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ORIGINAL PAPER

Retrospective review on the outcome and safety of transscleral diode laser cyclophotocoagulation in refractory glaucoma in Chinese patients

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Abstract

Purpose Transscleral cyclodiode laser cyclophotocoagulation (TSCP) is often reserved for treatment of refractory glaucoma. This retrospective study investigates the safety and efficacy of TSCP among the Chinese population.

Methods A retrospective review was performed on electronic patient records of all patients receiving TSCP between years 2009 to year 2016. Patient demographics, indication for laser, success and response rate, change in intraocular pressure (IOP), number of treatment sessions, laser energy, glaucoma medication, visual acuity, pain symptoms and complication rate were documented.

Results The study included 126 patients: 81 patients were male and 45 were female, and the mean age was 66.6 ± 14.3 years old and the mean follow-up was 22.7 ± 14.1 months. The mean number of treatment sessions was 1.5 ± 0.8. The success rate was 67.3%. The mean IOP before TSCP was 67 ± 38.6 mmHg and 22.8 ± 14.2 mmHg after TSCP, the mean IOP reduction was 38.4%, which was statistically significant (P value < 0.001, Wilcoxon signed rank test). The mean laser energy used per eye was 72.7 ± 56.6 and 49.2 ± 22.9 J per individual treatment session. The mean number of laser shots was 15.0 ± 6.1. 71% of patients were able to reduce their glaucoma medication after TSCP, (P value < 0.01, Wilcoxon signed rank test). 86.1% of patients had improvement in pain symptoms after TSCP. The overall complication rate was 7.1%.

Conclusion TSCP was found to be safe and effective among the Chinese population, with comparably low laser energy setting and complication rate. It was found to be most effective in treatment of glaucoma due to trauma, acute angle closure, uveitis and chronic angle closure.

Keywords Transscleral cyclodiode photocoagulation · G-probe · Refractory glaucoma · TSCP · Chinese · Pigmented eye

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Introduction

The destruction of the ciliary body has been used for a long time to treat glaucoma. The mechanism of action is to decrease aqueous production by destroying the

ciliary body secretory epithelium. Many modalities can be used to achieve cyclodestruction, such as diathermy, surgical excision, cryotherapy, ultrasound and laser light. Transscleral cyclophotocoagulation (TSCP) with semiconductor laser diode of 810 nm wavelength is now commonly used. The indications of TSCP include refractory glaucoma, failed conventional trabeculectomy or tube shunt surgeries, minimal useful vision but persistent elevated intraocular pressure, painful eyes in need for pain relief and patients who either refuse surgery or are unsuitable for surgery due to poor general condition or severe conjunctival scarring. More common complications following TSCP include pain which can usually be relieved by analgesics or non-steroidal anti-inflammatory drugs (NSAIDS), uveitis, inflammation, eye lid swelling, hyphema, cystoid macular edema, conjunctival scarring and hypotony. More severe complications include phthisis bulbi, sympathetic ophthalmia, hypotony, scleral burn, scleritis, malignant glaucoma and perforation. Due to the destructive nature of the procedure and risk of complication, TSCP is usually reserved for cases of refractory glaucoma. With advances in glaucoma medication, surgical techniques and adjuncts, TSCP is now less commonly performed. Many studies have demonstrated various degrees of efficacy and safety in using TSCP [1–6]. Many factors can affect its outcome, and this can vary between different population groups and disease etiologies [1, 3, 4, 7]. This retrospective study investigates the outcome of TSCP in the Chinese population.

Method

A retrospective review was performed on electronic patient records of all patients receiving TSCP from January 2009 to June 2016.

Inclusion criteria:

- First TSCP treatment done from January 2009 to June 2016.
- At least 6-month follow-up

Exclusion criteria:

- Retreatment case (i.e., the first TSCP done prior to 2009)

Patient demographics including age and gender, duration of follow-up, indication for TSCP, type of glaucoma, snellen visual acuity before and after TSCP, intraocular pressure (IOP) before and after TSCP, number of glaucoma medication before and after TSCP, laser energy, number of treatment sessions and presence of complications were all documented. A treatment session is defined as each TSCP treatment for a single eye within a single session. Success in IOP control is defined as IOP between 5 and 21 mmHg or greater than 30% IOP reduction after laser. Response is defined as IOP less than 22 mmHg or greater than 30% IOP reduction after laser (including eyes with hypotony, i.e. IOP < 5 mmHg).

