A Systematic Review and Meta-Analysis on the Long-Term Efficacy and Safety of Micro Pulse Diode Laser Transscleral Cyclophotocoagulation in Patients with Glaucoma*

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ABSTRACT

Background: This systematic review and meta-analysis aimed to review available information that addresses the question regarding the long-term efficacy in intraocular pressure (IOP) control and reduction, and the complication rates of Micropulse Transscleral Cyclophotocoagulation in patients with glaucoma.
Methods: CENTRAL, PubMed, and Google Scholar were used as data sources. Studies that included glaucoma patients who underwent MP-TSCPC with a one-year or more postoperative follow-up with data on pre- and postoperative IOP and complications were considered. NHLBI Quality Assessment Tools were used for the included studies. The treatment effect measures were 1) weighted mean difference (WMD) for the IOP reduction and 2) proportions for the complication rate. Outcome measures were reported with a 95% confidence interval (CI), and $p < 0.05$ was considered statistically significant. Analysis was performed using Microsoft Excel and Open Meta Analyst software.
Results: In this systematic review, a total of 13 studies were included. Ten were case series, two were observational cohorts, and one randomized controlled trial. Risk of bias studies showed low to moderate risk among the included studies. In random effects model, the pooled weighted mean difference was -13.649 (95% CI: [-16.350 – -10.948], $p < 0.001$) showing statistically significant reduction in IOP after MP-TSCPC. Pooled proportion risk for complications was 0.418 (95% CI: [0.174 – 0.663], $p < 0.001$). Among the most common complications are post-operative inflammation at 0.257 (95% CI: [0.094 – 0.420], $p = 0.002$) and post-operative pain at 0.039 (95% CI: [0.017 – 0.061], $p < 0.001$). I^2 statistics showed considerable heterogeneity for IOP reduction ($I^2 = 94.013\%$, $p < 0.001$) and complication rate ($I^2 = 99.422\%$, $p < 0.001$).
Discussion: There is a lack of high-quality evidence on the subject as only one RCT was retrieved. Therefore, present findings are based primarily on case series and non-controlled observational studies. Nevertheless, these results showed that MP-TSCPC has good efficacy in reducing and controlling IOP after a year post-operatively. It is also safe with a low risk of complications, with the more common complications being postoperative inflammation and postoperative pain. However, these results should be interpreted with due caution due to this review's high heterogeneity and possible publication bias.

Key words: Glaucoma, intraocular pressure, complications, micropulse transscleral cyclophotocoagulation, meta-analysis, systematic review

Glaucoma is a form of progressive optic neuropathy that has been considered worldwide as one of the foremost causes of irreversible vision loss.[1] According to WHO, in 2002, glaucoma was the second leading cause of blindness worldwide. In the Philippines, glaucoma has been the leading cause of irreversible blindness.[2] The main target in glaucoma treatment is the reduction of intraocular pressure (IOP), which is considered the only modifiable component in glaucoma. Topical and oral medications are included treatment modalities for the reduction of IOP. However, there are instances where the IOP remains uncontrolled despite using maximal medications,

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which is called refractory glaucoma. Thus, the turn to laser treatment and/or surgical procedures for IOP control. Surgical procedures may be filtering surgeries or implantation of drainage devices. In addition, laser treatment may be used to increase the aqueous outflow, such as in trabeculoplasty, or by decreasing the production of aqueous, such as in transscleral cyclophotocoagulation (TSCPC).[3] A forerunner in managing uncontrolled intraocular pressure in advanced glaucomatous disease has been presented with the arrival of diode laser technology in the form of cyclo-ablative therapy or thermal destruction of the ciliary body.[4]

TSCPC delivers a continuous, high-intensity, high-energy laser to the ciliary body. However, this spread of energy would damage the nearby tissues causing complications such as changes in visual acuity, macular edema, uveitis, sympathetic ophthalmia, hypotony, and phthisis bulbi. Hence, due to its perceived risks, the use of TSCPC is deemed as the final resort for patients with refractive glaucoma, which led to the invention of the Micro Pulse Diode laser Transscleral Cyclophotocoagulation (MP-TSCPC).

MP-TSCPC is believed to produce lower rates of ocular complications due to its delivery of repetitive "on and off" bursts of laser energy in contrast to the continuous wave of the TSCPC. This method allows the pigmented absorbing tissues to achieve coagulation threshold with the "on" interval while preventing the adjacent non-pigmented structures to not reach the coagulation threshold with the "off" interval.[5] This modality of delivering energy reduces the damage to adjacent tissues leading to a lesser chance of ocular complications without sacrificing the reduction of intraocular pressure.

In view of this treatment method, some of the concerns are about the long-term effectiveness of IOP control and the long-term complications that it may exhibit. There has also been no standard protocol for the laser parameters, settings, and techniques that may influence this procedure's clinical outcome. A systematic review can provide useful information on these aspects. Since controlled trials are few for MP-TSCPC, observational studies are included, which can provide useful information on the efficacy of the treatment when implemented in an uncontrolled or real-world condition.

