Efficacy and Safety of Transscleral Diode Laser Cyclophotocoagulation Therapy in Advanced Glaucoma Cases with Good Visual Acuity

Işıl Paşaoğlu[1], Çiğdem Altan[2], Uğur Tunç[3], Banu Solmaz[4], Berna Başarır[4], Zeynep Kayaarası Öztürker[5], Aslı İnal[4], Tekin Yaşar[2]

ABSTRACT

Purpose: To evaluate the efficacy and safety of transscleral diode laser cyclophotocoagulation (TSDLC) in advanced glaucoma patients with best-corrected visual acuity (BCVA) of 0.3 Snellen unit or better.

Materials and Methods: Patients with BCVA of 0.3 Snellen unit or better who underwent TSDLC for uncontrolled intraocular pressure (IOP) and followed up regularly for at least 12 months were evaluated retrospectively. The primary end-point was the decrease of one or more Snellen lines in BCVA, secondary end-point was the IOP control with or without medications.

Results: Thirty-six eyes of 36 patients were included and followed for a mean of 24.1±26.4 months. The mean IOP was reduced from 28.3±6.0 mmHg at baseline to 14.4±5.0 mmHg ($p<0.001$). The average number of antiglaucoma medications was significantly reduced from 3.7±0.5 at baseline to 3.0±0.87 ($p<0.05$) at last follow-up. BCVA remained constant in 24 (66.7%) eyes, improved in 4 (11.1%), and deteriorated by one line or more in 8 (22.2%). The vision loss was attributed to TSDLC in only 3 patients who had cystoid macular edema, central retinal vein occlusion and post-laser hypotony.

Conclusion: TSDLC is an effective, safe, and technically easy procedure for controlling the IOP in advanced glaucoma cases with good visual acuity. TSDLC may be considered both as primary treatment and as an alternative treatment after failed filtration procedures instead of invasive glaucoma surgeries.

Keywords: Advanced glaucoma, Intraocular pressure, Good visual acuity, Transscleral diode laser cyclophotocoagulation, Visual loss.

INTRODUCTION

Transscleral diode laser cyclophotocoagulation (TSDLC) therapy is used to lower intraocular pressure (IOP) in refractory glaucoma when maximum medical therapy and/or glaucoma surgeries fail to control the IOP.[1,2] The TSDLC procedure causes thermal damage to ciliary processes, resulting in reduced aqueous humor production.[3]

Various complications have been documented after TSDLC, such as anterior chamber reaction, pain, transient IOP rise, hyphema, vitreous hemorrhage, cataract progression, vision loss, hypotony, and phthisis.[4-6] Among these, the most significant complication is vision loss which has prevented the use of TSDLC in eyes with good visual acuity. There are few publications in the literature emphasizing TSDLC results in patients with good visual acuity. The use of TSDLC as a primary surgical treatment in glaucoma cases was also reported. [7-11]

Here we evaluated the efficacy and safety of TSDLC in advanced glaucoma patients with best-corrected visual acuity (BCVA) of 0.3 Snellen unit or better who were followed for at least 12-months follow-up.

MATERIALS AND METHODS

A retrospective chart review was performed for all patients who underwent TSDLC between January 2014 and December 2019 in a glaucoma division of a tertiary eye hospital affiliated with the University of Health Sciences Turkey. The study was conducted in accordance with the

1- MD, University of Health Sciences, Beyoglu Eye Training and Research Hospital, Istanbul, Turkey

2- MD, Professor, University of Health Sciences, Beyoglu Eye Training and Research Hospital, Istanbul, Turkey

3- MD, University of Health Sciences, Beyoglu Eye Training and Research Hospital, Istanbul, Turkey

4- MD, Assoc.Prof., University of Health Sciences, Beyoglu Eye Training and Research Hospital, Istanbul, Turkey

5- MD, Asst.Prof., Baskent University, Faculty of Medicine, Ophthalmology Department, Istanbul, Turkey

