ISSN 2475-1278

THE OPHTHALMOLOGY OPEN JOURNAL

Openventio PUBLISHERS

Observational Study

Micropulse Transscleral Cyclophotocoagulation: Our Experience

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Article information
Received: February 10th, 2020; **Revised:** March 20th, 2020; **Accepted:** March 28th, 2020; **Published:** April 24th, 2020

Cite this article
Ahmad SS, Ghani SA, Khatoon G, Sagheer S, Ilyas J. Micropulse transscleral cyclophotocoagulation: Our experience. *Ophthalmol Open J*. 2020; 4(1): 1-4.
doi: 10.17140/OOJ-4-120

ABSTRACT

Introduction

Traditionally, ciliary body destruction has been used to treat uncontrolled intraocular pressure (IOP) following maximally tolerable medical therapy. This is due to the large number of complications seen with this procedure. However, recently a new technique of sub-threshold laser or micropulse laser, is able to provide selective destruction of the ciliary body in a controlled manner. This avoids most of the complications seen with other modalities. We have performed a small case descriptive pilot study to assess the effectiveness of micropulse transscleral cyclophotocoagulation (MP-TSCPC) in lowering IOP.

Methods

This pilot study was conducted on four patients in the age range 55-70-years with intractable glaucoma. Two patients had primary angle closure glaucoma, one-each had steroid-induced glaucoma and neovascular glaucoma. Mean baseline IOP was 32±2.4 mmHg. Mean number of glaucoma medications were 2.5±1.5. All patients underwent 180° MP-TSCPC. Absolute success was defined as IOP<20 mmHg without acetazolamide.

Results

Following the procedure the patients were followed-up at days 1,7,30 and 90. At the last follow-up of the study, mean IOP was 18.2±1.2 mmHg in all four patients. Mild anterior chamber inflammation was the only complication noted. Mean number of glaucoma medications reduced to 1.5±1.0 following the procedure. Thus, absolute success was achieved in all patients.

Conclusion

This small pilot study validates other studies which show effectiveness of MP-TSCPC as an efficient and safe procedure to lower IOP. This procedure can be used over a wide variety of cases, though the indications for such procedures are still evolving. More extensive and long-term studies will clarify the position of this procedure in our glaucoma management practices.

Keywords

Glaucoma; Micropulse laser; Cyclophotocoagulation.

INTRODUCTION

Glaucoma is a multifactorial neurodegenerative disorder. There are a number of risk factors involved in the pathogenesis of glaucoma. These include raised intraocular pressure (IOP), increasing age, race, family history of glaucoma, certain medical conditions such as diabetes mellitus and others. However, the only risk factor which can be controlled at present is IOP. This can be lowered either by reducing aqueous production by the ciliary body or increasing outflow through the trabecular meshwork (conventional pathway) or uveo-scleral tract (unconventional pathway). Certain drugs are able to act through these two aforementioned mechanisms. Glaucoma filtering surgeries and glaucoma drainage devices aim to decrease IOP by increasing aqueous outflow. Aqueous production can be decreased by utilizing surgical and laser methods for the destruction of ciliary body. These cyclodestructive procedures have been in clinical use for many years and provided mixed results.

Ophthalmol Open J. 2020; 4(1): 1-4. doi: 10.17140/OOJ-4-120

Cyclodestruction was previously reserved for refractory glaucoma.[1] This technique was utilized after maximally tolerable medical therapy was ineffective and the patient had pain, poor visual acuity or poor visual potential or other complications due to uncontrolled IOP. It has also been advocated when conjunctival scarring prevents any further surgery on the eye or when patients are unfit or refuse surgery. The rationale for limiting cyclodestruction to such above mentioned cases was the unpredictable nature of the procedure. In eyes with satisfactory visual potential, more conventional methods such as trabeculectomy or lens extraction were preferred.[2]

Conventional cyclodestructive laser procedures use continuous laser delivery to destroy the ciliary body. Therefore, the site of aqueous production, namely the ciliary epithelium is damaged. IOP falls as a direct consequence of reduced aqueous production. However, these lasers also cause collateral damage to tissues in and around the ciliary body. This has the potential of excessive reduction of aqueous humor production leading to ocular hypotony or even sympathetic ophthalmia. Such unpredictable results of these cyclodestructive procedures have precluded their use in eyes with some degree of visual potential.