The purpose of this study was to examine the effectiveness of MP-TSCPC in terms of IOP control by comparing the pre-operative IOP and postoperative IOP of patients that had undergone this procedure after a year and to investigate its safety by determining the complications after undergoing MP-TSCPC.

This review aimed to evaluate the long-term efficacy of MP-TSCPC by determining the IOP reduction after twelve months of postoperative follow-up and to assess its safety profile by identifying the rate of complications that it may manifest post-operatively.

MATERIALS AND METHODS

Criteria for Considering Studies for this Review

Types of Studies

Literature was reviewed for all types of clinical studies, observational and experimental. This includes randomized control trials, observational cohort studies, case series, case-control studies that evaluated the outcomes of undergoing Micro Pulse Diode laser Transscleral Cyclophotocoagulation.

Types of Participants

Patients with primary or secondary glaucoma may be included in this study. No restrictions were made based on the participants' age, gender, ocular co-morbidities, or any surgical interventions previously done.

Types of Intervention

Included are the studies in which the participants have undergone Micro Pulse Diode laser Transscleral Cyclophotocoagulation with at least a follow-up period of 12 months or more.

Types of Outcome Measures

The primary outcome measure for this review will be the reduction of IOP and the complications that may be present after at least 12 months after undergoing MP-TSCPC.

Search Methods for Identification of Studies

Electronic searches were done in the Cochrane Central Register of Controlled Trials (CENTRAL) in The Cochrane Library, PubMed, and Google Scholar. Last searched up to December 2020. There were

no language restrictions on the electronic searches. Reference lists of included studies were manually searched for other potential studies. In addition, experts in the field were contacted and consulted for additional studies.

Selection of Studies

Two reviewers independently screened the titles and the abstracts resulting from the electronic searches. Potentially relevant reports and their full texts were obtained. The differences in classifications were resolved by consensus, and whenever needed, a third reviewer was consulted.

Assessment of Methodological Quality

The quality of all included studies in this review was assessed using the National Heart, Lung, and Blood Institute (NHLBI) Quality Assessment Tools. The tools included a criterion, and each criterion that applies to the study was given a point. In addition, every study was given a summary rating on quality based on the number of criteria met. Two authors independently assessed the quality of the studies, and disagreements were resolved by consensus.

Data Collection

Two authors independently extracted data from the included studies. For each of the included studies, the following data were extracted: title, author name, year of publication, study design, length of follow-up in months, sample size, demographic characteristics of subjects, laser parameters used, pre-operative IOP, postoperative IOP on last follow-up and complications that have occurred after the treatment.

Data Synthesis

Microsoft Excel and the Open Meta Analyst software were used for the data analysis. The main outcomes of interest were the mean and standard deviation (SD) of the pre-operative and postoperative IOP on the last follow-up. The number and type of complications were also obtained for this review. Weighted mean difference (WMD) was computed as the treatment effect or effect size for the continuous scale outcomes such as mean values. The pre-operative and the postoperative IOP on the last follow-up were used to compute the WMD. Weights were designated to each WMD according to the inverse variance. The complications were calculated as the total number of all the complications over the total number of eyes included in the study and the number of each complication over the total number of eyes included in the study. The complication rates were pooled using proportional meta-analysis. The 95% confidence interval was used, and for the overall effect, a value of $p < 0.05$ was considered statistically significant. Random - effects model was used to examine the outcomes and test the presence of variability of heterogeneity in the effect estimates. I^2 statistics was used to evaluate the statistical heterogeneity, with an interpretation of moderate heterogeneity for I^2 value of 30-60%, substantial heterogeneity for 50-90%, and considerable heterogeneity for 75-100%. The main results are presented in forest plots. Begg's funnel plot was used in the assessment of publication bias.

RESULTS

Study Selection

An initial electronic search identified a total of 110 studies. Subsequent search updates were conducted monthly, which increased the total of the studies to 116. Case reports and literature reviews were disregarded from the study. Ongoing trials were also not included. Studies with no full texts and abstracts with insufficient information were also not included. Out of the remaining 24 studies, 11 were excluded due to incomplete data, insufficient follow-up periods, and high drop-out rates. After manually reviewing the full texts of the remaining articles, 13 studies were identified which met the criteria for inclusion in this review. Figure 1 describes the PRISMA flow diagram for the literature search and screening process.

