Major Review

Micropulse diode cyclophotocoagulation: A review of the literature

ABSTRACT

Transscleral diode cyclophotocoagulation (CPC) has conventionally been reserved for refractory glaucoma, where other surgery is not feasible. The newer micropulse cyclophotocoagulation (mpCPC) has become popular in recent times and is increasingly being used as a primary surgery for glaucoma in eyes with good vision. The available literature on mpCPC and its mechanism, histological changes caused in the eye, the technique of usage, efficacy, safety, potential applications, and comparison with continuous wave CPC and other surgeries have been reviewed. Varying criteria for inclusion and different definitions of success in studies make a direct comparison between studies difficult. The lack of definite evidence to prove superiority of mpCPC and the potential for rare but reported sight threatening complications should be kept in mind, especially before using this in nonrefractory cases of glaucoma when other time tested options are available.

Keywords: Cyclophotocoagulation, glaucoma, intraocular pressure, micropulse diode

INTRODUCTION

Transscleral diode cyclophotocoagulation (CPC) achieves a reduction in the intraocular pressure (IOP) by the destruction of the pigmented ciliary epithelium and reducing aqueous production.[1,2] Due to its irreversible nature and a higher risk of rare, but sight-threatening complications such as hypotony, phthisis, sympathetic ophthalmia, and surgically induced necrotizing scleritis it has been reserved for refractory cases of glaucoma where filtering surgeries and glaucoma drainage devices are not feasible.[3-5] Micropulse lasers achieve targeted tissue damage and decreased damage to surrounding tissue. Initially used for retinal diseases, its use has expanded to glaucoma, including trabeculoplasty and in cyclophotocoagulation. Recent studies have shown a shift favoring micropulse diode cyclophotocoagulation (mpCPC) over CPC and also increasing the use of mpCPC earlier in glaucoma management and in eyes with better visual potential than those eyes that conventionally underwent CPC.[6,7]

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TECHNIQUE AND MECHANISM OF ACTION

MpCPC uses 810 nm light in the near-infrared region, similar to CPC. This light is absorbed by the melanin in the pigmented ciliary epithelium.[1-3,8] The difference lies in the delivery of energy. Micropulse laser additionally subdivides the energy into short pulses with specific "on" and "off" times, minimizing heat build-up and hence thermal damage to adjacent non-treated tissue. In a mpCPC device with a 31.3% duty cycle, the "on" time is 0.5 ms and "off" time 1.1 ms per cycle.[8]

Two devices in use are the Iridex cyclo G6 glaucoma laser system (Mountain View, California, USA) with the P3 probe and the Supra 810 nm Subliminal Quantel Medical

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laser (Cournon d'Auvergne Cedex– France) with the subcyclo probe. The Iridex cyclo G6 is more commonly used.[9]

A unique pars plana probe (P3 probe) is used in delivering the laser energy in mpCPC [Figure 1]. The ball lens tip contact probe houses a fiber optic cable 600 μ in diameter, with its hemispherical tip protruding 0.7 mm from the handpiece, enabling accurate positioning of the fiber optic tip 3 mm posterior to the limbus to target the pars plana, unlike in CPC where the laser is delivered 1.2 mm posterior to limbus targeting pars plicata. During mpCPC, the probe is applied perpendicular to the limbus, moved to and fro over each hemisphere in a continuous sliding manner avoiding 3 and 9'o clock as well as any areas of scleral thinning or bleb. Adequate firm pressure is applied to ensure contact with sclera at all times.[10,11] The sub cyclo probe has a glass ball at the tip for a smooth sweeping motion. This probe, however, does not have a footplate like the P3 probe. Hence, a marking must be made 3 mm posterior to the limbus to enable accurate probe placement. The sweep technique is similar to that with the P3 probe.[9]

