공막경유 다이오드레이저 섬모체광응고술이 시력이 남아있는 환자에게 안전한가?

Is the Transscleral Diode Laser Cyclophotocoagulation Safe for the Patients with Retained Visual Potential?

김창식

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Purpose: To evaluate the effects of trans-scleral diode laser cyclophotocoagulation (TSDLC) on best corrected visual acuity (BCVA) in patients with refractory glaucoma with and without retained visual potential.

Methods: The medical records of 148 eyes (148 patients) with refractory glaucoma who were followed-up > 6 months after TSDLC were analyzed retrospectively. Among them, 49 eyes (49 subjects) who had BCVA > no light perception (NLP) before TSDLC were classified as Group 1 and the other 99 eyes (99 patients) who had NLP vision were classified as Group 2. The outcomes of TSDLC including change in BCVA following treatment were analyzed for all patients and 49 subjects in group 1 who had retained visual potential before treatment, separately.

Results: The mean follow-up period in Group 1 was 19.1 ± 13.5 months and 16.7 ± 12.7 months in Group 2. The intraocular pressure (IOP) and the number of IOP lowering medications decreased in both groups (both $p < 0.001$). In all subjects, there was no significant difference between BCVA before surgery and at the last follow-up (2.4 ± 0.9 logMAR and 2.5 ± 0.8 logMAR, respectively, $p = 0.612$). However, in Group 1, BCVA was decreased from 1.4 ± 1.0 to 1.9 ± 1.1 logMAR after the TSDLC ($p < 0.001$). In those patients, visual loss ≥ 0.2 logMAR was found in 31 eyes (63.3%) and light perception was lost in 15 eyes (30.6%). After treatment, corneal edema developed in 5 eyes (3.4%), phthisis bulbi and chronic hypotony occurred in 3 eyes each (2%) and iridocyclitis occurred in 2 eyes (1.4%).

Conclusions: TSDLC in patients with refractory glaucoma showed an efficient reduction in IOP and the number of IOP-lowering medications. However, there was a loss in BCVA in significant number of patients who had retained visual potential before treatment. Therefore, for patients with retained visual potential, surgical options other than cyclodestructive surgery should be first considered, and the patients should be warned of possible visual acuity deterioration resulting from this treatment.

Key words: Glaucoma, Diode lasers, Cyclophotocoagulation, Visual acuity

Cyclodestructive surgery was introduced by Weve in 1933, using nonpenetrating diathermy, and Bietti described cyclocryotherapy in 1950 to treat glaucoma.^{1,2} These pro-

cedures decreased intraocular pressure (IOP) by reducing aqueous humor production resulting from the partial destruction of the ciliary body. However, the procedures sometimes resulted in serious complications such as scleral necrosis, hemorrhage, severe pain and inflammation, unexpected vision loss, anterior segment ischemia, macular edema, chronic hypotony, and phthisis. In 1961, Weekers et al. used the xenon arc laser to transsclerally ablate the ciliary body.³ Since using a laser, the efficacy of cyclophotocoagulation has improved and the complications have been decreased due to improvements in the laser technology.

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Table 1. Treatment outcomes after transscleral diode laser cyclophotocoagulation

Clinical variables	Group 1 (N = 49)	Group 2 (N = 99)	Total [†] (N = 148)
IOP (mmHg)			
Baseline	38.8 ± 15.7	46.8 ± 12.3	41.1 ± 15.3
Last follow-up	19.3 ± 15.6	20.2 ± 12.9	19.9 ± 11.1
<i>p</i> -value*	<0.001	<0.001	<0.001
IOP-lowering medication (n)			
Baseline	2.6 ± 0.7	2.9 ± 0.8	2.8 ± 0.8
Last follow-up	1.5 ± 1.0	1.7 ± 0.9	1.6 ± 1.0
<i>p</i> -value*	<0.001	<0.001	<0.001
BCVA (logMAR)			
Baseline	1.4 ± 1.0	2.9	2.4 ± 0.9
Last follow-up	1.9 ± 1.1	2.9	2.5 ± 0.8
<i>p</i> -value*	<0.001	NA	0.612

Values are presented as mean ± SD unless otherwise indicated.

IOP = intraocular pressure; BCVA = best-corrected visual acuity; NA = not applicable.

*Paired *t*-test; [†]Mean ± SD.

However, cyclophotocoagulation still has many problems, including difficulty in predicting the IOP decrease, plus the possibility of serious complications such as chronic hypotony and phthisis. It is therefore regarded as the last resort in glaucoma treatment, and is usually performed in eyes with very limited visual potential.^{4,5}

As public awareness of glaucoma has increased and regular health check-ups have become more popular, early detection of glaucoma has become more frequent. The number of glaucoma cases with intractable IOP is increasing, despite maximal treatments including surgery, and there are increasing numbers of refractory glaucoma patients with good visual potential who need additional management after numerous surgical treatments.