Characteristics of Studies

The included studies are primarily observational research due to the limited availability of experimental designs. This review, based on 13 studies, has a total of 941 participants and 1048 eyes comprising male and female, adult, and pediatric participants. In addition, one study included pediatric patients,[7] while another evaluated the outcomes between adult and pediatric participants.[8]

Interventions of the included studies are treated with MP-TSCPC. Test parameters ranged from

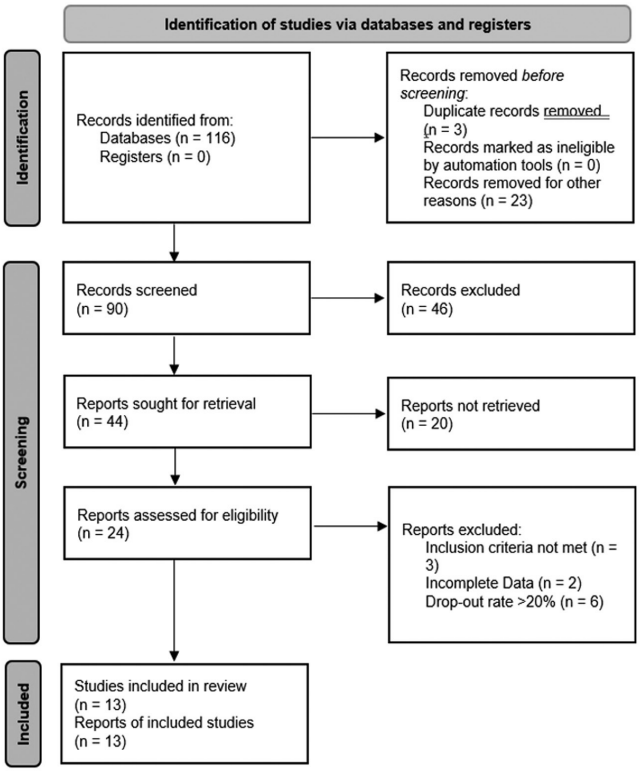

Figure 1. PRISMA Flow Diagram demonstrates the inclusion studies selection process

2000 to 2500 mW and were tested at a range of 50 to 180 seconds per hemisphere. In one study, lower milliwatts were used at 1750 mW.[7] Furthermore, the only randomized study was done comparing between Micro Pulse TSCPC and Continuous Wave TSCPC.[9]

The postoperative characteristics of the included studies are the difference between the pre-operative and the postoperative IOP and complications that occur post-intervention. Treatment success and anti-glaucoma medication reductions were also stated; however, they were not included in the review. All trials have substantially decreased IOP from the baseline to the last postoperative follow-up of 12 months minimum. The most frequent complication was postoperative inflammation, present in most of the included studies, and the least common were scleral thinning[9] and corneal edema.[10]

Eleven studies were not included in this review due to reasons such as incomplete data in the form of no postoperative IOP stated[11,12] due to not fulfilling the inclusion criteria by having a follow-up period of 12 months or more[6,13,14] and due to high drop-out rate.[15-20] Characteristics and details of included studies are shown in Tables 1 and 2.

Table 1. Characteristics of the included studies.

Study	Design	Participants	Intervention	Outcome
Al Habash 2019[21]	Case Series	68 patients (71 eyes)	MP-TSCPC 2200mW, 31.3% duty cycle, 120 secs per hemisphere	Change in IOP between 6 and 21 mmHg or 30% reduction in baseline IOP without vision loss of "light perception" with no secondary glaucoma intervention and without an increase in the number of medications
Aquino 2015[9]	Randomized Trial	48 patients (48 eyes)	MP-TSCPC 2000mW, 31.3% duty cycle, 50 secs per hemisphere CW-TSCPC 1500-2000mW, 2 secs exposure time per burn, 20-28 burns per eye	IOP between 6 and 21 mmHg and at least a 30% reduction with or without anti-glaucoma medications after 18 months
Elhefney 2019[7]	Case Series	29 patients (36 eyes)	MP-TSCPC 1750-2000mW, 31.3% duty cycle, 55-65 secs per hemisphere	IOP between 6 and 21mmHg or reduction by ⩾20% with or without anti–glaucomatous drugs
Jammal 2019[22]	Case Series	21 patients (21 eyes)	MP-TSCPC 2000mW, 31.3% duty cycle, 183.3±72.1 secs per hemisphere	IOP between 6 and 21 mmHg and/or 30% reduction from baseline IOP with or without the use of anti-glaucoma medications.