Recently, a new technique of micropulse transscleral cyclophotocoagulation (MP-TSCPC) has been introduced. The potential advantage of this procedure is focused, repetitive ("on-off") delivery of laser energy to the pigmented ciliary epithelium. This avoids collateral damage and more controlled IOP reduction is possible. This technique has expanded the indications for cyclophotocoagulation in eyes which had previously been excluded from these procedures.

We undertook this small pilot descriptive observational study to assess the effectiveness of MP-TSCPC. Being a relatively new technique very few studies regarding this modality have been published. We have provided here the results of our study as well as a review of the currently available literature.

MATERIALS AND METHODS

The inclusion criteria for our study were patients with poor visual potential despite maximally tolerable medical therapy. Pain was not a requisite for including the individual in the study. Infact, only one patient in the study had ocular pain from the high IOP. Exclusion criteria were patients who had good visual potential or who were unfit for the procedure or those who refused the procedure.

Four patients in the age group 55-70-years were enrolled for the procedure. There were two males and two female patients. Two patients had primary angle closure glaucoma, one had steroid-induced glaucoma and one had neovascular glaucoma. The mean baseline IOP was 32±2.4 mmHg. Written informed consent was obtained from all patients. Absolute success was defined as IOP below 20 mmHg without oral acetazolamide. The study was performed after clearance from the Institutional Ethical Board and with consideration to the tenets of Declaration of Helsinki (Table 1).

All procedures were performed on the same day by one of the authors (SSA). Peri-bulbar anesthesia was used for the procedure using 2% lignocaine. Under aseptic precautions adequate exposure of the upper limbus was made. We performed MP-TSCPC using the Iridex MP3 machine, provided to us on loan. The laser was set to 2000 mW; total duration of the procedure was 1.6 millisecond (ms), including 0.5 ms "on" time and 1.1 ms "off" time, with 31.33% duty cycle. Only the upper 180° of the limbus was treated, avoiding the 3- and 9- o'clock area where the ciliary neurovascular structures are present. The probe was kept about 3 mm posterior from the limbus and perpendicular to the globe. In a "painting fashion" the probe was passed from one end to the other. Following the procedure an antibiotic-steroid ointment was applied and the eye padded for 24-hours.

The patients were seen in the clinic the next day and followed-up on day 7, day 30 and at day 90 after the procedure. During each visit parameters such as visual acuity and IOP were recorded. The symptoms and signs were noted by attending clinicians. At three months after the procedure the mean IOP was 18.2±1.2 mmHg; thus, absolute success was achieved in all four patients. No serious complications were noted during follow-ups. The only complication noted was mild anterior chamber inflammation which resolved within 30-days after the procedure. The number of glaucoma medications reduced from a pre-procedure mean of 2.5±1.5 to 1.5±1.0 post-operatively.

DISCUSSION

Historically, cyclodestruction by non-penetrating diathermy was first used by Weve.[3] Subsequently, Vogt[4] modified the technique so that a penetrating diathermy probe could be introduced through the sclera and destroy the ciliary processes. Experimental use of radium to destroy the vascular supply of ciliary body was reported by Haik et al.[5] The technique led to lens damage and was not used

Table 1. *Patient Characteristics*

S.No	Age (Years)	Sex	Type of Glaucoma	Mean preop IOP (mmHg)	Laterality	Mean postop IOP (mmHg)	Visual Acuity
1	64	Female	PACG	32	Right eye	16	HM
2	55	Male	SIG	34	Left eye	18	CF 1m
3	70	Male	NVG	36	Left eye	20	NPL
4	62	Female	PACG	30	Right eye	18	HM

PACG=Primary angle closure glaucoma; SIG=Steroid induced glaucoma; NVG=Neovascular glaucoma; HM=Hand movement; CF=Counting fingers; NPL=No perception to light.

clinically. Berens et al[6] used cycloelectrolysis by using low-frequency galvanic current. High-intensity focused ultra-sound was initially conceptualized by Purnell et al.[7] The most recent application of high-intensity focused ultrasound (HIFU) has been ultrasound cycloplasty. This procedure allows selective coagulation of the ciliary body and avoids possible damage to the adjacent ocular structures. In addition, stimulation of supra-choroidal and trans-scleral portions of the uveoscleral outflow pathway has recently been proposed as possible adjunctive mechanisms in reducing IOP.[8]

Finger et al[9,10] used trans-scleral microwave radiation to produce heat-induced ciliary body destruction. Weekers et al[11] used xenon arc photocoagulation to achieve transscleral cyclodestruction (TS-CPC). Vucicevic et al[12] used a ruby laser to achieve the first laser-induced transscleral cyclophotocoagulation. Later neodymium yttrium aluminum garnet (Nd:YAG) laser and finally diode laser were successfully incorporated as procedures for TSCPC.

