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20 Peer-Reviewed Studies of MicroPulse® Transscleral Laser Therapy

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Name of Study and Authors	Publication	Glaucoma Type	Glaucoma Stage	Mean Age (Years)	# of patients, # of eyes	Treatment Para-meters*	Follow-up (Months)	IOP Reduction (mmHg)	Medication Decrease	Success Rates	Conclusions & Observations
Early Results of MicroPulse Transscleral Cyclophotocoagulation for the Treatment of Glaucoma Nguyen AT, et al.	*Eur J Ophthalmol* 2019;11206 72119839303 Published online ahead of print	POAG, PXF, CACG, congenital and/or juvenile	Moderate to advanced	69.2 (range 16 - 95)	95 patients / 95 eyes	2000 to 2500 mW 90 secs per hemisphere	12	30.3 % average	1.6 (from 3.0 ± 1.1 to 1.4 ± 1.0)	76.8 % (1 treatment) 100 % (1 to 5 retreatments)	Micropulse transscleral cyclophotocoagulation appears to be a safe and efficacious treatment for glaucoma refractory to topical medical therapy. Given its improved safety profile compared to conventional TSCPC, it deserves consideration as a primary procedure.
MicroPulse Transscleral Cyclophotocoagulation: A Look at Long Term Effectiveness and Outcomes Sarrafpour SS, et al.	*Ophthalmology Glaucoma 2019;2167-171*	POAG, NVG, PXF	Advanced	73.7 mean (range 43 - 93)	62 patients / 73 eyes	2500 mW for LP or worse 2400 mW for HM or CF 2250 mW for 20/80 - 20/400 2000 mW for 20/20 - 20/70 100 secs (50 per hemi-sphere, 4 to 6 passes per hemisphere). Avoided 3 and 9 o'clock positions	12 minimum, mean 1.8 years	46 % average (from 25.5 to 13.8 at 1 year)	from 3.1 ± 1.1 to 2.5 ± 1.0 (19 % reduction) 11 of 15 pts taking an oral CAI pre treat-ment did not require it 1 year post treatment	Not noted	This study provides evidence that MP-TSCPC is a clinically useful procedure associated with good long-term medication burden reduction and IOP reduction that follows a dose response pattern related to power use.
Outcomes of MicroPulse Transscleral Cyclophotocoagulation in Uncontrolled Glaucoma Patients Zaarour K, et al.	*J Glaucoma* 2019;28(3): 270-275	POAG, secondary, PK, CACG, congenital, NVG, mixed mechanism, PXF, aphakia, aniridia, FHI, juvenile, unknown	Advanced	55.5 ± 22.9	69 patients / 75 eyes	2000 mW 90 secs per hemisphere	Mean 13.2 ± 3.04 (range, 1 to 15) 47 eyes (62.7 % reached 15-month follow-up)	35.4 % (from 26.0 to 14.8 at 15 months)	0.5 (from 3.53 to 3.03) Acetazolamide decreased significantly up to 15 months	81.4 % at 6 months 73.3 % at 12 months	MP-TSCPC is an efficient non-invasive glaucoma treatment that achieves sustained IOP reduction and reduced need for ocular antihypertensive medications for up to 15 months. The optimal laser parameters to achieve the best success rate with the least side effects still need to be determined.
MicroPulse Transscleral Cyclophotocoagulation in Keratoplasty Eyes Subramaniam K, et al.	*Comea* 2019;38(5): 542-545	POAG, PACG	Advanced	65 (range, 25 - 91)	57 patients / 61 eyes	2000 mW 80 or 90 secs per hemisphere	21 (range, 2 to 35)	35 % mean at 12 months	0.5 (from 2.7, range 0 - 4 to 2.2, range 0 - 4)	Graft survival was 94 % at 1 year and 81 % at 2 years after the initial laser treatment	MicroPulse transscleral cyclophotocoagulation is a noninvasive alternative to glaucoma filtration surgery for IOP reduction in keratoplasty eyes.