Lee 2017[8]	Case Series	36 patients (36 eyes)	MP-TSCPC 2000mW, 31.3% duty cycle, 80 secs per hemisphere	(1) 5 mm Hg ≤ IOP ≤ 21 mm Hg and reduced ≥ 20% from baseline at the 12 months of follow-up; (2) no use of oral carbonic anhydrase inhibitors, (3) no loss of light perception vision, and (4) no reoperation for glaucoma within the 12-month follow-up period
Magacho 2020[23]	Cohort	143 patients (185 eyes)	MP-TSCPC 2000mW, 31.3% duty cycle, 80-120 secs per hemisphere	An IOP between 6 mmHg and 18 mmHg and an IOP reduction of more than 20% with or without medication or at least a 50% reduction in the number of glaucoma medications compared to pre-operative values with no serious complications, including the loss of vision or phthisis bulbi
Nguyen 2019[24]	Case Series	95 patients (95 eyes)	MP-TSCPC 2000-2500mW, 31.3% duty cycle, 90 secs per hemisphere	IOP-lowering of at least 20% of the baseline value was achieved at all time points 1month and beyond with one treatment. Patients were considered to achieve qualified success if they achieved the 20% IOP reduction with eventual retreatment
Nutterova 2020[25]	Case Series	47 patients (50 eyes)	MP-TSCPC 2000mW, 31.3% duty cycle, 80 secs per hemisphere	Reduction of IOP values by a minimum of 30% as the criterion of success
Preda 2019[26]	Case Series	97 patients (100 eyes)	MP-TSCPC 2000mW, 31.3% duty cycle, 80-130 secs per hemisphere	Decrease of at least 30% or maintenance in the range of 6–21 mmHg of the IOP value 18 months after the first session
Sarrafpour 2019[27]	Case Series	62 patients (73 eyes)	MP-TSCPC 2000-2500mW, 31.3% duty cycle, 50 secs per hemisphere	Visual acuity, IOP, medication burden, phthisis, and development of macular edema was followed
Tan 2010[28]	Case Series	38 patients (40 eyes)	MP-TSCPC 2000mW, 31.3% duty cycle, 50 secs per hemisphere	Maintaining an IOP of 6 - 21 mmHg or achieving a reduction of 30% or more from baseline IOP with or without supplementing topical anti-glaucoma medications at final follow-up
Tekeli 2020[10]	Case Series	96 patients (96 eyes)	MP-TSCPC 2000mW, 31.3% duty cycle, 80 secs per hemisphere	Criteria A - maintaining IOP ⩽18mmHg and ⩾20% reduction in IOP; Criteria B - ⩽15mmHg IOP and ⩾25% reduction in IOP; Criteria C - ⩽12mmHg IOP and ⩾30% reduction in IOP from baseline, with or without topical glaucoma medications at final follow-up
Yelenskiy 2018[29]	Cohort	161 patients (197 eyes)	MP-TSCPC 2000mW, 31.3% duty cycle, 90-120 secs per hemisphere	IOP defined as IOP > 6 or <18 mm Hg or 20% reduction in IOP from baseline. total success in our study required that the eye fulfill multiple definitions of success, including IOP, VA and no further needs for another glaucoma surgery.

Table 2. Outcome data of interest of the included studies

Study	Pre-operative IOP	Postoperative IOP	Complications
Al Habash 2019[21]	35.0 mmHg (21.0–70.0 mmHg)	16 mmHg (8–32 mmHg)	1 inflammation, 4 tonic pupil, 9 decrease in visual acuity
Aquino 2015[9]	MPCPC: 36.5 mmHg (29.5–56.5 mmHg) CWCPC: 35.0 mmHg (29.5–46.5 mmHg)	MPCPC: 20 mmHg (16–23.5 mmHg) CWCPC: 19 mmHg (8–30 mmHg)	MPCPC: 1 decrease in visual acuity, 1 Scleral thinning, 1 prolonged inflammation CWCPC: 1 phthisis, 5 hypotony, 7 prolonged inflammation, 2 decrease in visual acuity, 4 Scleral thinning, 3 post operative pain
Elhefney 2019[7]	33.8±9.37 mmHg	20.03±2.7 mmHg	none
Jammal 2019[22]	33.38±15.95 mmHg	41.59% ± 18.93% reduction	5 inflammation
Lee 2017[8]	Adults: 28.41±8.32 mmHg Pediatric: 34.28±9.92 mmHg	Adults: 18.98 ± 6.45 mmHg Pediatric: 27.20 ± 15.68 mmHg	65% inflammation
Magacho 2020[23]	G1 (without prev. glaucoma surgery): 26.2±6.9 mmHg G2 (with prev. glaucoma surgery): 31.1±5.4 mmHg	G1: 14.9±5.2 mmHg G2: 13.6±4.1 mmHg	G1 1 Cystoid macular edema, 8 anterior chamber reaction, 5 persistent flares, 6 persistent mydriasis G2: 4 Cystoid Macular Edema, 15 anterior chamber reaction, 5 persistent flares, 7 persistent mydriasis
Nguyen 2019[24]	25.3±5.3 mmHg	17.5±5.1 mmHg	11 hypotony, 10 surface keratopathy, 3 choroidal effusion, 3 persistent mydriasis, 6 hyphema, 1 posterior synechiae
Nutterova 2020[25]	25.0±6.7 mmHg	14.0±5.1 mmHg	7 post operative pain, 7 subconjunctival suffusions, 6 conjunctival hyperemia, 3 post operative inflammation, 1 transitory mydriasis, 4 burning sensation of the eye
Preda 2019[26]	39.14±13.84 mmHg	22.77±8.13 mmHg	3 hypotony, 30 post operative inflammation, 5 decreased visual acuity
Sarrafpour 2019[27]	25.5±9.4 mmHg	13.8±7.0 mmHg	14 decreased visual acuity
Tan 2010[21]	40.1±11.6 mmHg	24.6±9.6 mmHg	7 post operative pain, 40 post operative inflammation, 7 hyphema, 4 uveitis
Tekeli 2020[10]	Primary open angle glaucoma: 34.3±8.15 mmHg Pseudoexfoliation glaucoma: 34.2±10.48 mmHg Secondary Glaucoma: 35.7±10.78 mmHg	Primary open angle glaucoma: 19.72±6.71 mmHg Pseudoexfoliation glaucoma: 21.5±7.57 mmHg Secondary Glaucoma: 21.88±7.65 mmHg	2 hypotony, 1 corneal epithelial edema (dec VA), 1 ocular surface problem (dec VA), 48 post operative inflammation with conjunctival hyperemia
Yelenskiy 2018[29]	21.5±9 mmHg	15.8±6 mmHg	2% cystoid macular edema, 86 immediate post operative pain, 91 post operative inflammation