Traditional TSCPC lasers, such as the diode laser, deliver continuous energy to the ciliary body. This has the potential to damage collateral tissues, leading to complications such as hypotony, visual acuity changes, sympathetic ophthalmia and phthisis bulbi. MP-TSCPC delivers repetitive, short bursts of laser energy in an "on-off" manner. The pulses of light are emitted in the infrared region (810 nm) and strongly absorbed by melanin present in the pigmented ciliary epithelium. During the "on" phase the thermal photocoagulative effect of the laser destroys the ciliary body. During the "off" phase the adjacent non-ciliary structures are allowed to cool, protecting them from thermal damage. This reduces the complications seen in traditional TSCPC. The mechanism of TSCPC is apparently through damage to ciliary body, increased uveoscleral outflow, inflammatory effect on the ciliary body, and activation of cellular biochemical cascades which cause decreased IOP.[13-16]

There are only a few studies on the efficacy of MP-TSCPC available in current literature. In a study of MP-TSCPC in refractory glaucoma conducted by Tan et al[17] a 30% reduction in IOP in 72.7% patients and reduction in glaucoma medications from 2.1 to 1.3 at 18-months of follow-up was reported. Aquino et al[18] has compared MP-TSCPC with continuous wave-TSCPC (CW-TSCPC) in 48 patients with refractory glaucoma. At 18-months of follow-up 52% in the MP-TSCPC group and 30% in the CW-TSCPC group were able to maintain an IOP of 6-21 mmHg (30% reduction from preoperative level). Mean number of glaucoma medications reduced from 2 to 1.[19] Kuchar et al[20] has reported his study of MP-TSCPC on 19 patients with advanced glaucoma. Atleast 20% lowering of IOP was achieved in 73.7% patients after 60-days of follow-up. Mean glaucoma medications reduced from 2.6 to 1.9. In another study by Emanuel et al[21] consisting of 84 eyes, MP-TSCPC achieved success in all patients by reduction of IOP from a mean of 27.7 to 11.1 mmHg (59.9% reduction). Glaucoma medications reduced from mean 3.3 to 2.3 after 12-months of follow-up. Gavris et al[22] in his study of MP-TSCPC in refractory glaucoma reported mean IOP reduction at one week in 60.3% patients and in 33.4% patients at one month. There was mean reduction in glaucoma medications by 0.71 at one month of follow-up. Williams et al[23] performed their study in which 79 patients with refractory glaucoma underwent MP-TSCPC. Following the procedure, IOP between 6-21 mmHg was achieved in 75% cases at 3-months and in 66% at 6-months. Mean number of glaucoma medications reduced from 2.3 to 1.5 at last follow-up. Our study provided better results compared to the above mentioned reports probably due to the small size of cohort and shorter follow-up. We plan to undertake a larger and longer evaluation after this pilot study.

CONCLUSION

Micropulse transscleral cyclophotocoagulation appears to be a useful addition to our armament of glaucoma management. The indications for the procedure are evolving. Presently, the treatment is being offered to patients in order to reduce the number of glaucoma medications or reduce ocular discomfort from raised IOP. We performed this small case descriptive pilot study to determine the protocol and efficacy of this procedure. As this was a pilot study we restricted our intervention to only those eyes who had limited visual potential. In this study IOP reduction was achieved in all patients with minimal complications at three months of follow-up. However, looking at the limited number of patients and types of glaucomas encountered during the study we recommend larger studies with longer follow-up and with different types of glaucoma. Such studies will provide us better understanding of the procedure and the possibility to extend it to other patients who have traditionally been kept out of the purview of cyclodestructive procedures. The exact status of MP-TSCPC at this time remains equivocal.

LIMITATIONS

Since the number of patients in our study are very small and restricted to a few types of glaucomas it is not possible to extrapolate the results to all types of glaucomas. Secondly, our follow-up was short (3-months) and so long-term results of the procedure are not available yet.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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