PHILIPPINE JOURNAL OF
Ophthalmology

VOL. 29 • NO. 4 OCTOBER - DECEMBER 2004

ORIGINAL ARTICLE

Single-setting treatment protocol for diode-laser transscleral cyclophotocoagulation

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ABSTRACT

Objective

To determine the efficacy of diode-laser transcleral cyclophotocoagulation (TSCPC) using a standard treatment protocol in the treatment of Asian patients with refractory glaucoma.

Methods

This is a prospective, noncomparative, interventional case series involving 35 eyes of 35 patients with refractory glaucoma and no previous cycloablation. After clinical examination and intraocular-pressure (IOP) measurements, diode laser TSCPC was performed using a standard protocol (30 shots over 270° at 1500 mW x 1500 msec). Patients were followed up at one day postoperatively, weekly for the first month, then every four weeks for 48 weeks. Complete success was defined as IOP less than 22mm Hg or an IOP reduction of at least 30% from pretreatment level. The pre- and posttreatment IOPs were analyzed by paired student t-test and the probability of success at different follow-up periods was determined by Kaplan-Meier survival analysis.

Results

Mean pretreatment IOP was 50.9 ± 12.8 mm Hg. Mean posttreatment IOP was 26.9 ± 10.7 mm Hg (45% reduction) at 24 weeks and 27.8 ± 10.9 mm Hg (40% reduction) at 48 weeks. The cumulative success rate was 80% at 24 weeks and 77% at 48 weeks. Twelve eyes (34 %) were retreated. Medications were reduced from a mean of 1.8 pretreatment to 0.4 at the end of the study period. Among the 28 patients who completed the 48-week follow-up period, visual-acuity score remained stable in 18 (64%) and deteriorated in 9 (32%). One patient experienced a 1-Snellen line improvement. Treatment complications included hyphema, tilting of an intraocular lens, severe inflammation, and conjunctival chemosis. No cases of phthisis, hypotony, or sympathetic ophthalmia were encountered.

Conclusion

The diode-laser treatment protocol using fixed settings (30 shots over 270° at 1500 mW x 1500 msec) was effective in controlling IOP in patients with refractory glaucoma. There was minimal risk of hypotony.

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Presented at the Annual Meeting of the Philippine Academy of Ophthalmology, November 2003.

The authors have no proprietary or financial interest in any product used or cited in this study.

Keywords: *Glaucoma, Diode laser, Transscleral cyclophotocoagulation, Intraocular pressure*

PHILIPP J OPHTHALMOL 2004; 29(4): 171-174

CILIARY body ablation in end-stage glaucoma had previously been performed with cryotherapy and neodymium:yttrium aluminum garnet (Nd:YAG) laser. Both techniques frequently involved considerable pain and postoperative inflammation, with an unpredictable final intraocular pressure (IOP) and a significant risk of phthisis.[1] Since the advent of the 810 nm semiconductor diode-laser, transcleral cyclophotocoagulation (TSCPC) has become the method of choice for ciliary-body destruction in refractory glaucoma.[2]

A standard laser dose has yet to be established to effect adequate IOP reduction while maintaining an acceptable margin of safety from overtreatment. Various treatment parameters utilize different combinations of power and duration settings as well as extent of treated area.[3,4,5] Some authors adjusted the power settings intraoperatively depending on the presence or absence of an audible "pop." But this crude method of "dosimetry," thought by some to represent ciliary body disruption, may not exactly be a sound basis for titrating power and duration settings.[6]

Setting the optimum treatment parameters has indeed become difficult considering the variability among published treatment protocols. The more pigmented Asian eye may yet present another variable in calculating the amount of energy delivered since abundance of pigment in these eyes may result in greater tissue absorption. Lower energy settings may therefore be justified.

This study evaluated the efficacy of TSCPC in reducing the IOP in patients with refractory glaucoma using a fixed energy setting in a sample of Asian eyes. We investigated the IOP reduction achieved over 48 weeks using a set treatment protocol, the number of medications used to control glaucoma, and the adverse effects of treatment. We also compared visual acuity before and 48 weeks after diode treatment.

