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Original Article / *Özgün Araştırma*

Transscleral Diode Laser Cyclophotocoagulation for Uncontrolled Intraocular Pressure Secondary to Emulsification of Silicone Oil

Silikon Emülsifikasyonuna Bağlı Kontrol Edilemeyen Göz İçi Basıncı Yüksekliğinde Transskleral Diod Lazer Siklofotokoagülasyon

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Summary

Purpose: To evaluate the efficacy and safety of transscleral diode laser cyclophotocoagulation (TDCP) for treatment of uncontrolled intraocular pressure (IOP) elevation secondary to emulsification of silicone oil (SiO) injection.

Material and Method: In this retrospective case series, forty-one eyes of 41 patients who underwent TDCP for uncontrolled IOP secondary to emulsified SiO were reviewed. Main outcome measures included visual acuity (VA), IOP changes, number of antiglaucomatous medication, and postoperative complications.

Results: Mean±SD follow-up was 30.2±10.3 months (range, 16-41 months). Mean preoperative BCVA was 20/666 and mean postoperative BCVA at final visit was 20/400 (p=0.02). Mean intraocular pressure (IOP) on the preoperative and last postoperative visit was 34.1±8.3 mmHg and 15.7±4.1 mmHg, respectively (p<0.001). The mean number of glaucoma medication was reduced from 3.1±0.6 at baseline to 1.1±1.2 at postoperative last visit (p<0.001). The postoperative complications were transient pain in 9 (21.9%) eyes and transient hypotony in 1 (2.4%) eye.

Discussion: TDCP is an effective and safe procedure for medically uncontrolled IOP secondary to emulsification of SiO. *(Turk J Ophthalmol 2013; 43: 178-82)*

Key Words: Diode laser, refractory glaucoma, silicone oil emulsification, transscleral cyclophotocoagulation

Özet

Amaç: Silikon yağı (SiY) emülsifikasyonuna bağlı gelişen kontrol edilemeyen göz içi basıncı (GİB) yüksekliği tedavisinde transskleral diod lazer siklofotokoagülasyonun (TSDLS) etkinlik ve güvenilirliğinin değerlendirilmesi.

Gereç ve Yöntem: Bu geriye dönük vaka serisinde, SiY emülsifikasyonuna bağlı gelişen kontrol edilemeyen GİB için TSDLS tedavisi yapılmış 41 hastanın 41 gözü incelendi. En iyi düzeltilmiş görme keskinliği (EİDGK), GİB değişiklikleri, antiglokomatöz ilaç sayısı ve postoperatif komplikasyonlar değerlendirildi.

Sonuçlar: Ortalama takip süresi 30,2±10,3 aydı (16-41 ay). Ameliyat öncesi ortalama EİDGK 20/666 ve ameliyat sonrası ortalama EİDGK 20/400 idi. (p=0,02). Ortalama GİB ameliyat öncesi ve ameliyat sonrası son vizitte sırasıyla 34,1±8,3 mmHg ve 15,7±4,1 mmHg idi (p<0,001). Ortalama anti-glokomatöz ilaç sayısı başlangıçta 3,1±0,6 den ameliyat sonrası son vizitte 1,1±1,2 ye düştü. (p<0,001). Ameliyat sonrası komplikasyon olarak 9 (%21,9) gözde geçici ağrı ve 1 (%2,4) gözde geçici hipotoni görüldü.

Tartışma: Transskleral diod lazer siklofotokoagülasyon SiY emülsifikasyonuna bağlı gelişen, medikal olarak kontrol edilemeyen GİB yüksekliği tedavisinde etkin ve güvenilir bir yöntemdir. *(Turk J Ophthalmol 2013; 43: 178-82)*

Anahtar Kelimeler: Diod lazer, refraktör glokom, silikon emülsifikasyon, transskleral siklofotokoagülasyon