The procedure is done under topical and regional anesthesia with the patient lying supine. A speculum is used to maintain good exposure of the eye. The laser probe is held parallel to the visual axis next to the limbus. This will center the fiber optic 1.0–1.2 mm posterior to the limbus, directly over the ciliary processes. The laser power is titrated depending on the presence of a 'pop' sound. If no 'pop sound occurs during the first or second laser application, the laser power is increased in 100 mW increments. If there is 'pop' sound more than once, laser power will be reduced by 100 mW decrements subsequently. Topical antibiotic and steroid eye drops is applied followed by an eye pad after the procedure. The patient is prescribed with steroid eye drops and oral analgesics upon discharge.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the local Institutional Review Board (IRB) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Statistical significance of difference of IOP and glaucoma medication before and after TSCP was analyzed with Wilcoxon signed rank test, with P value < 0.01 being considered significant.

Results

Between January 2009 and June 2016, 126 patients (126 eyes) fulfilled the inclusion and exclusion criteria for the study, including 81 (64.3%) male and 45 (35.7%) female, ages ranged from 30 to 92 years old (mean 66.6 $\pm$ 14.3 years old), 54.8% in the right eye and 45.2% in the left eye. The follow-up period was 7–43 months (mean 22.7 $\pm$ 14.1 months).

Among the 126 patients, the most common causes of refractory glaucoma included central retinal vein occlusion (CRVO) in 33%, primary open angle glaucoma (POAG) in 17.5%, chronic angle closure glaucoma (CACG) in 13.5% and proliferative diabetic retinopathy (PDR) in 7.9% (see Table 1).

In our study, number of treatment sessions range from 1 to 5 (mean 1.5 ± 0.8). Among the 126 patients, 40% required retreatment. 67.5% only required 1 treatment session, while 32.5% required more than 1 treatment session (see Table 2). The retreatment rate was highest in retinal detachment (see Table 3).

Regarding success rate, 67.3% achieved success after TSCP according to the definition of success. As no cases had IOP below 5 mmHg, the response and success rates were the same. The IOP ranged from 8 to 67 mmHg (mean 38.6 ± 14.4 mmHg) before TSCP, while IOP ranged from 6 to 59 mmHg (mean 22. ± 14.2 mmHg) after TSCP. The IOP reduction after TSCP was 38.4%, which was statistically significant (P value < 0.001, Wilcoxon signed rank test). The mean percentage reduction of IOP after TSCP was highest in trauma (60.7%), AACG (59.5%), uveitic glaucoma (52.5%) and CACG (51.3%). It was the lowest in phacomorphic glaucoma (15%) and angle recession glaucoma (18.8%) (see Table 3).

The mean total laser energy used per eye including retreatment sessions ranged from 8.4 to 340 J (mean 72.7 ± 56.6 J). The mean laser energy used per individual laser treatment ranged from 6.2 to 208 J (mean 49.2 ± 22.9 J), and the mean number of laser burns per treatment session was 15.0 ± 6.1.

Table 2 Frequency and percentage of different number of laser sessions required

Number of sessions	Frequency	Percentage %
1	85	67.5
2	32	25.4
3	4	4
4	3	2.4
5	2	1.6

The mean number of glaucoma medications to control IOP before TSCP was 3.7 (range 0–6, SD 1.4), and 2.1 (range 0–5, SD 1.7) after TSCP. There was reduction in number of glaucoma medication required after TSCP in 71.0% of patients, which is statistically significant (P value < 0.01, Wilcoxon signed rank test). In our study, 48 out of 126 (38.1%) of the patients required oral Diamox before TSCP, but only 6 out of 126 (4.8%) required oral Acetazolamide after receiving TSCP treatment.