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Correspondence Adress:
Işıl Paşaoğlu
University of Health Sciences, Beyoglu Eye Training and Research Hospital, Istanbul, Turkey

Phone: +90 505 854 8821
E-mail: ibasgil@yahoo.com

Declaration of Helsinki principles, and the local medical ethics committee approved the research with the decision number 48670771-514.10. Written informed consent was obtained from all participants. Eyes with preoperative BCVA of 0.3 Snellen unit or better and followed up regularly for at least 12 months were included in the study. All patients were diagnosed with uncontrollable advanced glaucoma with antiglaucoma medications and/or previous surgical therapy.

The primary end point for the study was a decrease of one or more lines of Snellen BCVA at postoperative 1 and 3 months. The secondary endpoint was a successful pressure control defined as IOP ³ 6 mmHg and ≤ 21 mmHg with or without topical antiglaucoma medications or not having a further glaucoma surgery.

Study parameters included demographic data, BCVA, IOP, number of antiglaucoma medications, details of previous ocular surgery, glaucoma type, and surgical and postoperative complications. Spectral-domain optical coherence tomography (SD-OCT) imaging (OCT Spectralis, Heidelberg Engineering, Heidelberg, Germany) and visual field testing by Humphrey 24-2 standard automated perimetry (HFATM II; Humphrey Instruments Inc., San Leandro, California, USA) were performed.

Best-corrected visual acuity, IOP, and the number of glaucoma medications were documented preoperatively and postoperatively at 1, 3, 6, 12 months and the last follow-up visit. The power, duration, the number of laser applications, and additional TSDLC procedures during follow-up were also recorded. In patients with repeated TSDLC procedure, the most recent measurements were evaluated in the study. If the patient was reoperated, the examination findings were recorded before the reoperation as the last visit.

Surgical Procedure

Indications for treatment included patients who had previously failed filtration surgery, patients with uncontrolled IOP despite maximum-tolerated antiglaucoma treatment in whom tube shunt or trabeculectomy was either contraindicated or associated with a high risk to benefit ratio at that time and patients who could not tolerate or were incompatible with the antiglaucoma medications due to side effects. An OcuLight Tri-Mode 810-nm diode laser with a contact G-probe (Iris Medical Instruments, Mountain View, California, USA) was used for cycloablation in all patients. Treatment with TSDLC was performed under subtenon or general anesthesia in operating room. We started with 1500 mW power for 1500 ms, then the power was increased in 200 mW increments and time increased in increments 500 ms until a 'pop' sound was heard. The power and duration are then reduced in steps of 100 mW and 500 ms, respectively. Laser energy was applied 1-2 mm behind the inferior limbus at six clock hours (180 degrees) with 14 to 18 burns, avoiding the three and nine o'clock positions. Postoperatively, topical steroids were prescribed four times daily and tapered for 3-4 weeks, and the glaucoma medications were discontinued based on the IOP reduction achieved.

Additional TSDLC procedures were performed in patients when the target IOP could not be reached, and a further reduction was needed, or an increased IOP was observed after the first treatment. In repeated TSDLC procedures, the inferior two quadrants and an untreated quadrant were treated with the same protocol, avoiding three and nine o'clock positions to reduce post-laser pain, anterior segment ischemia, fix-dilated pupilla, and risk of hypotony. No additional surgery other than retreatment with TSDLC was performed in patients during follow-up.

Statistical Analysis

The Shapiro-Wilk test was used to determine whether the data were appropriate for normal distribution. Descriptive statistics were performed, including means and standard deviations for samples of normally distributed variables. Paired-sample *t*-test was used for comparison of differences between baseline BCVA, IOP, and the number of glaucoma medications at 1, 3, months and the last follow-up, *p*-values less than 0.05 were considered to be statistically significant. The Kaplan-Meier survival analysis used to detect treatment-related loss of BCVA was based on the time between the TSCPC procedure and the primary endpoint.