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Introduction

Silicone oil (SiO) is frequently used as an endotamponade for complex retinal detachments as in eyes with proliferative vitreoretinopathy (PVR) or proliferative diabetic retinopathy. However, SiO leads to long-term complications including glaucoma, cataracts, and keratopathy.[1] The timing of SiO removal remains controversial. Many authors suggest the removal of SiO from the operated eye as soon as a stable retinal situation is achieved.[1] On the other hand, the rate of retinal redetachment after removal of SiO has been reported to vary between 6% to 31% and, therefore, SiO should be kept in the eye as long as possible.[2]

With time, SiO has a tendency to emulsify and break into smaller oil bubbles.[3] The silicone droplets may migrate through anatomically compromised areas such as broken zonules and ruptured posterior lens capsules. Emulsification of SiO has been reported to occur in 56% to 100% of cases over a period of months to years.[4,5] Several factors may contribute to SiO emulsification, including the use of low viscosity SiOs, reduced surface tension, residual fluid or hemorrhage in the vitreous cavity.[3,5-7] Also, many complications associated with the emulsification of SiO.[1,8]

Elevation of intraocular pressure (IOP) is a significant, common, and chronic complication of intraocular SiO. Use of anti-glaucoma medications controlled IOP in 30% of eyes.[9] When the IOP rise is resistant to medical treatment, the preferred treatment option is removal of SiO. The removal of SiO may be contraindicated in some eyes because of the potential risks of retinal redetachment or postoperative hypotony. However, removal of SiO alone may be insufficient in reducing IOP.

The main aim of treatment for SiO-related glaucoma includes decreasing the aqueous production. Transscleral diode laser cyclophotocoagulation (TDCP) has been demonstrated as an effective method in the treatment of intractable glaucoma.[10-12] In this study, we evaluated the efficacy and safety of TDCP in eyes with medically uncontrolled IOP secondary to emulsification of intravitreal SiO.

Material and Method

This retrospective study included 41 eyes of 41 patients who underwent TDCP for uncontrolled IOP secondary to emulsification of SiO. All surgeries (PPV and SiO injection) and TDCP treatment were performed between September 2003 and February 2007. The study protocol was reviewed and approved by the Local Ethics Committee. Informed consent was obtained from all of the subjects before the each treatment procedures.

Emulsification of SiO was determined with visualization of the anterior chamber angle by using a Goldmann goniolens, biomicroscopic evaluation of the anterior chamber, and a dilated retinal exam. Medically uncontrolled glaucoma was diagnosed when IOP control could not be achieved with maximal tolerated anti-glaucomatous therapy. Eyes with a pupillary block, a diagnosis of glaucoma prior to PPV, neovascular glaucoma, a history of other ocular diseases such as uveitis, and cases with previous history of any types of glaucoma or glaucoma surgery were excluded from the study.

Preoperative information such as age, gender, indications for PPV was recorded. The preoperative and postoperative examination included the best-corrected visual acuity (BCVA) with Snellen chart, slit lamp examination, IOP with Goldmann applanation tonometry, and dilated fundoscopy. Visual acuities were converted into a logarithm of the minimum angle of resolution (logMAR) score for analysis. Hypotony was defined as an IOP of <6 mmHg. Also, the anti-glaucomatous medications, number of TDCP treatment, and complications were collected from the medical records.

Technique of TDCP

The patient's periocular skin was prepared thoroughly with 5% povidone-iodine (Betadine, Purdue Fredrick Co., Norfolk, CT). After insertion of an eyelid speculum, patients received general anesthesia or local anesthesia by subtenon injection (60 mg lidocaine HCL and 5 mg bupivacaine HCL). TDCP was performed using a continuous-wave semiconductor diode laser system (wavelength 810 nm; Nidek, Tokyo, Japan). Energy was delivered through a 600 µm-diameter laser delivery G-probe (IRIS Medical Instruments, Mountain View, CA) placed 1.5 mm behind the surgical limbus. The laser power was adjusted to a "pop" sound and ranged 1500-2000 mW. The treatment consisted of 18 to 24 applications, and was performed for 2.0 seconds over a 180° circumference, avoiding the 3- and 9-o'clock positions. Postoperatively, antibiotic and steroid ointments were applied and the eye was patched for 4 hours. The patients received topical antibiotic five times a day and topical steroids 6 times a day for one week.