There have been many recent reports describing effective control of IOP and decreased complications after cyclophotocoagulation using the Nd:YAG laser and diode laser, and numerous studies have described its potential for primary surgery in eyes with good visual potential.⁶⁻¹⁰ However, patients with very poor vision, and even those with no light perception, were included in these reports. A significant number of patients had very limited visual potentials, and it was possible that overall changes in visual acuity were underestimated.

This study by Lee et al.¹¹ therefore evaluated the effects of

transscleral diode laser cyclophotocoagulation (TSDLC) on best-corrected visual acuity (BCVA) in patients with refractory glaucoma. The patients were divided into two groups: patients with some visual potential [group 1, N = 49, BCVA greater than no light perception; average logarithm of the minimum resolution (logMAR) = 1.4] and patients with no light perception (group 2, N = 99, average logMAR = 2.9). There was no difference in patient demographics between 2 groups except for the baseline visual acuity and number of previous glaucoma drainage implant surgery (13/49 vs. 6/99 in group 1 and 2 respectively, *p* = 0.001). Treatment doses were not significantly different between group 1 and 2 in terms of power (1,886.4 vs. 1,951.6 mW), duration (1,831.8 vs. 2,344.1 msec), total energy (54.6 vs. 66.3 J, respectively, all *p* > 0.1). They compared the difference in visual acuity change according to the visual potential before treatment between group 1 (patients with retained visual potential) and the entire group (all patients including patients with no light perception).

Subjects were patients with uncontrolled IOP with maximal medical and surgical therapies including laser treatments. Clinical data including IOP and visual acuity were collected. TSDLC was performed in a conventional manner using a diode laser (Oculight SLx; Iridex, Mountain View, CA, USA) and G-probe (Iridex) under retrobulbar anes-

Table 2. Change in BCVA in group 1 (patients with preoperative BCVA of "light perception" or better)

Amount of change (logMAR)	Number of eyes	Cumulative number (%)
Deteriorated BCVA		
Amount ≥ 0.3	26 (15)*	26 (53.1)
$0.3 > \text{Amount} \geq 0.2$	5	31 (63.3)
$0.2 > \text{Amount} \geq 0.1$	8	39 (79.6)
No change	5	44 (89.8)
Improved BCVA	5	49 (100.0)
Total	49/49	49 (100.0)

Change in best-corrected visual acuity (BCVA) = last follow-up BCVA - baseline BCVA in logMAR.

*The number in parenthesis indicates the number of patients who lost light perception after TSDCP.

Figure 1. A Kaplan-Meier plot showing the survival rate after loss of visual acuity in group 1 (patients with preoperative BCVA of "light perception" or better). (A) Kaplan-Meier plot showing the survival rate after the loss of ≥ 0.1 logMAR. (B) Kaplan-Meier plot showing the survival rate after the loss of ≥ 0.2 logMAR. (C) Kaplan-Meier plot showing the survival rate for the loss of ≥ 0.3 logMAR. BCVA = best-corrected visual acuity.

thesia. Laser energy was adjusted from 1,500 mW to 2,250 mW, the duration was adjusted from 1,500 msec to 2,500 msec, and the range of the treatment was from 180–270 degrees in one session. In a few patients who needed additional TSDLC to further lower the IOP, multiple treatments were performed.

After treatment, the mean follow-up periods in groups 1 and 2 were 19.1 ± 13.5 months and 16.7 ± 12.7 months, respectively. The IOP and the number of IOP-lowering medications decreased significantly in both groups (both $p < 0.001$). In all patients, there was no significant difference between the BCVA before surgery and at the last follow-up

Table 3. Comparison of clinical variables after transscleral diode laser cyclophotocoagulation in group 1 (patients with preoperative BCVA of "light perception" or better)