RESULTS

A total of 468 TSDLC procedures were performed during study period. Among these procedures, 432 eyes with a baseline BCVA of < 0.3 Snellen unit and/or inadequate follow-up were excluded. A total of 36 eyes of 36 patients were enrolled and followed for a mean of 24.1±26.4 months (12-165). Table 1 shows demographic data and the baseline clinical characteristics of the study population.

For the 14 (38.9%) patients, TSDLC was performed as primary treatment. Among them, 4 patients had POAG, 4 patients had exfoliation (XF) glaucoma, 4 patients had glaucoma after complicated cataract surgery (one of these patients was in the pediatric age group), 1 patient had glaucoma after pars plana vitrectomy, and 1 patient had glaucoma after penetrating keratoplasty. Of the 4 patients with POAG, 2 had high myopia in the younger age group, the other 2 patients with POAG and

Table 1: *Baseline demographic data and clinical characteristics of the study population.*

Variable	Patients (n=36)
Sex, n (%)	
Male	15 (41.7)
Female	21 (58.3)
Oral acetazolamide, n (%)	17 (47.2)
Phakic status, n (%)	
Phakic	11 (30.6)
Pseudophakic	22 (61.1)
Aphakic	3 (8.3)
Prior glaucoma surgery, n (%)	
None	14 (38.9)
Trabeculectomy	22 (61.1)
Glaucoma type, n (%)	
POAG	18 (50)
CCAG	1 (2.8)
Complicated cataract surgery	5 (13.9)
Congenital	6 (16.7)
Post PK	1 (2.8)
Pseudoexfoliation	4 (11.1)
Post PPV	1 (2.8)
Continuous Variables	Mean (SD)
Age in years (range)	56.8±22.7 (8-84)
Cup to disc ratio, mean	0.8 ± 0.2
Preoperative mean deviation (dB)	-14.04 ± 9.1
Preoperative retinal nerve fiber layer thickness (µ)	66.83 ± 18.4

POAG, primary open-angle glaucoma; CCAG, chronic closed-angle glaucoma; PK, penetrating keratoplasty; PPV, pars plana vitrectomy.

XF glaucoma patients were of elderly age group in poor general health with the mean age of 72.1±9.9. TSDLC was preferred as primary surgery in elderly patients since it requires less postoperative visits, systemic risks and in patients with low success rate of filtration surgery and high risk of intraoperative complications. TSDLC was used as the primary treatment in patients who developed secondary glaucoma due to previous intraocular surgery, in high myopic patients with low success rate in filtration surgery or high risk of intraoperative complications, and in advanced age groups of POAG and XF patients for the purpose of fewer postoperative visits.

Treatment was performed using a mean power setting of 1965.3±445.9 mW (1200-3000 mW) for a mean duration of 1994.4±396.4 ms (1500-3000 ms) for all shots. The mean number of quadrants treated was 2.0±0.2 quadrants (1-3). We applied a mean of 15.9±1.5 (14-18) shots per treatment episode.

IOP Reduction and Medical Therapy

Intraocular pressure measurements and the number of antiglaucoma medications at baseline and during the 1 and 3 months follow-up periods in the whole study group were shown in Table 2. The mean IOP values at these follow-up periods were significantly lower than the baseline IOP ($p<0.001$). IOP was controlled with defined success criteria in 33 (91.7%) patients at the final examination only three patients were on acetazolamide treatment.

Re-treatment with TSDLC

Eleven eyes (30.6%) required re-treatment with TSDLC at a mean interval of 15.8±14.8 (4-48) months due to uncontrolled IOP. Of these, 7 had POAG, 3 had congenital glaucoma, and one had glaucoma after pediatric cataract surgery. Nine out of 11 eyes had previous trabeculectomy surgery. A mean of 1.5±1.0 (1-4) treatments were applied per eye, and 3 eyes out of 11 needed a further treatment with TSDLC. At the 3 month follow-up period of the second treatment episode, the mean IOP was 16.0±7.3 mmHg, and decreased significantly compared to the last control IOP before re-treatment ($p=0.01$).