In our study, 77 (61.1%) had baseline visual acuity (VA) worse than or equal to finger count, while the remaining patients had VA better than finger count. After TSCP, 77 (36.7%) patients had no change in VA, 14 (11.7%) had improvement in VA and 62 (51.7%) worsened. Among the subgroup of patients with poor baseline VA defined as finger count or worse, VA

Table 1 Frequency and percentage of different disease categories requiring TSCP

Diagnosis	Frequency	Percentage (%)
Central retinal vein occlusion	42	33.3
Primary open angle glaucoma	22	17.5
Chronic angle closure glaucoma	17	13.5
Proliferative diabetic retinopathy	10	7.9
Angle recession	9	7.1
Post-vitreoretinal surgery	8	6.3
Uveitic glaucoma	6	4.8
Central retinal artery occlusion	3	2.4
Phacomorphic glaucoma	2	1.6
Acute angle closure glaucoma	2	1.6
Retinal detachment	2	1.6
Trauma	1	0.8
Steroid	1	0.8
Aphakic glaucoma	1	0.8

Table 3 The mean number of treatment, mean pre-TSCP IOP, mean post-TSCP IOP, mean percentage change in IOP, success rate and complication rate based on disease categories

Diagnosis	Mean no. of treatment	Mean pre-TSCP IOP (mmHg)	Mean post-TSCP IOP (mmHg)	Mean % change in IOP	Complication rate (%)
Central retinal vein occlusion	1.26	40	28	30.0	4.7
Primary open angle glaucoma	1.50	33	21	36.4	9.0
Chronic angle closure glaucoma	1.18	39	19	51.3	11.7
Proliferative diabetic retinopathy	1.80	40	32	20.0	20.0
Angle recession	1.89	32	26	18.8	0
Post-vitreoretinal surgery	1.75	31	20	35.5	0
Uveitic glaucoma	1.67	40	19	52.5	16.6
Central retinal artery occlusion	1.00	37	19	48.6	2.4
Phacomorphic glaucoma	1.00	46	40	15.0	0
Acute angle closure glaucoma	1.89	47	18	59.5	0
Retinal detachment	3.00	47	35	25.5	0
Trauma	1.00	51	20	60.7	0
Steroid	2.00	46	30	34.8	0
Aphakic glaucoma	1.00	25	19	24	0

improved in 9.1%, stayed the same in 53.2% and worsened in 37.7%. In the subgroup of patients with VA better than finger count, the mean snellen VA before TSCP was 0.4 ± 2.6, and 0.4 ± 2.7 after TSCP.

Complications after TSCP included hyphema, conjunctival burn, scleral burn, phthisis bulbi as a result of TSCP and mild bleeding at the angle. The overall complication rate was 7.1% with hyphema as the most common complication (see Table 4). The highest complication rate occurred in PDR (20%) and uveitic glaucoma (16.6%) (see Table 3).

Pain control was the indication for TSCP in 36 (28.6%) eyes. Among these cases, 5 (13.9%) eyes had persistent eye pain despite TSCP and 31 (86.1%) had improvement in pain symptoms after TSCP.

Table 4 Number and percentage of complications after TSCP

Complication	Number	Percentage (%)
Hyphema	6	4.8
Conjunctival burn	1	0.8
Phthisis bulbi	1	0.8
Bleeding at the angle	1	0.8

Discussion

The aim of TSCP is to provide adequate IOP control while avoiding damage to adjacent tissues and minimizing complications. Success rate among different studies ranged from 52 to 82% and the percentage of IOP reduction ranged from 31 mmHg to 57.1 mmHg [1–6]. Kaushik et al. [1] reported the success rate of 78.8% and IOP reduction of 57.1% in India. Frezzotti et al. [2] in Italy reported 63% patients had IOP less than 21 mmHg and IOP reduction of 31.7 mmHg. In a study of Caucasian patients, Ansari et al. [3] reported success rate of 82% and IOP reduction of 43%. However, in their study, success was defined as 30% or more reduction, irrespective of medication and IOP, which differed from the definition of success used in this paper. In our study, the success rate was 65.8% and the percentage of IOP reduction was 38.4%. Among these, percentage IOP reduction was most pronounced in trauma, AACG, uveitic glaucoma and CACG, which is similar to other studies [4, 7].

The mean energy used in this study was 72.6 J, which is comparatively lower than the laser energy used in most of the other studies. The mean energy used per eye in the other studies ranged from 75.2 J, as reported by Pucci et al. [5] to 155.2 J as reported by Murphy et al. [4]. Most of the other studies used greater mean energy per treatment session than our study, with the exception of Pucci et al. [5] which used

mean energy of 43.6 J per treatment. Pucci et al. [5] used a more conservative approach and limited the number of laser shots to 10 shots per session during the first treatment session, while the mean number of laser shots per session in this study was 15.

