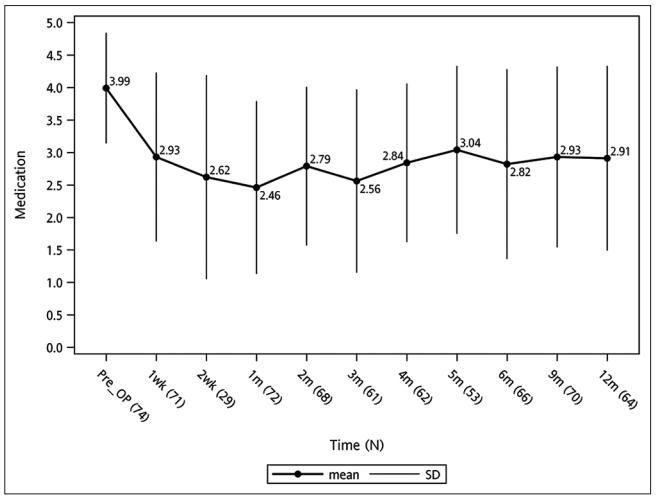

Figure 3: Medication used before and after micropulse transscleral cyclophotocoagulation

micropulse TSCPC treatment duration. By comparing the success and failure groups, baseline IOP and treatment duration were found to be the predictive factors for successful IOP reduction. Treatment duration over 200 s showed significantly increased success of IOP reduction rates compared with that of under 140 s after 12 months and the final visit. Therefore, the optimal treatment duration can be determined by considering the desired level of IOP reduction for the individual patient. In the study, the univariate model showed that baseline IOP and treatment duration over 200 s were the significant predictors for successful IOP reduction in 12 months after treatment. The multivariable model showed that only treatment duration over 200 s was the significant factor. The predictive ability of the multivariable model was the highest if compared to treatment duration and baseline IOP. This result further confirmed treatment duration as the most important factor for IOP reduction that we could modulate. The Youden index predicted the optimal treatment duration threshold for success. This result also provided a guide for the selection of treatment duration.

Several previous studies explored the best treatment duration for IOP reduction, using a 2000mW laser power with different durations. Different studies applied treatment durations of 100, 210, 300, and 319 s, yielding average IOP reduction rates of 45%, 27%, 51%, and 59.9%, respectively.[3,6-8] Another evidence-based article in 2022 also summarized the consensus from original articles on micropulse CPC energy settings. The most common micropulse CPC treatment duration ranged from 50 to 160 s per hemisphere, resulting in IOP reduction rates of 27.8%–57.2%, averaging 40.6% from baseline IOP.[4] The above articles reported that as the treatment duration was prolonged, there was typically an observed increase in IOP reduction rates. However, none of the studies

performed a comparative analysis of the IOP reduction rates between various treatment durations. Only the present study compared different treatment durations and their associated IOP reduction rates, revealing variability among these groups. The present study also emphasized that IOP reduction significantly improved within the 200–240-s treatment duration, compared to treatment duration under 140 s.

Higher treatment duration beyond 320 s was rarely used in most studies.[3,6-8] Longer treatment (320 s) led to a significantly higher IOP reduction rate compared to shorter treatment (240 s) by Marchand *et al*.[5] Based on the results of the present study, treatment duration between 200 and 240 s reaches the optimal IOP reduction rate (47.8 ± 17.4%). The findings of the present study revealed that extending the treatment duration beyond 240 s did not yield an improved IOP reduction rate. Therefore, a higher treatment duration, as over 240 s, may not be necessary. While increased energy levels may lead to improved IOP reduction rates, a limitation remains in achieving significant advancements in IOP reduction. Furthermore, the complication rate may increase when utilizing excessively high energy levels.

According to the results of the present study, micropulse CPC is a safe and effective treatment for refractory glaucoma. Compared to continuous-wave transscleral laser therapy, micropulse CPC had a lower postoperative complication rate and maintained an excellent success rate.[3,9,10] Most of the complications, such as reduction of visual acuity and mydriasis, usually recover within a few months after the treatment. The predominant complication observed throughout the postoperative follow-up period was mydriasis, and it may have had a temporary impact on visual acuity. Mydriasis was also described in other studies as the most common complication after micropulse CPC.[11] Mydriasis could be managed by 1% pilocarpine and lead to improvement in visual acuity, and it was usually resolved within a few months. Radhakrishnan *et al*.[11] showed that mydriasis resolved in 39% of the patients after pilocarpine treatment, with the time of resolution ranging from 1 to 28 weeks. CME was only barely observed after this treatment. It was confirmed that the safety of micropulse CPC treatment would be ensured under this range of laser power, and the complication rate may be well controlled.

Limitations

Although the results of micropulse CPC were satisfying, there are still several limitations of this study. The retrospective study design limits generalization of results to other populations, and selection bias cannot be ruled out. The number of patients in each treatment duration group was limited to achieve a linear relationship between treatment duration and IOP reduction rate. In this study, 10 patients received micropulse CPC treatment in both eyes, and the treatment duration they received was not influenced by the outcome of the other eye. Given the relatively small sample size and varied treatment duration, making it hard to analyze the relationship between both eyes and the influence of the statistical results, we decided to separately analyze the changes in IOP for each eye. In addition, the number of eyes with complications in each group was also limited, making it difficult to find a relationship between treatment duration and complication rate. No conclusion can be made if higher energy is associated with more complications.

Conclusion

In micropulse cyclophotocoagulation, treatment duration is the most significant predictive factor for IOP reduction rates. Treatment duration ranging between 200 and 240 s gains the highest IOP reduction rate. Customized therapy according to the target IOP reduction rate can be applied with different treatment duration settings to achieve optimal outcomes.

Data availability statements

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest in this article.

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