Risk of Bias in Studies

The quality assessment for the case series studies showed good to fair quality with a low to moderate risk of bias, respectively. Of the case series, six studies had a moderate risk of bias, and four studies had a low risk of bias. For the quality assessment of the cohort studies, the evaluation showed good quality with a low risk of bias on both cohort studies. Furthermore, the quality assessment of the only randomized controlled study in this review showed good quality with a low risk of bias. The summary of the bias risk assessment of the included studies is listed in Table 3.

Results of Synthesis

Thirteen studies investigated the efficacy of MP-TSCPC in the reduction of IOP. A decrease in postoperative IOP was seen in all the included studies. In the random effects model, the pooled weighted mean difference was -13.649 (95% CI: [-16.350 – -10.948], $p < 0.001$), showing a statistically significant reduction in IOP after MP-TSCPC. There was noted considerable heterogeneity ($I^2 = 94.013\%$, $p < 0.001$) observed among the studies. Figure 2 illustrates the forest plot of the outcome measure of IOP reduction by MP-TSCPC.

The thirteen studies reported such outcomes for the rate of complications after undergoing MP-TSCPC. In random effects model, the pooled proportion risk was 0.418 (95% CI: [0.174 – 0.663], $p < 0.001$). A considerable heterogeneity ($I^2 = 99.422\%$, $p < 0.001$) was detected among the studies. Figure 3 illustrates the forest plot of the complication risk by MP-TSCPC. Table 4 shows the risk per complication after undergoing MP-TSCPC.

Visual inspection of funnel plots in Figure 4 and 5 for IOP reduction and risk of complications respectively shows some asymmetry present suggesting a possible publication bias.

DISCUSSION

There are some cases wherein the glaucoma is non-responsive to medication and surgical treatment. Once glaucoma progresses, it would lead to optic atrophy. Once the optic atrophy sets in, it would lead to vision loss. Nothing could be done to restore its function. Micropulse Transscleral Cyclophotocoagulation has been used as a last effort to alleviate the intraocular pressure. Compared to the early reiterations of cyclophotocoagulation, this method of treatment provides quality IOP reduction and a more broader safety profile with lesser events of complications. A

Table 3. Quality assessment of the included studies

Study	Quality Assessment Tool	Quality Rating		Comments
Al Habash 2019[21]	NHLBI Quality Assessment for Case Series Studies	7/9	Fair	Moderate Risk
Aquino 2015[9]	NHLBI Quality Assessment of Controlled Intervention Studies	13/14	Good	Low Risk
Elhefney 2019[7]	NHLBI Quality Assessment for Case Series Studies	7/9	Fair	Moderate Risk
Jammal 2019[22]	NHLBI Quality Assessment for Case Series Studies	8/9	Good	Low Risk
Lee 2017[8]	NHLBI Quality Assessment for Case Series Studies	9/9	Good	Low Risk
Magacho 2020[23]	NHLBI Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies	12/14	Good	Low Risk
Nguyen 2019[24]	NHLBI Quality Assessment for Case Series Studies	7/9	Fair	Moderate Risk
Nutterova 2020[25]	NHLBI Quality Assessment for Case Series Studies	7/9	Fair	Moderate Risk
Preda 2019[26]	NHLBI Quality Assessment for Case Series Studies	7/9	Fair	Moderate Risk
Sarrafpour 2019[27]	NHLBI Quality Assessment for Case Series Studies	7/9	Fair	Moderate Risk
Tan 2010[21]	NHLBI Quality Assessment for Case Series Studies	9/9	Good	Low Risk
Tekeli 2020[10]	NHLBI Quality Assessment for Case Series Studies	8/9	Good	Low Risk
Yelenskiy 2018[29]	NHLBI Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies	12/14	Good	Low Risk