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Prospective Evaluation of MicroPulse Transscleral Diode Cyclophotocoagulation in Refractory Glaucoma: 1 year results Costa VP, et al.	*Arq Bras Oftalmol* 2019; 82(5):381-388	POAG, NVG, traumatic, silicone oil-induced	Advanced	61 ± 12.00	21 patients / 21 eyes	2000 mW Duration was at the discretion of the surgeon, considering target IOP and glaucoma diagnosis. Avoided 3 and 9 o'clock positions	12	41.59 %	from 3.48 to 2.00	66.67 %	MicroPulse transscleral diode cyclophotocoagulation was safe and effective for reducing IOP in eyes with refractory and advanced glaucoma, with reduced need for ocular antihypertensive medication.
Patient Outcomes Following MicroPulse Transscleral Cyclophotocoagulation Intermediate-term Results Yelenskiy A, et al.	*J Glaucoma* 2018;27 (10):920-925	POAG, NVG, uveitic, CACG, PK, ICE	Broad range	73 (range 19 to 96)	161 patients / 197 eyes	2000 mW 90 to 120 secs per hemisphere	12 mean (range, 3 to 25)	27 % average (from 21.5 to 15.8)	1 (from 3 to 2)	71 %	Our large longitudinal cohort study has provided evidence that MP-TSCPC is a safe and generally effective option in the treatment of POAG up to 12 months. This new method of delivery may be of help in patients who cannot take medications or delay incisional surgery. Patients at high risk of complications from incisional surgery can potentially use MP-TSCPC as an alternative. Given the safety profile (2 % complication rate in our study), MPTSCPC can also complement prior tube shunt or filtration procedures.
Efficacy and Safety of MicroPulse Transscleral Cyclophotocoagulation in Glaucoma Grippo T, et al.	*Arch Soc Esp Oftalmol* 2018;93 (12):573-579	Congenital, PXF, post-keratoplasty, mixed mecha-nism, aphakic, POAG, juvenile	Broad range	44.7 (range 11 - 79)	22 patients / 17 eyes	2000 mW Surgeon 1: 90 secs per hemisphere Surgeon 2: 80 secs per hemisphere Surgeon 3: 50 secs per hemisphere	7.9 mean (range, 6 to 14)	36 % in eyes that met the success criteria (6/22 eyes) (from 26.3 to 16.7)	Differences not recorded	Success Rates Overall 1 mo: 72.7 % 4 mo: 54.5 % (12/2 eyes) 6 mo: 41 % (9/22 eyes) Final: 27.3 % (6/22 eyes) Success Rates Based on Duration 90s: 75 % (3/4 pts) 80s: 21.4 % (3/14 pts) 50s: None (0/4 pts)	In a heterogeneous population of glaucoma (mostly congenital and pseudoexfoliation types), a low success rate (27.34 %) was obtained in the medium-term with a single session of Micropulse®. Patients with longer treatment durations (90 seconds per hemisphere) achieved better results.