The power settings in various studies vary from 1600 mW to 2500 mW over 100–360s for 360 degrees with up to 3000 mW power for retreatment eyes.[1,6,7,9,11-26] The time taken for the sweeping motion or dwell time varied from 5 to 12 s per hemifield.[6,7,12-14] One or both hemispheres may be treated in a sitting. Common power settings are 2000 mW and total 100–200 s for treating both hemispheres in one sitting with 10 s per sweep of a hemisphere.[1,6,7,9,11-26]

Recent modifications in techniques like the double session and MP3 plus, which increase the total energy delivered, have been reported.[7,26] Use of 25% duty cycle has also been reported.[9] The MP3plus technique described by Wong *et al*. uses a combination of 2 phases-an initial phase with a 31.3% duty cycle where energy is delivered by sliding motion like in routine application of mpCPC over 100s, followed by a second phase where additional discrete pulses of energy (1500–2000 mW) are focused over points for 2 s per spot similar to the technique of CPC and energy is decreased on hearing an audible pop sound. Unlike in CPC, the site of delivery is 3 mm behind the limbus and the energy is delivered in micropulses with a duty cycle of 40% (on 0.75s off 1.1s) in the second phase.[26] Magacho *et al*. described the double session micropulse technique where all patients underwent double sessions of micropulse per treatment. Each session used 2000 mW energy at a 31.3% duty cycle for 80–120s per hemisphere. The probe was then moved to the opposite hemifield and alternated between upper and lower hemifield till two sessions were completed in both hemifields. The energy was delivered for a total of 320–480 s per eye for each treatment.[7] Keilani *et al*. compared the results of a 25% duty cycle (on 0.63 ms, off 1.89 ms) versus a 31% duty cycle (on 0.5 ms off 1.1 ms) using the Supra 810 nm Subliminal Quantel Medical laser with the subcyclo probe.[9]

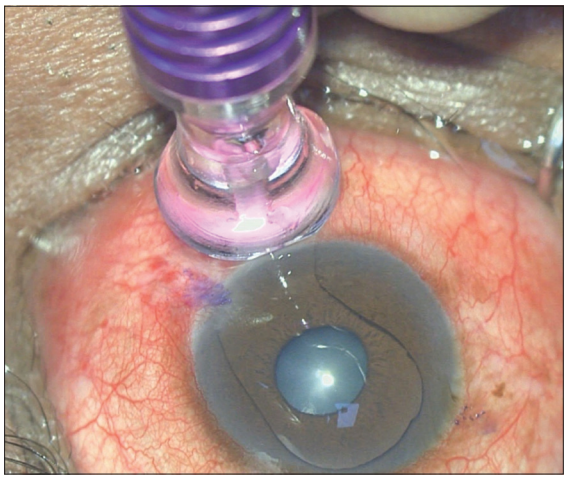

Figure 1: Micropulse cyclophococoagulation in an eye using the pars plana probe (P3 probe). A continuous to and fro sliding motion is used within a hemisphere avoiding 3 and 9'o clock

PATHOLOGICAL CHANGES

Pathological changes reported following CPC include damages to pars plicata, pars plana, ciliary muscle, and iris root.[2,27,28] Changes include the destruction of pigmented and nonpigmented ciliary epithelium and capillaries in the ciliary processes, coagulative necrosis, and destruction of ciliary muscle with a moderate reduction in vascularity.

Moussa *et al*. reported histopathological changes of the ciliary body following CPC in enucleated cadaveric eyes. There were significantly greater rates of separation of pigment epithelium from the stroma, coagulation of collagen, and destruction of ciliary stroma compared to the control eye. These changes were present in mpCPC eyes at rates similar to control eyes. Streak-like macroscopic whitening of the pars plana alone was reported in eyes that had undergone mpCPC. Interestingly, all the eyes that had undergone CPC in this study had macroscopic white spots in only the pars plana, unlike in most previous studies.[27-29] Although macroscopic streak-like whitening was reported in all eyes that had undergone mpCPC, there were no significant histological changes between the untreated eyes and mpCPC eyes. As these findings are contradictory, the question of whether mpCPC causes significant ocular changes or not is still inconclusive.