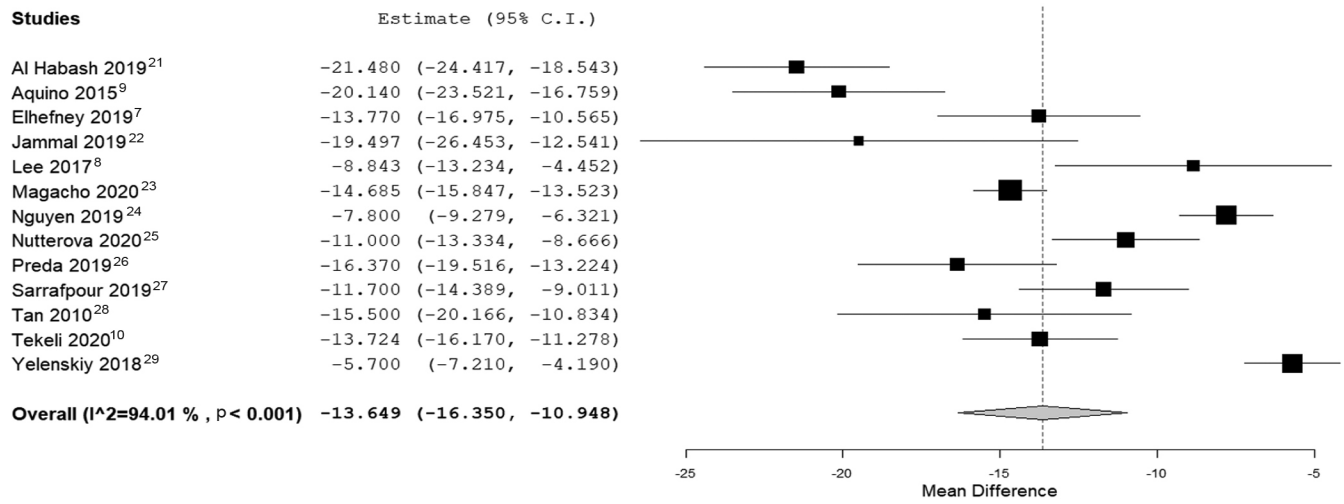

Figure 2. Forest plot representing the reduction of IOP (mmHg)