METHODOLOGY

This is a prospective, noncomparative, interventional case series involving 35 patients of Asian descent recruited from the glaucoma section of the East Avenue Medical Center (EAMC) and the University of the East-Ramon Magsaysay Memorial Medical Center (UERMMMC) from July 2001 to August 2002. Included in the study were patients who have refractory glaucoma despite maximum tolerable medical treatment and were deemed poor candidates for or have refused filtering surgery, and patients who have failed glaucoma surgery. All patients had best-corrected visual acuity of ≤ 20/100 (6/30). Excluded were patients who have undergone previous cycloablative procedures.

The study complied with the requirements of the Declaration of Helsinki and was approved by the Institutional Review Boards of EAMC and UERMMMC. All participants gave informed consent.

Diode-laser cyclophotocoagulation was performed as follows. Anesthesia was administered via a 2 to 4 ml retrobulbar injection of an equal mixture of 2% lidocaine HCl (Elin Pharmaceuticals, Quezon City, Philippines) and 0.5% bupivacaine HCl (Sensorcaine, AstraZeneca, London, United Kingdom) accompanied by topical instillation of proparacaine HCl (Alcaine 0.5%, Alcon Laboratories, Fort Worth, TX, USA). Laser treatment was performed using the IRIS Medical OcuLight SLX (810 nm) diode-laser with G-Probe (IRIS Medical Instruments, Iridex Corporation, Mountain View, CA, USA). The laser energy was delivered through a 600 µm diameter quartz fiber within the G-probe handpiece to apply treatment 1.2 mm behind the limbus. Each laser application was spaced approximately 2 mm apart, using half the width of the G-probe footplate as a guide. A single-treatment setting of 1500 mw power and 1500 msec duration (2.25 J) was used for each application. Thirty shots were applied over 270° of the circumference of the limbus, sparing the supero-nasal quadrant. This setting was not altered during the course of the treatment session even if audible "pops" were noted.

Postoperatively, all previous glaucoma medications were discontinued and patients were prescribed prednisolone acetate 1.0% eye drops (Pred Forte 1%, Allergan, Irvine, CA, USA) every 4 hours. Follow-up examinations, which included visual acuity, IOP determination, and slit-lamp biomicroscopy, were performed on the first postoperative day, weekly for the first month, and every four weeks thereafter for the duration of the 48-week follow-up period. IOP-reducing medications were reintroduced as needed. Repeat diode-laser treatment was given at least 5 weeks following initial laser treatment to those whose first treatment failed. Repeat treatment consisted of additional 30 shots at the same power setting applied to the previously treated 270° and another 5 shots applied to 45° of previously untreated area.

Differences in pre- and posttreatment IOP were analyzed using the paired student t-test. The probability of success at different follow-up periods was determined by Kaplan- Meier survival analysis. Complete success was defined as IOP less than 22 mm Hg or a reduction of at least 30% from baseline levels. Qualified success was defined as IOP reduction at least 20% but less than 30%. A reduction of less than 20% was considered failure. Differences in initial and final visual-acuity scores and in the number of antiglaucoma medications required were evaluated using Wilcoxon-signed-rank test.

RESULTS

Thirty-five eyes of 35 patients of Asian descent (14 males, 21 females) with a mean age of 53 years (range 18 to 79 years) were included in the study. Most of the patients

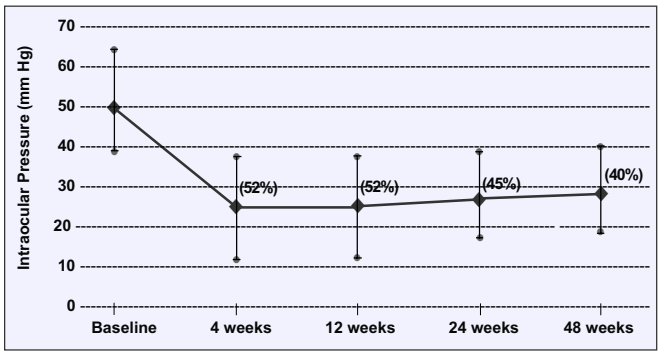

Figure 1. Mean intraocular pressure at baseline and follow-up. Percent decline from baseline shown in parentheses.