Clinical variables	Patients with deteriorated BCVA	Patients with stable BCVA	<i>p</i> -value*
Number of patients/number of eyes	39/39	10/10	
Age (years)	58.0 ± 15.6	64.7 ± 14.1	0.085
Sex (male/female)	27/12	7/3	0.642 [†]
BCVA (logMAR)			
Baseline (decimal)	1.4 ± 0.9 (0.04)	1.8 ± 0.9 (0.01)	0.874
Last follow up (decimal)	2.0 ± 1.0 (CF)	1.5 ± 1.1 (0.03)	0.110
IOP (mmHg)			
Baseline	40.3 ± 15.7	32.8 ± 14.5	0.142
Last follow up	18.9 ± 16.7	20.9 ± 8.0	0.705
IOP lowering medication (n)			
Baseline	2.6 ± 0.6	2.3 ± 1.5	0.966
Last follow-up	1.7 ± 1.3	1.8 ± 1.0	0.861
Follow up months	19.1 ± 13.5	19.7 ± 12.7	0.426
Lens status n (%)			
Phakia	20 (51.3)	6 (60.0)	0.447 [†]
Aphakia	5 (12.8)	1 (10.0)	0.645 [†]
Pseudophakia	14 (35.9)	3 (30.0)	0.518 [†]
Previous ocular surgery			
AGV implantation	10	3	0.533 [†]
Vitreoretinal surgery	4	0	0.569 [†]
Filtration surgery	1	2	0.102 [†]
Glaucoma type n (%)			
Neovascular glaucoma	19 (48.7)	4 (40.0)	0.447 [†]
Secondary glaucoma	10 (25.6)	2 (20.0)	0.534 [†]
Primary open-angle glaucoma	5 (12.8)	3 (30.0)	0.197 [†]
Primary angle-closure glaucoma	2 (5.1)	1 (10.0)	0.504 [†]
Uveitic glaucoma	2 (5.1)	0	0.630 [†]
Congenital glaucoma	1 (2.6)	0	0.796 [†]
Treatment dose			
Power (mW)	1,888.9 ± 260.4	1,875.0 ± 250.1	0.902
Spot numbers	16.4 ± 2.8	16.2 ± 3.1	0.932
Duration (ms)	1,822.2 ± 239.0	1,875.0 ± 250.0	0.712
Treatment range (degrees)	272.0 ± 103.9	339.6 ± 180.0	0.625
Total energy (J)	53.6 ± 13.4	57.9 ± 12.3	0.466

Values are presented as mean ± SD unless otherwise indicated.

BCVA = best-corrected visual acuity; CF = finger count; IOP = intraocular pressure; AGV = ahmed glaucoma valve.

*Mann-Whitney *U*-test; [†]Fisher's exact test.

(2.4 ± 0.9 logMAR and 2.5 ± 0.8 logMAR, respectively; *p* = 0.612). However, in group 1, BCVA decreased from 1.4 ± 1.0 logMAR to 1.9 ± 1.1 logMAR after the TSDLC (*p* <

0.001, Table 1).

In group 1 patients, who retained potential vision before treatment, visual loss ≥ 0.3 logMAR was found in 26 eyes

(53.1%) and light perception was lost in 15 eyes (30.6%). In addition, 31 eyes (63.3%) showed a visual loss ≥ 0.2 logMAR, 39 eyes (79.6%) had decreased vision by ≥ 0.1 logMAR, and visual acuity increased in 5 eyes (10.2%; Table 2). Visual acuity decreased from corneal edema in three eyes, and there was uveitis, chronic hypotony, and phthisis in one eye each. They could not find any specific reason for the visual acuity deterioration in the remaining eyes.

A cumulative visual acuity loss ≥ 0.1 logMAR occurred in 30 (61.2%), 35 (71.4%), and 36 (73.5%) patients at 6 months, 1 year, and 2 years after treatment respectively. A cumulative visual acuity loss ≥ 0.3 logMAR occurred in 12 (24.5%), 23 (46.9%), and 26 eyes (53.1%) at 6 months, 1 year, and 2 years, respectively (Fig. 1).

In group 1, they compared the parameters of patients who showed stable visual acuity after treatment with patients who showed visual acuity deterioration, but they could not identify any parameter associated with the deterioration of vision (Table 3).

As a complication after treatment, corneal edema developed in five eyes (3.4%), phthisis bulbi and chronic hypotony occurred in three eyes each (2%), and iridocyclitis occurred in two eyes (1.4%); there was no difference in frequency between the two groups.

In studies of visual acuity changes after cyclodestructive surgery, the deterioration may have been underestimated. First, many of the patients had poor vision, so there was a limited potential range for visual deterioration. Second, there were patients who showed visual acuity improvement after treatment as a result of a decrease in the IOP or as a result of the clearing of corneal edema caused by a high IOP. Deteriorated visual acuity in some patients could therefore be masked by improved vision in other patients when averaging the visual acuity in patients after treatment.

In conclusion, TSDLC in patients with refractory glaucoma may result in a very effective reduction in IOP and number of IOP-lowering medications. However, a significant proportion of the patients showed a significant degree of visual acuity deterioration. We could not identify any preoperative or intraoperative parameter associated with visual acuity deterioration after TSDLC, so we could not predict

which patients were more likely to show decreases in visual acuity, as well as which mechanisms were involved in the decreases. Therefore, for patients with retained visual potential, surgical options other than cyclodestructive surgery should be first considered, and the patients should be warned of possible visual acuity deterioration resulting from this treatment.

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