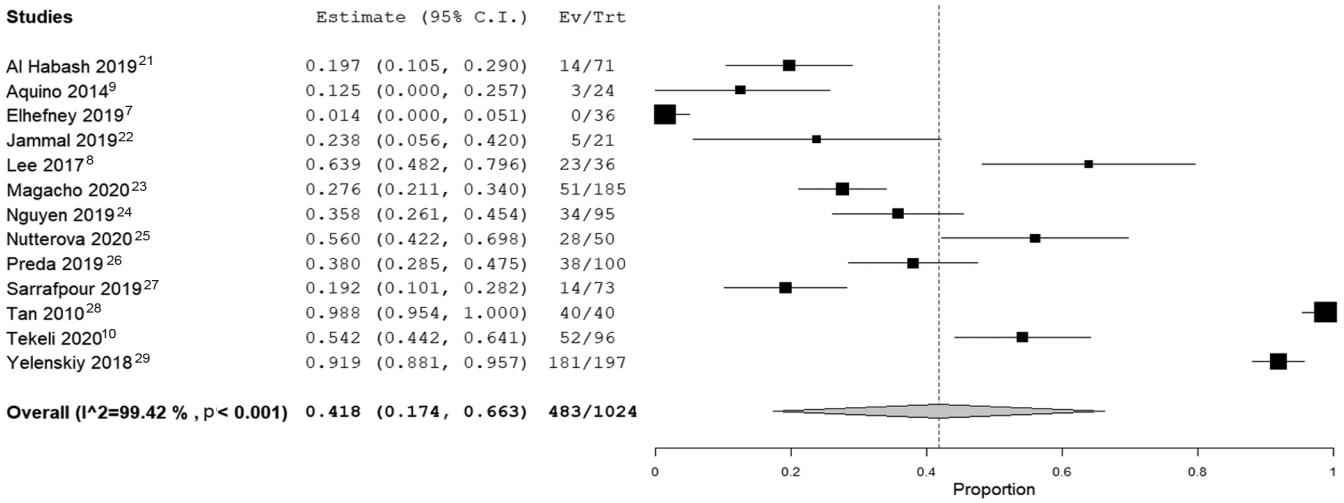

Figure 3. Forest plot representing the risk of complications after MP-TSCPC

Table 4. Summary of risk per complication

Complication	Random Effects Model - Risk (95% CI)	Heterogeneity
Post-operative Inflammation	0.257 [0.094 – 0.420] (p 0.002)	I^2 = 99.631% (p < 0.001)
Tonic Pupil	0.012 [0.004 – 0.020] (p 0.004)	I^2 = 37.634% (p 0.083)
Decreased Visual Acuity	0.013 [0.003 – 0.023] (p 0.011)	I^2 = 63.232% (p 0.001)
Scleral Thinning	0.004 [0.000 – 0.008] (p 0.031)	I^2 = 0% (p 0.998)
Hypotony	0.008 [0.002 – 0.015] (p 0.014)	I^2 = 28.342% (p 0.159)
Cystoid Macular Edema	0.009 [0.003 – 0.015] (p 0.002)	I^2 = 0% (p 0.962)
Ocular Surface Keratopathy	0.007 [0.001 – 0.013] (p 0.025)	I^2 = 25.841% (p 0.183)
Choroidal Effusion	0.005 [0.001 – 0.009] (p 0.026)	I^2 = 0% (p 0.979)
Hyphema	0.006 [0.001 – 0.012] (p 0.032)	I^2 = 21.648% (p 0.225)
Post-operative Pain	0.039 [0.017 – 0.061] (p < 0.001)	I^2 = 92.723% (p < 0.001)
Uveitis/Iritis/Posterior Synechiae	0.008 [0.002 – 0.014] (p 0.009)	I^2 = 15.483% (p 0.288)
Corneal Edema	0.004 [0.000 – 0.009] (p 0.029)	I^2 = 0% (p 0.999)
Subconjunctival Suffusion	0.004 [0.000 – 0.008] (p 0.029)	I^2 = 0% (p 0.665)
Conjunctival Hyperemia	0.004 [0.000 – 0.008] (p 0.029)	I^2 = 0% (p 0.775)