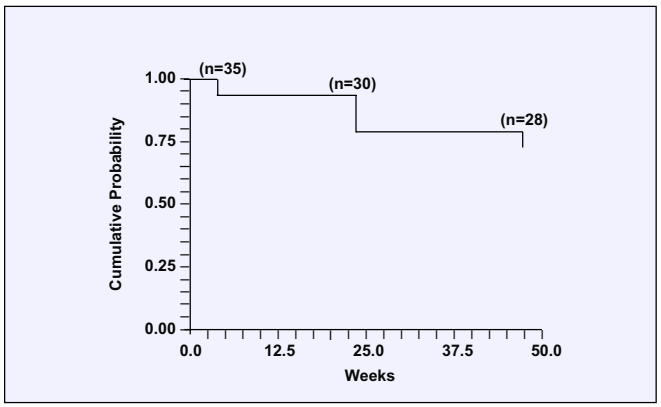

Figure 2. Kaplan-Meier survival analysis. The cumulative probability of success defined as IOP reduction >30% from baseline was 0.80 at 24 weeks and 0.77 at 48 weeks.

Table 1. **Treated eyes by type of glaucoma.**

Diagnosis/ Glaucoma Type	Single Treatment (n=23)	Retreatment (n=12)	Total (n=35)
Neovascular (NVG)	10	8	18 (51.4%)
Absolute	7	0	7 (20.0%)
Primary Open Angle	3	2	5 (14.3%)
Chronic Angle Closure	1	1	2 (5.7%)
Angle Recession	0	1	1 (2.8%)
Secondary Open Angle	1	0	1 (2.8%)
Secondary Angle Closure	1	0	1 (2.8%)

Table 2. **Mean intraocular pressure at baseline and follow-up.**

Time of Follow-up	Mean IOP(mm Hg)	Percent Decline	ANOVA *p* value
Baseline (n=35)	50.9 ± 12.8		
4 weeks (n=35)	24.9 ± 12.0	52.1 ± 18.1	< 0.001
24 weeks (n=30)	26.9 ± 10.7	44.9 ± 22.3	< 0.001
48 weeks (n=28)	27.8 ± 10.9	40.4 ± 25.5	< 0.001

(18) had neovascular glaucoma. Twelve of the 35 eyes were retreated (Table 1).

The mean IOP at 4, 24, and 48 weeks of follow-up was lower than at pretreatment ($p < 0.001$) (Table 2). A significant drop in IOP was seen during the first 4 weeks posttreatment, and the level was sustained (Figure 1). There was no statistically significant difference among the four follow-up measurements compared with baseline.

Thirty-three (94.2%) of the 35 eyes seen at the fourth week of follow-up met the criteria for complete success. This dropped to 23 at 24 weeks and 21 at the end of the 48-week follow-up period (Table 3).

Using the Kaplan-Meier life table analysis, the mean final IOP of the 28 eyes that completed 48 weeks of follow-up was 27.8 mm Hg ± 10.9. The cumulative probability of complete success was 80% at 24 weeks and 77% at 48 weeks after diode-laser TSCPC (Figure 2). The cumulative probability of qualified success was 83% at 24 weeks and 83% at 48 weeks.

The mean number of treatment sessions was 1.2 (range 1-2). Twenty-three out of 35 eyes (65.7%) had single treatment while 12 eyes (34.3%) had repeat treatment (Table 1). Retreatment of the 12 eyes resulted in 8 complete successes, one qualified success, and one failure at 48 weeks. Two patients from the retreated group failed to report for follow-up. The IOP at 24 and 48 weeks in each group did not differ significantly (Table 4). All retreatments were done between the 5th and 20th weeks.