Although the definition of success in IOP reduction often permits the use of glaucoma medication after TSCP, the ability to reduce glaucoma eye drops reflects the efficacy of TSCP treatment and also has important implications on patient quality of life and cost effectiveness. In our study, although two cases had pre-treatment IOP less than 21 mmHg, the IOP was initially uncontrolled on maximum topical glaucoma medications but was subsequently lowered on oral Diamox. The indication for TSCP in these cases was to avoid side effects from long-term systemic Diamox. There was a reduction in number of glaucoma medication use after TSCP in 71.0% of the patients. Percentage of glaucoma medication reduction ranged from 19.5 to 52.6% in other studies. In this study, 4.8% of patients required Diamox after TSCP. The percentage of patients requiring oral Diamox after TSCP was 24.2 and 10.4% in Kaushik et al. [1] and Frezzotti et al. [2], respectively.

Since TSCP is associated with possible risks, patient selection is important. It is important to determine suitable timing for performing TSCP. Some studies have suggested earlier TSCP in patients with good vision may improve IOP control without sacrificing vision, eventually improving visual prognosis [8]. Some have even advocated using TSCP as a primary treatment. Ansari et al. [3] found VA was preserved in their study of subgroup patients with good baseline VA with POAG. In our study, 48.3% of cases maintained or improved in VA after TSCP, while the remaining 51.7% had worsened VA. However, within the subgroup of subjects with VA better than finger count, the average VA was maintained the same before and after TSCP. This is similar to what was previously described by Ansari et al. [3]. It appears VA is more susceptible to decline in patients with poor baseline VA. This is likely due to advanced glaucoma with higher chance of glaucoma progression and other ocular comorbidities like cataract and retinopathy.

Other than timing, laser energy should also be carefully titrated as ocular response to laser can be affected by many factors such as age, gender, ethnicity, underlying etiology and previous treatments received. Some studies have suggested pigmented eyes require less laser energy due to increased melanin absorption [1, 9, 10]. All our patients are of Asian ethnicity and may have a more similar ocular response to the pigmented eyes included in Kaushik et al. [1]. We found that both the mean total laser energy used (72.7 ± 56.6 J) and mean energy per treatment used (49.2 ± 22.9 J) were lower than most of the other studies. Kaushik et al. [1] used mean total energy of 87.8 J and mean energy per treatment of 75.3 J. Studies from other patient population used higher laser energies. The mean total laser energy used in the study conducted by Anasari et al. [3] was 124.1 J. Similarly, the mean total laser energy demonstrated by Murphy et al. [4] was 155.2 J, and the mean laser energy per treatment was 104.1 J. Hypotony is seen as severe complication of TSCP. Hypotony was found to be more common among neovascular glaucoma [4, 11] in some studies. While CRVO, PDR and central retinal artery occlusion (CRAO) comprised of 33.3, 7.9 and 2.4% of cases, respectively, none of the cases developed hypotony. On the other hand, this may explain why hyphema was the most common complication in our series. Another study among Asian patients also reported low complication rate, which included transient hypotony and persistent iritis [12].

TSCP often requires multiple treatments to achieve treatment goal [13]. Other studies reported similar number of treatments per eye and retreatment rate, Murphy et al. [4] reported average of 1.50 treatment sessions and retreatment rate of 38.9%, Pucci et al. [5] reported average of 1.70 treatment sessions and retreatment rate of 45.8% and Lliev and Gerber [6] reported 1.54 treatment sessions on average and 38.9% retreatment rate. Kaushik et al. [1] and Ansari and Gandhewar [3] reported lower number of treatment sessions, 1.16 and 1.01, respectively, while retreatment rate was 16.7 and 1.2%, respectively. However, the study by Ansari and Gandhewar [3] also included non-refractory glaucoma cases. In our study, the retreatment rate was 40% and mean treatment session was 1.5. Retinal detachment cases had highest retreatment rate, all of which had intravitreal silicone oil. Previous studies similarly have reported suboptimal outcome after TSCP requiring retreatment after silicone oil [14, 15]. Ocular comorbidities in these cases may also contribute to the poor outcome [16].