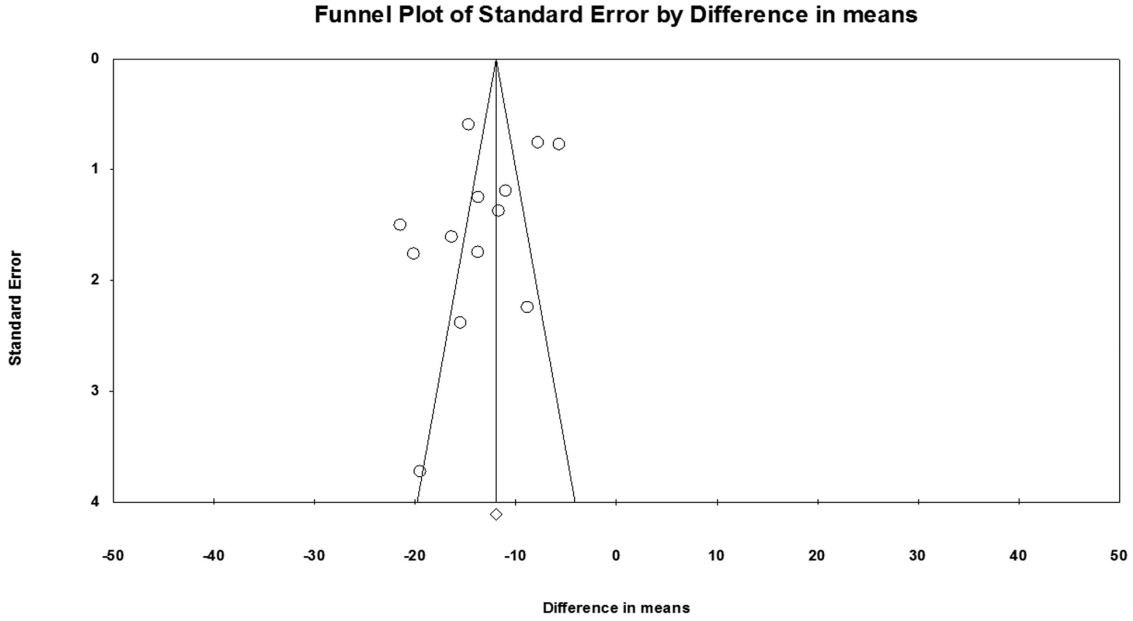

Figure 4. Funnel plot examining the IOP reduction

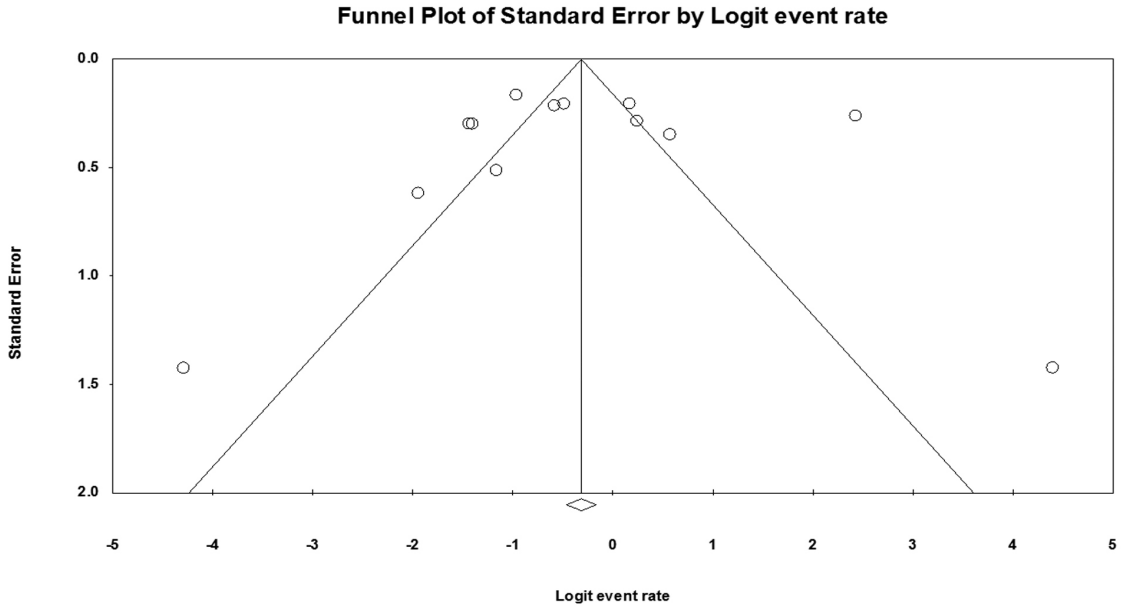

Figure 5. Funnel plot examining the risk of complications

crucial question is how effective IOP control is and how safe it is long term.

The research conducted a systematic review to determine the performance of Micropulse Transscleral Cyclophotocoagulation in patients with glaucoma. Intraocular pressure reduction and complication risks after a year post-operatively were the evaluated primary outcomes. During the search for relevant literature to be included in the systematic review, it was noted that there was a deficiency of published studies regarding this mode of treatment, especially those with longer follow-up duration, which is the primary limitation of this review. In their search, they included 13 studies; however, most of them were

case series. There were two observational cohorts and only one randomized control trial in this review. The variation in study designs would contribute to the heterogeneity of this review, and the lack of a sufficient number of studies led to a detection of a possible publication bias, which would suggest that additional research on MP-TSCPC is warranted. Additional studies with greater sample sizes and with a controlled setting are recommended. To better comprehend the efficacy in IOP control and safety profile of MP-TSCPC, it would be ideal if more controlled studies are conducted. Comparing with a different IOP controlling modality or a placebo would give a more weighted conclusion regarding the efficacy of the MP-TSCPC. The heterogeneity observed in the results of this review should be taken into consideration and should be treated with caution. Additionally, performing a subgroup analysis or even meta-regression may help explore the heterogeneity and use of asymmetry tests in future studies.

The results of the meta-analysis showed that there was a significant reduction in IOP even after a year post-treatment. Pooled analysis of the included studies showed a statistically significant IOP reduction (-13.649) after undergoing MP-TSCPC. Future reviews should include the reduction in the number of glaucoma medications after treatment of MP-TSCPC since the glaucoma medications are a factor in reducing the IOP. This would give significant strength to the analysis when there is a conjunction with IOP and medication reduction. Retreatment and laser parameters of MP-TSCPC can also be investigated further. Retreatment though not that common, may still be required for some cases, and previous study results confirmed that a higher laser setting around 90-100 seconds could reduce the incidence of retreatment.[10]

Meta-analysis showed that complications were frequently occurring (0.418). However, the common incidence would be postoperative inflammation (0.257) and postoperative pain (0.039). The postoperative inflammation, particularly of the ciliary body, has been hypothesized to result in the IOP-lowering effect of MP-TSCPC, consequentially in a transient reduction of IOP that disappears after the inflammation subsides IOP reduction is still maintained even after the advent of the inflammation.[28] The majority of the postoperative inflammation subsided in less than a month with postoperative medication of topical steroids, and no oral steroids were given.[29] Regarding postoperative pain, MP-TSCPC delivers less energy compared to traditional cyclophotocoagulation making it less painful. The pain was minimal in severity, with less than half complaining of some degree of pain.[29] In other studies, none experienced moderate to severe pain, and the mild pain was tolerable even with no oral analgesia.[28]

CONCLUSION

In conclusion, this meta-analysis suggests that Micropulse Transscleral Cyclophotocoagulation effectively reduces and controls the intraocular pressure of patients with any type of glaucoma even after a year post-operatively. MP-TSCPC is also a safe modality with a low complication rate consisting of less severe complications. However, since there is a lack of high-quality evidence on the subject as few randomized control studies were available and with the inclusion of heterogeneity of the included studies, present findings should be interpreted with due caution. A well-designed study with adequate sample size, blinded outcome, and long-term follow-up will provide a more statistically significant result.

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