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Outcome of MicroPulse Laser in Treatment of Open Angle Glaucoma in a Peripheral Hospital in Rivers State, Nigeria: Our Initial Experience Awoyesuku EA, et al.	*Advances in Medicine and Medical Research* 2019;29(2): 1-7	POAG	Moderate to advanced	37.42 ± 7.00	12 patients / 13 eyes	2000 mW 90 secs per hemisphere Avoided 3 and 9 o'clock positions	6	38.20 % Mean IOP change over 6 months was 10.46	11 out of 13 eyes showed a 50 % (3 to 1) reduction in the number of drops to achieve target IOP by 6 months	Not noted	MicroPulse Transscleral Cyclophotocoagulation is a safe and effective way of managing glaucoma. It caused a mean drop in IOP of 10.46mmHg (38.20%) over 6 months in our study.
MicroPulse versus Continuous Wave Transscleral Diode Cyclo-photocoagulation in Refractory Glaucoma: A Randomized Exploratory Study Aquino MC, et al.	*Clin Exp Ophthalmol* 2015;43(1): 40-6	POAG, PACG, NVG, silicone oil, aphakic, traumatic	Advanced	Micro-Pulse: 63.5 CW: 66	48 patients / 48 eyes MicroPulse: 24 eyes CW: 24 eyes	2000 mW 50 seconds per hemi-sphere Avoided 3 and 9 o'clock positions	18 months	45 % in both groups	from 2 to 1 in both groups	MicroPulse: 75 % @12 months, 52 % @18 months	Diode transscleral cyclophotocoagulation in both micropulse and continuous modes was effective in lowering intraocular pressure. The micropulse mode provided a more consistent and predictable effect in lowering intraocular pressure with minimal ocular complications.
Choroidal Thickness Increase after MicroPulse Transscleral Cyclophotocoagulation Barac R, et al.	*Romanian J Ophthalmol* 2018;62 (2):144-148	POAG, NVG, PACG, juvenile, trauma, RD surgery	Broad range	50 (25 to 85)	22 patients / 22 eyes	2000 mW 80 to 130 secs per hemisphere.	6	33.12% (from 35.23 to 23.56)	0.04 (from 3.14 to 3.1 at 6 months) Acetazolamide dropped from 1.18 to .27 dose per day (77.11 %)	Majority of cases	MP-TSCPC is a safe and effective treatment option for a variety of glaucoma types. It can be used in patients with advanced and mild glaucoma cases. Visual acuity was generally not affected by this procedure. In responsive patients, a significant growth in choroidal thickness was noted, which was maintained at 6 months follow-up. Non-responsive patients had no choroidal thickness gain postoperatively. Choroidal thickness variation may be the result of the rise in uveoscleral outflow after MP-TSCPC.
Clinical Efficacy and Safety Profile of Micropulse Transscleral Cyclophotocoagulation in Refractory Williams AL, et al.	*J Glaucoma 2018;27(5):445-449*	POAG, CACG, PXF, uveitic, NVG, pigmentary	Advanced	70.2	79 patients / 79 eyes	2000 mW Avoided 3 and 9 o'clock positions.	Mean 7.8 ± 4.5 months	51% average	.8 (from 2.3 to 1.5)	67%	MP-TSCPC is an effective treatment for patients with refractory glaucoma. Shorter treatment times with more frequent repeat treatments, if necessary, should be considered given the incidence of significant vision loss in this study.
Long-term Efficacy of MicroPulse Diode Transscleral Cyclophoto-coagulation in the Treatment of Refractory Glaucoma Aquino MC, et al.	Poster: European Glaucoma Society 2016	POAG, PACG, NVG, juvenile, secondary	Advanced	59.9	14 patients / 14 eyes	2000 mW 50 secs per hemisphere	78	39 % (mean)	0.7 (mean) (from 1.8 to 1.1)	67 % based on 14 pts @ 39 % IOP drop	Micropulse diode transscleral cyclophotocoagulation was effective in the long term IOP control of refractory glaucoma.

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MicroPulse Transscleral Diode Laser Cyclophotocoagulation in the Treatment of Refractory Glaucoma Chew P, et al.	*Clin Exp Ophthalmol* 2010;38(3): 266-72	NVG, POAG, PACG, aphakic, silicone oil induced, juvenile	Advanced	63.2	38 patients / 40 eyes	2000 mW 100 sec (50 sec per hemisphere) Avoided 3 and 9 o'clock positions and any area of thinned sclera	17.3 ± 2.0 mean (range 12 to 18 months)	35 % (from 39.3 to 26.2 at 18 months)	0.8 (mean) (from 2.1 to 1.3) 6 pts who required aceta-zolamide preop were able to stop day 1 post laser	72.7 % after a mean of 1.3 treatment sessions	Micropulse TSCPC is a safe and effective method of lowering IOP in cases of refractory glaucoma and is comparable with conventional TSCPC.
Outcome of MicroPulse Laser TSCPC on Pediatric vs Adult Glaucoma Patients Lee JH, et al	*J Glaucoma* 2017;26(10): 936-939	Adult: POAG; secondary: steroid, post corneal transplant, and trauma; aphakic, NVG, congenital Pediatric: Sturge-Weber syndrome, aphakic, The Peter anomaly, persistent hyperplastic primary vit-reous, primary congenital	Moderate to advanced	60.6	34 patients / 36 eyes	2000 mW 160 secs per hemisphere	12	Adults: 33.2 % (mean) Pediatric: 21% (mean)	0.5 (from 3.0 to 2.5)	Adults: 72.2 % Pediatric: 22.2%	MP-TSCPC is a safe procedure in pediatric and adult glaucoma patients, but the IOP reduction does not last long in pediatric patients.
Micropulse versus Continuous Wave Transscleral Cyclophotocoagulation in Refractory Pediatric Glaucoma Abdelrahman AM, et al.	*J Glaucoma* 2018; 27(10):900-905	PCG, phakia/ pseudophakia, aniridia, Peter's anomaly, microsphero-phakia, Sturge Weber	Advanced	Micro-Pulse: 67.8 ± 48 months CW: 61.3 ± 38.3 months	36 patients / 45 eyes MicroPulse: 17 eyes CW: 28 eyes	2000 mW 100 to 120 seconds Avoided 3 and 9 o'clock positions.	6	MicroPulse: 63% ± 28% CW: 67% ± 25%	From 2-4 meds to 0-4 meds	MicroPulse: 71% CW: 46%	Both the MP-CPC and CW-CPC are effective in lowering the IOP in children with refractory glaucoma. However, the rate of complications, pain, and inflammation seem to be lower with the micropulse mode, making it a safer alternative for cyclophotocoagulation, especially since retreatments are often needed.