At 48 weeks , 32% (9/28) of subjects suffered deterioration in visual acuity (Table 5).

The mean number of medications was 1.8 at baseline, which was significantly reduced to 0.4 at 48 weeks ($p < 0.001$). By the end of the study period, 64.3% (18/28 patients) of the remaining subjects were maintained without any topical or oral medication. At four weeks post-TSCPC, 87% (30/35 patients) were able to discontinue oral acetazolamide (Diamox, Wyeth Pharmaceuticals, Collegeville, PA, USA). After 48 weeks, 93% (26/28 patients) were maintained without oral acetazolamide.

In terms of adverse effects, 12 subjects reported posttreatment redness, foreign body sensation, and moderate eye discomfort. However, the symptoms were transient and resolved spontaneously after the first week of follow-up. One patient had severe inflammatory reaction with chemosis during the first week of follow-up. Another developed grade 1 hyphema, which resolved after the first week of follow-

Table 3. **Treatment results.**

Time of Follow-up	Success			Failure[c]	Dropout	Total at Follow-up
	Complete[a]	Qualified[b]	Total			
4 weeks	33 (94.2%)	0	33 (94.3%)	2 (5.7%)	0	35 (100%)
24 weeks	23 (65.7%)	2 (5.7%)	25 (71.4%)	5 (14.3%)	5 (14.3%)	30 (85.7%)
48 weeks	21 (60.0%)	3 (8.6%)	24 (68.6%)	4 (11.4%)	7 (20.0%)	28 (80.0%)

a. defined as IOP <22 mm Hg or ≥30% IOP reduction from baseline
b. ≥20% but <30% IOP reduction from baseline
c. <20% IOP reduction from baseline

up. One subject developed tilting of the lens after repeat diode therapy. At last visit, there were 2 patients who noted occasional recurrent eye pain that spontaneously resolved. No hypotony (IOP <5 mm Hg) or phthisis bulbi occurred.

DISCUSSION

Histopathologic studies in animals and humans have shown the relative selectivity of 810 nm diode-laser treatment for ciliary tissue.[7, 8] However, significant damage to pars plicata and pars plana has been observed in a study of enucleated, postcyclodiode eyes.[9] Determining the optimum dose in a procedure where tissue reaction cannot be directly observed is difficult.

Our general approach has been to adopt the lowest possible dose given the more pigmented Asian eye and apply it consistently hoping to establish a definite dose-response relationship. Interestingly, IOP reduction, cumulative success rates, and retreatment rates in this study were similar to those in other studies that used variable settings. Bloom et al., using the same treatment settings of between 20 to 40 shots, reported that 66% of their patients were controlled at 10 months. The mean number of treatments in their study was 1.75.[4] Walland also used the same treatment settings, but treated the entire limbus (40 shots to 360 degrees). He reported 90% control at 10 months.[3] Thus, it is probably easier to determine the amount of energy delivered in the "single-setting" strategy and propose the optimum dose for a particular patient.

Another important aim of treatment is to decrease the requirement for antiglaucoma medications. In end-stage refractory glaucoma, costly treatment is difficult to justify given the limited benefit for the patients. Diode-laser TSCPC effectively decreases medication requirement and almost abolishes the need for systemic medications (acetazolamide). This simple, minimally invasive, modestly expensive procedure may be the best choice for patient with limited financial capacity.

A persistent issue with diode TSCPC is a significant rate of visual deterioration after the procedure. In this study, 32% experienced visual deterioration while 64% had no change. Bloom et al., using the same settings, reported that visual acuity was worse in 29% and remained unchanged in 60% of their patients.[4]

Most patients in this study had neovascular glaucoma secondary to retinal ischemia and advanced glaucomatous damage. It is difficult, as in other studies, to equate the visual deterioration with the procedure itself. Properly designed studies should be done to investigate the potential of this procedure when used in eyes with better prognosis.