Although conjunctival changes are not clinically visible after mpCPC animal studies show significant inflammatory changes

in the conjunctiva compared to control eyes. Tan *et al*. reported changes similar to the changes found after CPC and included loss of goblet cells in the conjunctival epithelium, an increase in conjunctival stromal fibrosis, and increased infiltration of inflammatory cells and myofibroblasts. Immunohistochemistry also showed similar results between CPC and mpCPC groups, which were significantly higher than control groups when stained with leukocyte common antigen (pan-leukocyte) and CD4, markers.[30]

EFFICACY

Reported success rates of mpCPC are highly variable with success rates varying from 5.9% at 6 months in a prospective study in pediatric eyes with refractory glaucoma by Abdelrahman and El Sayed to 95.7% at 18 months in a prospective case series by Al Habash and AlAhmadi[13,19] Such wide variations in success rates are partly due to differences in the criteria for success such as the range of IOP and percentage of the drop in IOP included, use of IOP-lowering medication after the procedure (with lower rates where criteria for success includes no medication), repeat procedures (mpCPC and other glaucoma procedures) and whether eyes with serious complications with adequate IOP control are included in the successful group. Success rates also vary according to the follow-up duration, etiology of glaucoma, and whether the eye undergoing mpCPC is treatment naïve or an eye with refractory glaucoma with multiple prior procedures.[1,6,7,9,11-26] All these must be taken into account while analyzing the success rates in reported studies.

Most studies with adult eyes have a higher proportion of eyes with primary open-angle glaucoma (POAG) compared to other etiology.[6,7,9,12,14-18,20-22,24] POAG contributes to >80% of the total eyes included in the studies by Toyos and Toyos (100%), Yelenskiy *et al*. (88%), Sarrafpour *et al*. (86%) and Varikuti *et al*. (84%).[6,14,18,22]

Toyos and Toyos in their study of 26 eyes of 13 patients with mild to advanced POAG that underwent mpCPC with 2000 mW for 160s per eye reported a 30% IOP reduction and a decrease in IOP-lowering medication use to an average of 1.8 medications (baseline-3.3 medications) at final follow-up at 6–12 months. They report that none of the eyes underwent further incisional surgery though 7.6% required additional laser. The success rates are not mentioned in the study.[22] Yelinski *et al*. studied 197 eyes of 161 patients with a median follow-up of 12 months (range = 3–25 months) and reported a total success rate of 71% and a slightly higher success rate of 73% in POAG patients. However, 12.7% underwent concurrent procedures such as phacoemulsification, phacoemulsification and iStent and abinterno trabeculotomy with Kahook dual blade along with initial mpCPC. The total success rate in the group with additional concurrent procedures was 88% and in the eyes without these procedures 68%. Among all study eyes, 8% systemic acetazolamide use was reported at last follow up visit compared to 10% at baseline. The success rates were calculated based on maintenances of IOP of >6 and <18 mmHg or 20% reduction from baseline, no additional glaucoma procedures, and no loss of vision of ≥3 lines. Three significant independent predictors of total success on multivariable logistic regression were diagnosis ($P = 0.011$), previous glaucoma surgery ($P = 0.003$, higher success in eyes with prior glaucoma surgery), and other concurrent procedures ($P = 0.013$). POAG eyes had a higher total success than other diagnoses (odds ratio = 3.4; 95% confidence interval [CI] = 1.4–8.9), patients with previous glaucoma surgery had a significantly higher odds of total success (odds ratio = 2.9; 95% CI = 1.4–6.0) as did patients with concurrent procedures (odds ratio = 4.0; 95% CI = 1.2–14.2).[18] Sarrafpour *et al*. studied 73 eyes of 62 patients with best-corrected visual acuity (BCVA) ranging from 20/20 to no perception of light. Of these, 43.8% of eyes had BCVA of 20/20–20/70. The investigators varied the power applied from 2000 to 2500 mW for 100s per eye depending on the preoperative BCVA such that eyes with better acuity received less total energy. At 1-year follow-up of all eyes, the percentage IOP reduction varied from 30.1% to 57.2%. Multivariate analysis showed that baseline IOP and laser power used during mpCPC were associated with a reduction in IOP at 1 year.[14] Varikuti *et al*. studied 61 eyes of 46 patients with a baseline BCVA of ≥20/60, of which 75.4% of the patients had mpCPC as the primary glaucoma surgery. Complete success was defined as eyes that attained an IOP of 6–21 mmHg, had a reduction of IOP of ≥20%, and lost ≤2 lines of vision without the need for reoperation. The number of IOP-lowering medications was not considered in the definition of success. At 1 year, 75% achieved complete success.[6]