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Outcomes of Micropulse Transsclera-l Cyclophotocoagulation in Eyes with Good Central Vision Varikuti VNV, et al.	*J Glaucoma* 2019; 28(10):901-905	POAG, CACG, Other	Mild to advance	68.80 ± 17.12	46 patients 61 eyes	2000 mW, 31.3% Laser Duration Superior hemifield: mean 78.39 ± 6.82 seconds Inferior hemifield: mean 80.17 ± 1.30 seconds. 10 seconds per hemifiled sweep Avoided 3 and 9 o'clock positions.	10.2 ± 3.1 months mean 49 eyes were followed to 12 months All pts had a min of 3 months follow-up	40.2% at 12 months with 85.4% of patients ha-ving an IOP reduction of ≥ 20%	0.82 ± 0.53 with 79.6% patients having a reduction of ≥ 1 medication at 12 months	75% complete success at 12 months 93.75% qualified success at 12 months	The significant reduction in IOP and glaucoma medication use, limited vision loss, less vision threatening complications and multiple logistical advantages, demonstrates MP-TSCPC as a safe and effective procedure. MP-TSCPC should be considered earlier in the management of glaucoma and can possibly be offered as an alternative to incisional glaucoma surgeries.
Outcome of MicroPulse® Transscleral Photocoagulation in Different Types of Glaucoma Al Habash A, et al.	*Clin Ophthal-mol* 2019; 13: 2353–2360. Published online 2019 Dec 2.	NVG, POAG, Secondary Keratoplasty Aphakia Keratopro-sthesis, Cyst excision ICS, Trauma	Moderate to advanced	60 (13 - 89)	68 patients 71 eyes	2200 mW 120 secs, 10 passes per hemisphere. Each sweep in one direc-tion was 12 seconds over 5 clock hours in the superior and then in the inferior hemisphere. Avoided thinned sclera, cystic blebs and tube devices.	12 months/ last follow-up, up to 24 months	Median 52% (0.0 - 89%)	1 from 5 (3-5) to 4 (2-4) All 44 pts taking Diamox pretre-atment did not require it at last follow-up	95.7% total at 6 months and remained unchanged at last follow-up 91.5% in 66.2% of pts who were on MTMT with no surgical intervention.	MP-TSCPC demonstrated good efficacy and safety profiles with minimal vision-threatening complications in treating a variety of glaucoma types. It is an encouraging treatment option for patients as a primary procedure in cases of high IOP or medication intolerance, and can be used as a temporary treatment session for patients with high IOP refractory to MTMT before proceeding to incisional glaucoma surgery, which can help decrease the postoperative risks associated with an elevated IOP. The efficacy and safety of µP-TSCPC for patients who previously underwent other glaucoma surgery was very promising. It was an ideal treatment option for patients with failed incisional surgeries and very high IOP, where additional incisional surgery would have been too risky.