Studies involving new procedures generally suffer from limited application, small sample size, and limited duration of observation. In the future, as this procedure enters the mainstream of glaucoma treatment, we hope to see studies involving more patients, longer follow-up, and standard protocols.

The single-setting protocol used in this study for diode-laser TSCPC is effective in reducing IOP in Asian eyes and decreasing the number of glaucoma medications at the 48-week follow-up period, while exposing the patient to minimal risk of complications.

Table 4. **Single treatment versus retreatment.**

Treatment Group	Mean IOP (mmHg) Baseline	Mean IOP (mm Hg) Post-TSCPC (%decrease)	
		24 weeks	48 weeks
Single treatment (n=23)	47.2 ± 11.0	29.8 ± 11.5 (36.6)	29.9 ± 9.2 (36.7)
Retreated (n=12)	56.6 ± 15.6	26.2 ± 10.9 (44.0)	27.2 ± 10.9 (40.0)

Table 5. **Visual acuity outcome at 48 weeks post-TSCPC.**

Outcome	Eyes	Percent
Improved by 1 Snellen line (20/200 to 20/100)	1	3.6
Remained the same	18	64.2
Deteriorated by 2 grades (HM to NLP)	3	10.7
Deteriorated by 1 grade	5	17.9
CF[1] to HM = 1 HM[2] to LP = 2 LP[3] to NLP[4] = 2		
Deteriorated by 5 grades (20/100 to NLP)	1	3.6
Total	**28**	**100.0**

[1]counting fingers
[2]hand movement
[3]light perception
[4]no light perception

References

1. Assia EI, Hennis HL, Stewart WC, *et al*. A comparison of neodymium:yttrium aluminum garnet and diode-laser transscleral cyclophotocoagulation and cyclocryotherapy. *Invest Ophthalmol Vis Sci* 1991; 32: 2774-2778.
2. Samples, JR. Laser cyclophotocoagulation for refractory glaucomas. *Ophthalmol Clin North Am* 1995; 8: 401-410.
3. Walland MJ. Diode-laser cyclophotocoagulation: dose-standardized therapy in end-stage glaucoma. *Aust N Z J Ophthalmol* 1998; 26: 135-139.
4. Bloom PA, Tsai JC, Sharma K, *et al*. Cyclodiode: transscleral-diode laser cyclophotocoagulation in the treatment of advanced refractory glaucoma. *Ophthalmology* 1997; 104: 1508-1519.
5. Spencer AF, Vernon SA. Cyclodiode: results of a standard protocol. *Br J Ophthalmol* 1999; 83: 311-316.
6. Gaasterland D. Diode-laser transscleral cyclophotocoagulation: treating refractory glaucoma with the OcuLight SLX and G-Probe. *Iris Medical Newsletter* 2002; 7: 1-6.
7. Gaasterland DE, Pollack IP. Initial experience with a new method of laser transscleral cyclophotocoagulation for ciliary ablation in severe glaucoma. *Trans Am Ophthalmol Soc* 1992; LXXXX: 225-246.
8. Brancato R, Leoni G, Trabucchi G, *et al*. Histopathology of continuous wave neodymium:yttrium aluminum garnet and diode-laser contact laser transscleral lesions in rabbit ciliary body. A comparative study. *Invest Ophthalmol Vis Sci* 1991; 32: 1586-1592.
9. McKelvie PA, Walland MJ. Pathology of cyclodiode laser: a series of nine enucleated eyes. *Br J Ophthalmol* 2002; 86: 381-386.
10. Kosoko O, Gaasterland DE, Pollack IP, Enger CL. The Diode-Laser Ciliary Ablation Study Group. Long-term outcome of initial ciliary ablation with contact diode-laser transscleral cyclophotocoagulation for severe glaucoma. *Ophthalmology* 1996; 103: 1294-1302.