Tekeli *et al*. found a similar success rate between POAG, pseudoexfoliation glaucoma, and other secondary glaucoma of 68.75% (22/32), 66.6% (20/30), and 64.7% (22/34) ($P = 0.185$), respectively. Success was defined as IOP ≤18 mmHg, ≥20% reduction with or without medication at the final follow-up. The mean follow-up was 14.2 months (range = 12–16).[25]

The percentage of neovascular glaucoma (NVG) eyes vary from 5% to 40% in reported studies.[1,6,7,9,11-26] Tan *et al*. studied 40 eyes, of which NVG was seen in 40%. Success was defined as an IOP of 6–21 mmHg or ≥30% IOP reduction,

with or without topical IOP lowering medications at final follow-up (mean follow up 17.3 ± 2 months, range = 12–18 months). The need for a repeat mpCPC was not a criterion for failure. They reported a total success of 80% and a success of 50% (6/12) among NVG. On regression analysis, etiology was not identified as a predictor for failure.[1] Al Habash and Al Ahmad *et al*. reported higher success rates of 95.7% for the whole group and 91.7% in the NVG subgroup in a study of 71 eyes with 33.8% NVG (n = 24) and a mean follow-up of 12 months (range = 3–24). The criteria for success were similar to that defined by Tan *et al*. except that repeat mpCPC was considered a failure. In the study by Al Habash and AlAhmadi, the total energy was higher (2200 mW × 240s vs. 2000 mW × 100s), and only 14.1% had a prior history of surgical intervention for glaucoma.[13]

Thirty-six eyes with pediatric glaucoma of various etiology including primary congenital glaucoma (PCG, 47.2%), aphakic glaucoma (41.7%) and pseudophakic glaucoma (11.1%) was followed up after mpCPC by Elhefney *et al*. for a mean duration of 15.08 ± 1.1 months (range = 12–16).[12] The highest rate of success was recorded in aphakic glaucoma (75%) followed by PCG (73.3%) and pseudophakic glaucoma (50%) though no significant difference was seen between the three types (P = 0.61). The median age was 2 years (range = 0.5–14), and all eyes had a history of prior glaucoma surgery with a mean of 2.4 ± 0.5 surgeries per eye and mean time between the last glaucoma surgery and mpCPC of 2.7 ± 0.7 months (range = 2–4). Repeat mpCPC was not criteria for failure and 66.7% required a second session for IOP control with 8 weeks between the first and the second session.[12]

Lee *et al*. compared the results of mpCPC in pediatric (n = 9, age = 1–17 years) versus adult (n = 27, mean age 60.6 ± 17.7 years) eyes followed up for a minimum of 12 months.[20] The pediatric group comprised 44.4% Sturge Weber, 22.2% aphakic glaucoma and 11.1% each PCG, persistent hyperplastic primary vitreous and Peters anomaly with glaucoma. In the adult group, the common diagnoses were POAG (44.4%), steroid-induced glaucoma (18.5%), and NVG (14.8%). The success rates in the adult eyes were significantly higher (22.2% vs. 72.2%, P = 0.02), and more pediatric eyes (77.8%) required repeat procedures compared to adult eyes (11.1%). Repeat procedures for glaucoma was a criterion for failure in this study though the use of IOP-lowering medications was not. The authors have suggested variable anatomy and position of the ciliary process and the increased regenerative capacity in pediatric eyes to be possible causes for the increased failure in the group. This however, did not explain the higher rates of success by CPC reported in the literature.[20]