If IOP remained above 21 mmHg despite maximal-tolerated anti-glaucomatous therapy for more than 1 month after TDCP, the procedure was repeated. Success was defined as IOP≤21 mmHg with or without medication. A decrease in the number of medications was also considered as success. The main outcome measures included changes in IOP, VA, the number of medication and complications associated with the procedure.

Statistical Analyses

All statistical analyses were performed using statistical software (SPSS for Windows, Version 16.0; SPSS, Inc., Chicago, IL). The normality of the data was confirmed using the Kolmogorov–Smirnov test ($p>0.05$). Independent student's t-test was used to compare variables between groups. The 2-tailed paired t-test was used to evaluate preoperative and postoperative changes in study parameters such as IOP, number of anti-glaucomatous medications. Pearson's correlation was used to examine the relationships among the measured variables. Discrete variables were compared by using chi-square test or Fisher's exact probability test. A p-value of <0.05 was considered statistically significant.

Results

The study included 41 eyes of 41 patients. The patients' characteristics are shown in Table 1. The indications for PPV and SiO injection included rhegmatogenous retinal detachment (21 eyes, 51%), diabetic traction retinal detachment (DTRD) (10 eyes, 24%), retinal detachment with PVR (5 eyes, 12%), and traumatic retinal detachment (5 eyes, 12%). The mean ± SD number of vitreoretinal surgeries (PPV with and without SiO injection) before TDCP was 2.52±0.51 (range, 2 to 3).

At the time of TDCP treatment, four (10%) eyes were phakic, 25 (60%) eyes were aphakic, and 12 (30%) eyes had a posterior chamber intraocular lens with an intact posterior capsule.

Elevation of IOP occurred in 23 patients who had SiO in situ and in 18 patients who had no SiO. Emulsified SiO was seen in the angle or in the anterior chamber in all eyes. The mean duration of SiO tamponade was 9.4±2.3 months (range, 2-35) The mean overall follow-up period between intravitreal SiO injection and IOP rise was 10.5±9.0 (range, 1–24) months. TDCP was performed 3.1±1.7 weeks (range, 1-7 weeks) after the IOP elevation.

Overall, 27 patients (66.7%) required only one TDCP treatment and the remaining subjects received up to 3 treatments to control their raised IOP.

The mean reduction in IOP after TDCP was 18.4±7.2 (55%) mmHg. There was no significant correlation between age and the mean IOP reduction (r= - 0.150, p=0.35). However, a significant correlation was found between the baseline IOP and the mean IOP reduction (r = 0.863, p<0.001) (Fig. 1). There was no significant difference in mean IOP reduction between the phakic, pseudophakic, and aphakic eyes (p=0.937) (Table 2). Of the 41 eyes, 4 (9.8%) were on two medications, 26 (63.4%) were on three medications, and 11 (26.8%) were on four medications. Table 2 shows the mean IOP reduction according to gender, lens status, number of baseline medications, and presence of intraocular SiO.

Table 3 presents the mean IOP values and number of anti-glaucomatous medications at the baseline and during the follow-up period. Compared with pre-laser IOP, there was a significant difference in IOP on day 1, month 1, month 6, and at the final visit (p<0.001). The success rate was 52% at post-laser day 1; 84% at month 6, and 90% at final visit.

Also, the mean number of anti-glaucomatous medications was significantly lower on month 1, month 6, and at the final visit (p<0.001). While 12 patients (29.2%) needed oral acetazolamide before TDCP, only 2 patients (4.8 %) needed such treatment at final follow-up examination.

The mean preoperative BCVA was 20/666 (range, 20/125 to no light perception) and the mean postoperative BCVA at final visit was 20/400 (range, 20/100 to no light perception), which was a statistically significant improvement (p=0.02).