This study is limited by its retrospective nature. The number of cases in certain disease categories was

small, making results difficult to interpret. It is difficult to differentiate poor outcome due to the disease itself from the effects of laser treatment. A direct comparison with other studies is difficult, as studies differ in patient population, treatment protocols, follow-up time and success definitions.

Conclusion

In conclusion, our study shows that TSCP is effective in reducing IOP, number of glaucoma medication needed and symptoms of pain. In our study among the Chinese population, the average laser energy used was comparatively lower with low complication rate while demonstrating effectiveness in treating refractory glaucoma. We found it was most effective in treatment of glaucoma due to trauma, acute angle closure, uveitis and chronic angle closure.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Kaushik S, Pandav SS, Jain R, Bansal S, Gupta A (2008) Lower energy levels adequate for effective transscleral diode laser cyclophotocoagulation in Asian eyes with refractory glaucoma. Eye (Lond) 22(3):398–405
2. Frezzotti P, Mittica V, Martone G, Motolese I, Lomurno L, Peruzzi S, Motolese E (2010) Longterm follow-up of diode laser transscleral cyclophotocoagulation in the treatment of refractory glaucoma. Acta Ophthalmol 88(1):150–155
3. Ansari E, Gandhewar J (2006) Long-term efficacy and visual acuity following transscleral diode laser photocoagulation in cases of refractory and non-refractory glaucoma. Eye 21(7):936–940
4. Murphy CC, Burnett CA, Spry PG, Broadway DC, Diamond JP (2003) A two centre study of the dose-response relation for transscleral diode laser cyclophotocoagulation in refractory glaucoma. Br J Ophthalmol 87(10):1252–1257
5. Pucci V, Tappainer F, Borin S, Bellucci R (2003) Long-term follow-up after transscleral diode laser photocoagulation in refractory glaucoma. Ophthalmologica 217(4):279–283
6. Iliev ME, Gerber S (2007) Long-term outcome of transscleral diode laser cyclophotocoagulation in refractory glaucoma. Br J Ophthalmol 91(12):1631–1635
7. Kirwan JF, Shah P, Khaw PT (2002) Diode laser cyclophotocoagulation: role in the management of refractory pediatric glaucomas. Ophthalmology 109(2):316–323
8. Rotchford AP, Jayasawal R, Madhusudhan S, Ho S, King AJ, Vernon SA (2010) Transscleral diode laser cycloablation in patients with good vision. Br J Ophthalmol 94(9):1180–1183
9. Cantor LB, Nichols DA, Katz LJ, Moster MR, Poryzees E, Shields JA, Spaeth GL (1989) Neodymium-YAG transscleral cyclophotocoagulation. The role of pigmentation. Invest Ophthalmol Vis Sci 30(8):1834–1837
10. Fankhauser F, van der Zypen E, Kwasniewska S, Rol P, England C (1986) Transscleral cyclophotocoagulation using a neodymium YAG laser. Ophthalmic Surg 17(2):94–100
11. Hawkins TA, Stewart WC (1993) One-year results of semiconductor transscleral cyclophotocoagulation in patients with glaucoma. Arch Ophthalmol 111(4):488–491
12. Wong EY, Chew PT, Chee CK, Wong JS (1997) Diode laser contact transscleral cyclophotocoagulation for refractory glaucoma in Asian patients. Am J Ophthalmol 124(6):797–804
13. Schlote T, Derse M, Rassmann K, Nicaeus T, Dietz K, Thiel HJ (2001) Efficacy and safety of contact transscleral diode laser cyclophotocoagulation for advanced glaucoma. J Glaucoma 10(4):294–301
14. Sivagnanavel V, Ortiz-Hurtado A, Williamson TH (2004) Diode laser trans-scleral cyclophotocoagulation in the management of glaucoma in patients with long-term intravitreal silicone oil. Eye 19(3):253–257
15. Kumar A, Dada T, Singh RP, Kedar S (2001) Diode laser trans-scleral cyclophotocoagulation for glaucoma following silicone oil removal. Clin Exp Ophthalmol 29(4):220–224
16. Riedel KG, Gabel V-P, Neubauer L, Kampik A, Lund O-E (1990) Intravitreal silicone oil injection: complications and treatment of 415 consecutive patients. Graefes Arch Clin Exp Ophthalmol 228(1):19–23