Abdelrahman and El Sayed prospectively compared a series of pediatric eyes that underwent mpCPC (n = 17) versus CPC (n = 28) and were followed up for 6 months.[19] The most common underlying etiology in the mpCPC and CPC groups included PCG (64% vs. 53%) and aphakic/pseudophakic glaucoma (18% vs. 32%). A complete success of 5.9% and 17.8% were seen in the mpCPC and CPC groups, respectively. The use of IOP-lowering medication and repeat glaucoma procedures was not included in the criteria for complete success. The qualified success on medication was higher in both the groups with values of 70.6% and 46.4%, respectively. The rates of qualified success in this study are higher than the success rates obtained by Lee *et al*. though both had similar criteria.[19,20]

COMPLICATIONS

Reported complications in studies include a drop in visual acuity, loss of light perception, hyphema, hypotony, prolonged anterior chamber inflammation, phthisis, cystoid macular edema [Table 1]. Neurotrophic keratitis with a persistent epithelial defect with difficulty in healing and recurrence has also been reported.[31] Drop in visual acuity by two or more lines have been reported to vary from 0% to 35.1%.[6,13,14,16,17,21] Increase in total energy (power and or duration) and a varying technique like the stop and go (reported by Williams *et al*.) where the probe is held in place for 10 s at a time before moving to an adjacent site are seen in studies reporting higher rates of drop in acuity.[17,32]

COMPARISON WITH INCISIONAL GLAUCOMA PROCEDURES

When comparing success rates of mpCPC with incisional glaucoma surgeries, the difference in criteria for success must be kept in mind. Many studies with mpCPC do not consider repeat mpCPC procedure or continuation of IOP-lowering medication as criteria for failure. There are also no comparative studies between the two procedures. The primary tube versus trabeculectomy study consisted of 242 eyes of 242 patients, with a large percentage of POAG eyes (87% in tube vs. 93% in trabeculectomy group) and no prior history of incisional surgery for IOP control. The complete success (without IOP-lowering medication) and additional qualified success of 14% and 67% were seen in the tube group and 59% and 33% in the trabeculectomy group at 1 year. Reoperation, including CPC for IOP control was the criteria for failure.[33] Al Habash and AlAhmadi reported the highest success rates of 95.7% after mpCPC in 71 eyes with a mean follow-up of 12 months (range = 3–24). The success rate in POAG was 93.3%, and they also reported high rates of success in NVG of 91.7%. Use of medication or repeat mpCPC were not criteria for failure, and the median number

Table 1: Reported complications after micropulse diode cyclophotocoagulation in various studies