Intraocular pressure measurements and the number of antiglaucoma medications at final follow-up in patients with and without re-treatment were shown in Table 3. The

Table 2: *Intraocular pressure, glaucoma medications, and best-corrected visual acuity at baseline and after transscleral diode laser cyclophotocoagulation in the whole study group*

Variable	Baseline	1 month	3 months
Intraocular pressure			
Mean ± SD	28.27±6.03	17.87±7.1	17.43±6.8
Mean decrease †		10.40	10.50
p-value		< 0.0001*	< 0.0001*
Glaucoma medications			
Mean ± SD	3.69±0.5	2.69±1.43	3.03±1.09
Mean decrease †		1	0.7
p-value		< 0.0001*	0.002*
BCVA visual acuity			
Mean ± SD	0.39±0.15	0.37±0.17	0.38±0.21
Mean decrease †		0.01±0.08	0.02±0.12
p-value		0.3	0.3

SD, standart deviation; BCVA, best-corrected visual acuity
† Represents mean decrease of value from baseline.
* Indicates statistically significant value; p-value was calculated using paired sample t test for whether the difference from baseline is significant.

Table 3: *Intraocular pressure, antiglaucoma medication use, and best-corrected visual acuity at final follow-up in patients who received re-treatment and who did not.*

	Eyes not re-treated (n=25)	Eyes re-treated (n=11)
IOP (mmHg), mean (SD) (range)	15.7±5.5 (9-30)	16.4±5.4 (11-26)
IOP ≤ 21 mmHg (n (%))	5 (20.0)	8 (72.7)
IOP ≤ 16 mmHg (n (%))	17 (68.0)	7 (63.6)
No. of drops (mean (range))	3.0±1.4 (0-4)	3.2±0.6 (2-4)
Acetazolamide (n (%))	2 (8.0)	1 (9.0)
BCVA, mean (SD) (range)	0.3±0.2 (0.1-0.8)	0.2±0.1 (0.1-0.6)

IOP, intraocular pressure; BCVA, best corrected visual acuity

mean IOP was significantly reduced from baseline at the last follow-up visit, both in patients with and without re-treatment ($p<0.05$). However, while the average number of antiglaucoma medications were decreased significantly in patients who did not receive re-treatment, it did not change in patients who required re-treatment ($p>0.05$).

Visual Acuity

BCVA measurements at baseline and during the follow-up periods, and mean decrease of value from baseline are shown in Table 2. No significant change was observed in BCVA compared to the baseline at 1 and 3 months which are the primary end points ($p=0.3$).

TSDLC was applied as the primary treatment in 14 (38.9%) patients and only 1 patient had 2 lines of visual acuity loss.

In patients who underwent re-treatment, the mean BCVA was 0.2±0.1 Snellen unit during the 3-month follow-up period of the second treatment episode, and there was no statistically significant change in BCVA ($p>0.05$). When patients with and without re-treatment were evaluated independently, no significant change was observed in BCVA compared to the baseline in both groups at the last follow-up examination ($p> 0.05$) (Table 3). None of the eyes had BCVA £ 0.1 Snellen unit at the end of the follow-up.

Visual acuity remained constant in 24 (66.7%) eyes, increased in 4 (11.1%), and decreased by one line or more in 8 (22.2%). Among patients with decreased vision, 4 (11.1%) had a loss of 2 Snellen lines.

Among 8 patients with decreased visual acuity, 4 (50%) had decreased vision due to glaucoma progression after 6 months following the first TSDLC treatment. Although the mean IOP was below 21 mmHg during the follow-up and 11.7 mmHg at the last visit, the mean deviation deteriorated from -11.13 dB at baseline to -13.52 dB in the follow-up. One diabetic patient with XF glaucoma in whom TSDLC was used as the primary treatment developed cystoid macular edema (CME) after two months following TSDLC which resolved in six months with a consistent 2 lines of visual loss. One patient had central retinal vein (CRVO) occlusion at two months after TSDLC due to transient IOP spike, which resulted in 2 lines of visual loss at the final visit.