Preoperatively, six patients had corneal edema. Postoperatively, 5 eyes developed corneal edema on the first day, and only 1 eye had persistent corneal edema at the last visit. The main complication was transient pain in 9 eyes (21.9%), and it was resolved through a 1 to 2 week period. There was only one patient with hypotony, and it occurred 1 month after TDCP. Hypotony was resolved one week later.

Table 1. Patient demographics

Demographics	Number
Number of Patients	41
Gender	
Female	18
Male	23
Age, years	
Mean±SD	41±23
Range	7-75
Number of PPV	
Mean±SD	2.5±0.5
Range	2-3
Number of TDCP	
Mean±SD	1.3±0.6
Range	1-3
Follow-up (month)	
Mean±SD	30.2±10.3
Range	16-41

SD: Standard Deviation, PPV: Pars Plana Vitrectomy, TDCP: Transscleral Diode Laser Cyclophotocoagulation

Table 2. The mean IOP reduction according to gender, lens status and number of anti-glaucomatous medications

	Mean IOP Reduction, mmHg (Mean±SD)	P*
All of the eyes	18.4±7.2	
Gender		
Female	16.7±6.0	0.113
Male	20.3±7.7	
Lens status		
Phakic	16.5±1.0	0.73
Pseudophakic	19.8±6.8	
Aphakic	19.2±8.0	
Number of baseline antiglaucomatous		
2	10.5±4.6	0.047
3	19.8±7.2	
4	19.3±6.1	
Intraocular SiO		
In situ	20.9	0.008
Removed	15.1	

IOP: Intraocular pressure, SD: Standard Deviation, SiO: Silicone Oil

*: One-way ANOVA test

Tablo 3. The mean IOP values and number of anti-glaucomatous medications at baseline and during the follow-up period

	Pre-laser	Post-laser 1. day	Post-laser 1. month	Post-laser 6. month	Post-laser final visit
IOP (mmHg)					
Mean±SD	34.1±8.3	24.1±11.1	15.9±6.3	16.6±8.7	15.7±4.1
Range	28-53	10-50	2-32	8-48	9-22
P* values		0.001	<0.001	<0.001	<0.001
Number of AG					
Mean±SD	3.1±0.6	2.3±1.4	1.4±1.2	1.1±1.2	
Range	2-4	0-4	0-4	0-4	
P* values			0.006	<0.001	<0.001

IOP: Intraocular pressure, SD: Standard Deviation, AG: Anti-glaucomatous

*: 2-tailed paired t-test

During the follow-up period, no serious complications secondary to the TDCP procedure (such as retinal detachment, hemorrhage, infection, phthisis) were noted.

Discussion

IOP elevation after a PPV and SiO injection is a challenging management problem for an ophthalmologist. The reported prevalence of IOP elevation following SiO injection varies among studies, ranging from 6% to 48%.[13-16] Among the risk factors for IOP elevation after SiO injection, a history of preexisting glaucoma, SiO bubbles in the anterior chamber, emulsification of the SiO, diabetes mellitus, and aphakia have been reported.[9,14,17,18] Although the exact mechanism of IOP elevation is unknown, there are many theories about the role of SiO in IOP elevation. The secondary glaucoma following the use of SiO with retinal surgery may be caused by migration of emulsified oil to the anterior chamber, synechial angle closure, rubeosis iridis, pupillary block, and inflammation, or a combination of these.[17,18] However, prophylactic surgical inferior iridectomy reduces the risk of pupillary block glaucoma in aphakic eyes. The migration of emulsified oil to the anterior chamber and into the trabecular meshwork may mechanically obstruct the trabecular meshwork or it may cause inflammation of the trabecular meshwork, leading to decreased outflow facility.[18]