Author (year)	Eyes	Energy (mW)	Time(s) for 360°	VA drop*	Hypotony	Persistent inflammation	Phthisis	Others
Tan *et al*. (2010)[1]	40	2000	100	0	0	0	0	H: 17.5%
Aquino *et al*. (2015)[11]	24	2000	100	4% PL-	0	4%	0	ST: 4%
Kuchar *et al*. (2016)[23]	19	2000	100-240	21% lost 1 line	5.3%	0	0	CE: 5.3%
Toyos and Toyos (2016)[22]	26	2000	160	12%	NA	NA	NA	
Emanuel *et al*. (2017)[21]	84	Mean: 1939, R: 1600-2000	Mean 319, R: 180-360	1 month: 35.1%, 3 months: 26.2%	3 months: 13.1%, 6 months: 7.7%	3 months: 46%	0	H, IOPS
Lee *et al*. (2017)[20]	P:9, A: 27	2000	160	NA	NA	0	NA	
Abdelrahman and El Sayed (2018)[19]	17	2000	100-120	NA	Transient 5.9%	NA	0	
Yelenskiy *et al*. (2018)[18]	197	2000	180-240	NA	0	NA	0	ME: 2%
Williams *et al*. (2018)[17]	79	2000†	300±42 R: 120-360	16.5%	8.8%	≥3 months: 26%	2.5%	ME: 5.1%, CE: 2.5%
Zaarour *et al*. (2019)[16]	75	2000	180	14%	0	0	0	
Nguyen *et al*. (2019)[15]	95	2000-2500 retreatment: Up to 3000	180	NA	Transient (IOP <5): 1.1%	0	0	H: 6.3%, SK: 10.5%, ChE: 3.2%, PM:3.2%
Sarrafpour *et al*. (2019)[14]	73	2000-2500 based on VA	100	18.80%	NA	NA	0	
Varikuti *et al*. (2019)[6]	61	2000	S: 78.39±6.82, I: 80.17±1.30	12 months: 20.83%	1.6%	0	0	CP: 40%, ME: 3.3%, CE: 1.6%
Al Habash and AlAhmadi (2019)[13]	71	2200	240	12.7% loss ≥3 lines, PL-: 0	0	1.4%	0	TP: 5.6%, IOPS (9 months): 37.3%
Elhefney *et al*. (2019)[12]	36	S: 1750-2000, I: 2000	110-130	NA	0	0	NA	
Souissi *et al*. (2019)[24]	37	2000	160	5.40%	NA	Transient 1 month: 8%	NA	
Tekeli and Köse (2020)[25]	96	2000	160	POAG group: 3.1%, PXFG group: 3.33%	2° glaucoma group (transient): 8.8%	0	0	
Keilani *et al*. (2020)[9]	40 eyes, 20 each in 31.3% and 25% DC	2000	100	0	31.3%: 5%	31.3%, 25%: 6 month=20%, 10%; 1 year=0%	0	31.3% DC: PM-10%; 25% DC: PM- 10%, PS: 5%
Magacho *et al*. (2020)[7]	185; G1-84, G2-101‡	2000	320-480	G1:1.2%	G2:0.99%	G1: 2.4%	G2: 2%	PM: G1-7.1%, G2-6.9%; ME: G1-1.2%, G2-3.9%
Wong *et al*. (2020)[26]	32	Ph 1-2000, 31.3% DC; Ph 2-1500-2000, 40% DC	Ph 1=100s, Ph 2=2/spot × 12-16 shots	15.6% PL-	0	0	0	

*Visual acuity drop refers to people who have lost 2 or more lines unless otherwise specified, †Laser delivered in stop and go pattern held in place × 10s before moving to adjacent site, ‡G1 – Group where the eyes underwent micropulse diode laser as primary glaucoma surgery, G2 – Group where eyes underwent prior surgical intervention for glaucoma, VA – Visual acuity, H – Hyphema, PL- – No perception of light, ST – Scleral thinning, NA – Not available, CE – Corneal edema, R – Range, IOPS – Intraocular pressure spike, P – Pediatric, A – Adult, ME – Macular edema, SK – Surface keratopathy, ChE – Choroidal effusion, PM – Persistent mydriasis, S – Superior, I: Inferior CP - Cataract progression, TP – Tonic pupil, POAG – Primary open angle glaucoma, PXFG – Pseudoexfoliation glaucoma, DC – Duty cycle, G – Group, Ph – Phase

of medications, at last, follow-up was 4 (range = 2–4). A prior history of glaucoma surgery or combined procedure was present in 14.1%.[13]

COMPARISON WITH DIODE CYCLOPHOTOCOAGULATION

The relative efficacy and safety of diode CPC compared to other methods of CPC was reported by Bloom *et al*. with a success of 66% at a mean of 10 months follow up. Complications included phthisis (0.5%), chronic hypotony (1%), corneal graft decompensation (1%), macular pucker (0.5%), and combined hyphema with vitreous hemorrhage (0.5%).[3] CPC, as a primary procedure, has also been suggested previously. Ansari and Gandhewar, in a retrospective study with a mean follow-up of 12 months (range = 4–30 months), reported total success rates of 82.4% and a higher success rate of 91.3% in POAG.