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Micropulse transscleral cyclopho-tocoagulation using a standard protocol in patients with refractory glaucoma naive of cyclodestruction Souissi S, et al.	*Eur J Ophthal-mol* 2019	POAG, Uveitic, Congenital, Post-traumatic, Pigmentary, PXF, NVG, Juvenile, Malignant, CACG, Sturge Weber	Moderate to advanced	60.2 ± 18.1 (15–94)	37 patients 37 eyes	2000 mW 80 secs per hemisphere. Total energy delivered: 100 J. Avoided 3 and 9 o'clock positions, blebs and tubes.	9.7 ± 3.9 months	36% at 12 months	1.1 Withdrawal of acetazolamide achieved in 46% of cases (11/24).	35%	Using a standardized procedure, MicroPulse TSCPC allows a mild IOP decrease with a low rate of complications and thus achieves a relatively good profit risk benefit, mostly for moderately hypertensive refractory glaucoma. MicroPulse TSCPC was chosen as first-line surgical treatment for 27% of the patients because of the severity of their glaucoma to avoid potential complications related to sudden ocular decompression in case of incisional glaucoma surgery. 73% of patients had failed previous glaucoma surgery.
Double-session micropulse transsc-leral laser (CYCLO G6) for the treatment of glaucoma Magacho L, et al.	*Lasers Med Sci.* 2019 Dec 4. doi: 10.1007/s10103-019-02922-1	PXF, phakic, aphakic, POAG, con-genital, post vitreoretinal surgery, post penetrating keratoplasty, CACG, NVG, pseudophakic, pigmentary, uveitic, ICE, juvenile, trauma	Mild to advanced	55.6 +/- 20.7 years (range, 7 to 89)	76 patients 89 eyes	2000 mW 80 seconds per treatment with double sessions in each hemifield - 2x each hemifield, alternating between up-per and lower and upper and lower (total treatment time of 320 s). 10 seconds per hemifield. Avoided 3 and 9 o'clock positions.	16.7 ± 3.1	49%	1.7 48 eyes were also taking 2.9 ± 0.8250 mg acetazolamide daily. At last evaluation, no eyes were taking oral ace-tazolamide.	86.5%	MicroPulse P3 laser in two consecutive 80-s sessions was shown to be safe and effective in the treatment of glaucoma. In primary eyes, success was achieved in 90.3% of the cases (3 eyes did not require medication) with 1.2 ± 0.5 procedures per eye (83.9% with one, 9.7% with two, and 6.5% with three MicroPulse P3 laser procedures). Primary eyes required lower number of MicroPulse P3 laser procedures.

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Double-Session Micropulse Trans-scleral Laser (Cyclo G6) as a Primary Surgical Procedure for Glaucoma Magacho L, et al. GI Group = No previous glaucoma surgery (primary eyes) GII Group = Previous glaucoma surgery	*Journal of Glaucoma* 29(3):205-210, March 2020	POAG, post penetrating keratoplasty, post vitreoretinal surgery CACG, juvenile, PXF uveitic, trauma, post congenital cataract surgery, congenital, pigmentary, NVG, ICE	Mild to Advanced	GI: 64.4 GII: 54.4	GI: 65 patients 84 eyes GII: 78 patients 101 eyes	2000 mW Double sessions from 80 to 120 seconds per treatment in each hemifield. 10 seconds per hemisphere Avoided 3 and 9 o'clock positions	6 minimum; ~ 12 in both groups	GI: 41.2 ± 21.1% GII: 54.7 ±15.2%	GI: 1.7 GI: 1.4 All eyes (22 eyes in the GI group and 72 eyes in the GII group) were no longer taking Diamox at the last visit.	GI: 92.9% GII: 87.1%	Double-session MicroPulse P3 therapy could be considered as a safe and effective procedure to treat glaucoma in eyes that have not undergone any previous glaucoma surgery. Primary eyes achieved a success-rate similar to those with refractory glaucoma with fewer MicroPulse P3 procedures and fewer glaucoma medications.

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Indications for the MicroPulse P3 Device include, but are not limited to transscleral cyclophotocoagulation for the treatment of primary open-angle glaucoma, closed-angle glaucoma, and refractory glaucoma.

CACG: Chronic Angle Closure Glaucoma
CAI: Carbonic Anhydrase Inhibitor
CF: Count Fingers
FHI: Fuchs heterochromic iridocyclitis
GDD: Glaucoma Drainage Devices
HM: Hand Motion
ICE: Iridocorneal Endothelial Syndrome
NVG: Neovascular Glaucoma
LP: Light Perception
PACG: Primary Angle Closure Glaucoma
PCG: Primary Congenital Glaucoma
PK: Penetrating Keratoplasty
PXF: Pseudoexfoliation Glaucoma
POAG: Primary Open Angle Glaucoma
RD: Retinal Detachment

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