The medical treatment of SiO-related glaucoma includes decreasing the aqueous production with aqueous suppressants and reducing the inflammatory response using steroids. However, in many patients, IOP may not be sufficiently controlled with medical treatment. SiO removal for the reduction of IOP remains controversial and it may be insufficient for control of glaucoma.[19-21] Although, the removal of SiO as early as possible will decrease its potential ocular side effects, this is not always desired because of the risk of redetachment. The retinal redetachment has been reported in up to one in three patients especially in cases with previous complex vitreoretinal pathology.[22,23] The glaucoma filtration surgery for refractory glaucoma secondary to PPV and SiO injection is frequently unsuccessful because of pre-existing conjunctival scarring following previous vitreoretinal procedure.[15] Glaucoma drainage implants may be an alternative surgical procedure, but SiO migration may occur through the tube into the subconjunctival space and result in an inflammatory reaction.[24], 25 A 60% of success rate has been reported with Molteno implant surgery in eyes with SiO-related glaucoma.[22]

TDCP is an alternative treatment for IOP control in refractory glaucomas. Its success rate varies from 66% to 86%.[11,12,17] According to our best knowledge, this is the largest study that evaluates the results of TDCP in eyes with medically uncontrolled IOP secondary to emulsification of SiO. Our present study suggests a long-term success (IOP<21 mmHg) rate of 84% at 12 months and 90% at final follow-up visit of up to 41 months. The mean reduction in IOP was by 18.8 mmHg, achieving a mean reduction of 55%. Bloom et al achieved a 51% reduction in mean pre-treatment IOP in 36 patients with SiO-induced glaucoma and their overall success rate was 69% for an IOP under 22 mmHg.11 Sivagnanavel et al reported a 44% IOP reduction with TDCP at final follow-up visit.[26] However, Han et al reported 100% success in IOP reductions at the final follow-up.[12] But several factors, such as length of follow-up period and number of patients (11 patients) are the limitations of their study.

We found a mean of 18.4±7.2 (55%) mmHg IOP reduction after TDCP. There was no significant difference between the groups in terms of lens status and gender. However, mean IOP reduction was significantly lower in patients who were on two medications than in patients who were on three or four medications. Scholte et al reported that TDCP was less effective in younger patients with refractory glaucoma.[27] Our study showed no significant correlation between age and mean IOP reduction. The study also found a significant correlation between baseline IOP and mean IOP reduction.

In addition to IOP control, TDCP treatment has an important role in reducing the need for the long-term use of systemic and topical medication and the expected side-effects associated with this. In this study, there was a significant

reduction in the number of medications pre- and post-laser treatment. Also, a systemic carbonic anhydrase inhibitor was used to lower IOP in only 4% at the final follow-up compared to 29% prior to TDCP. Sivagnanvel et al reported that the mean number of IOP-lowering medications reduced from 2.6 to 1.[26]

The complications after TDCP include conjunctival burns, pain, vision loss, hyphema, uveitis, cataract progression, hypotony, choroidal detachment, and phthisis.[12,26,28-30] In our study, the main complication was transient pain in 9 eyes. However, no serious complications such as inflammation and phthisis occurred. Hypotony is a common side effect after cyclodestructive procedures. Cyclodiode treatment has a lower incidence of hypotony compared to cyclocryotherapy. Suziki et al reported an 8% incidence after TDCP.[31] Schuman et al reported a 10% incidence of hypotony and phthisis after cyclophotocoagulation.[32] Also, Sivagnanavel et al.[26] reported chronic hypotony in two patients (11%) after TDCP in patients with refractory glaucoma secondary to intravitreal SiO. In our study, hypotony occurred only in one patient at 1 month and it was resolved one week later.

Although the study aims to encourage clinicians to use TDCP for medically uncontrolled IOP secondary to SiO emulsification in patients with and without SiO as internal tamponade, it has some limitations. The main limitations of our study are its retrospective nature and the absence of a control group to distinguish the adverse effects of the treatment from the natural history of the underlying disease.

In conclusion, the TDCP treatment appears to be an effective and safe procedure for the treatment of medically uncontrolled IOP secondary to PPV and intravitreal SiO injections. Also, TDCP reduces the number of systemic and topical anti-glaucomatous medications and their side effects.

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