The series had no cases of hypotony or phthisis and 9% of all patients had complications, and the authors had suggested CPC as a modality of primary treatment in eyes with good visual acuity. In their study, there was no drop in mean vision following CPC in eyes with good visual acuity of 20/120 or more. However, 13% of those eyes had a worse final visual acuity.[34] This is similar to the results obtained by Toyos and Toyos after mpCPC where the preoperative mean visual acuity was 20/60 and a drop in vision by ≥2 lines was seen in 12%.[22] Recent publication of diode CPC results by Quigley in a dataset of 236 refractory glaucoma eyes with a larger percentage of POAG cases (44.1%) incorporated by oversampling had a total success rate of 70% at final follow-up with a median follow-up of 2.7 years (range = 0.17–11.2 years).[32] Success was defined as IOP reduced by 20% and ≤21 mmHg with no subsequent procedure for lowering of IOP, with or without medication. Phthisis was seen in 3% of study eyes, but 71.4% of eyes with phthisis were noted to have secondary ocular contributory conditions such as subsequent corneal or retinal surgeries. Only 20% of all eyes studied had a vision of 20/200 or better at initial follow-up and 54% of total eyes had a drop in vision by one category at final follow-up.[32] Aquino *et al*. compared the results of 24 eyes each that underwent mpCPC or CPC in a prospective randomized study. At 18 months, both groups had similar success rate (52% vs. 30%, $P = 0.13$). The reduction in IOP, use of medication, and retreatment rates were also similar among the two groups. A significantly higher complication rate was seen in CPC ($P = 0.01$), which also had a higher proportion of NVG eyes (29% vs. 50%).[11]

KNOWLEDGE GAP AND FUTURE DIRECTIONS

Being a relatively new modality, available literature on mpCPC is far from complete. Harry Quigley elegantly highlights the shortcomings in literature in a recently published editorial.[35] The sliding technique of application of the laser has no proven advantage over the traditional stationary technique.[35] Titration of energy levels for improved efficacy has been tried by some authors based on preoperative visual acuity.[14] However, no audible or visual cue exists for intraoperative titration. This may result in increased complication rates or decreased efficacy in depending on the variable pigmentation in the eyes. The mechanism for IOP reduction and the rationale for claimed better efficacy is also not very convincing.[35] The claimed mechanism of IOP reduction in mpCPC is by increasing uveoscleral outflow. Neither this mechanism of mpCPC nor its superiority or difference in inflow or outflow compared to CPC has been proven. Existing studies on monkey eyes or enucleated eyes with different site or technique of application do not show a quantifiable increase in uveoscleral outflow, or have shown IOP reduction with swelling of scleral collagen fibers which is incompatible with increased uveoscleral outflow.[35] Recent modifications to the technique like the MP3 plus, with additional stationary placement and titration according to the audible pop sound, have been described by investigators who had conducted the early mpCPC studies using the sliding technique. The authors have recommended the modifications for the treatment of eyes with refractory glaucoma and previously failed mpCPC. Even with the modified technique, the success rate was lower than most mpCPC studies, with 25.9% eyes successfully having a 20% reduction or an IOP of <25 mmHg without additional surgical intervention at 12 months.[26] There are no well-controlled studies with a large data set comparing incisional surgeries with mpCPC. In addition, in most studies using mpCPC, the surgical success is irrespective of medication use or repeat mpCPC. These differences must be accounted for when comparing success rates between the two techniques.

CONCLUSION

MpCPC can be considered an addition to the available procedures used for control of glaucoma. It however, is not foolproof and has its own share of complications. The biggest challenge has been the lack of large well-controlled studies on mpCPC and the variable definitions of success. The variability in success rates, the presence of complications, including sight-threatening ones and reported conjunctival changes following mpCPC calls for additional caution when considering this as a primary modality of treatment in glaucoma. As such, mpCPC may be used in refractory glaucoma instead of CPC with future studies determining the ideal parameters and further modifications in present protocols.

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Conflicts of interest
There are no conflicts of interest.

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