In two patients with congenital glaucoma, there was a transient BCVA loss due to post-laser hypotony which recovered in one month after the surgery. One of these patients developed transient post-laser hypotony in the second week of the re-treatment with TSDLC; she had cataract progression in further follow-up, which resulted in 1 line decreased visual acuity. In the other patient, the rapid loss of BCVA from 0.3 to 1-m finger count occurred after the first treatment episode. This was attributed to post-laser hypotony; and after the 1st month, BCVA increased to 0.2 Snellen unit with the recovery of hypotony with a persistent 1 line visual acuity loss.

Table 4 shows the clinical data of all patients with vision loss and patients whose vision loss was attributed to TSDLC.

COMPLICATIONS

Postoperative hypotony occurred in 2 congenital glaucoma patients, but it resolved at the end of the first month with medical treatment, none of them had choroidal detachment. In the postoperative 2nd month, CME was noted in 1 patient and CRVO was noted in 1 patient who had IOP spike. None of the patients developed phthisis bulbi**,** endophthalmitis, or sympathetic ophthalmia.

Success

The mean survival time using the primary endpoint was 35.5±3.7 months (95% CI 28.14 to 42.96) (Figure 1). There was no correlation between BCVA loss and the mean power ($p=0.22$), mean duration ($p=0.24$), mean

Table 4: *Clinical data of the eyes with BCVA loss of ≥1 Snellen line at last follow-up*

Eye	Reason for loss of VA	VA loss attributed to TSDLC	Change in VA	Glaucoma subtype	Change in IOP (mmHg)
1	Glaucoma progression	-	-1 line	POAG	32 to 14
2	Glaucoma progression	-	-1 line	POAG	20 to 11
3	Glaucoma progression	-	-2 line	POAG	22 to 10
4	Glaucoma progression	-	-2 line	POAG	26 to 12
5	Transient post laser hypotony+cataract	-	-1 line	Congenital	30 to 12
6	Transient post laser hypotony	√	-1 line	Congenital	25 to 14
7	Macular edema	√	-2 line	PEX	32 to 12
8	Central retinal vein occlusion	√	-2 line	POAG	35 to 12

VA; Visual acuity, IOP; Intraocular pressure, POAG; Primary open-angle glaucoma, PEX; Pseudoexfoliation, TSDLC; Transscleral diode laser cyclophotocoagulation

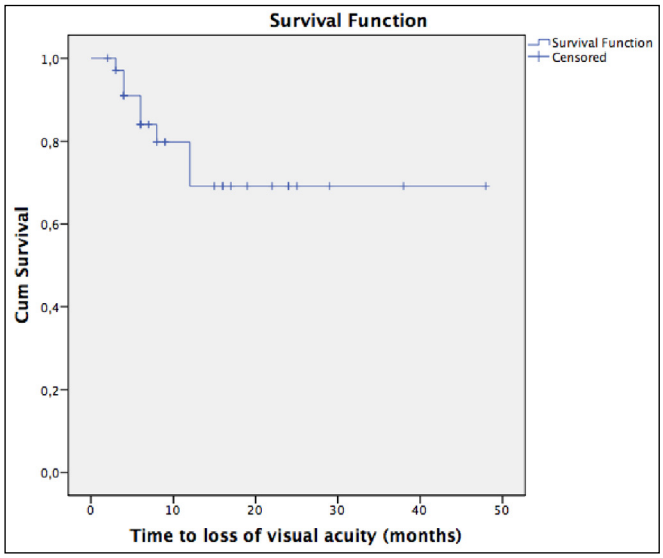

Figure 1: *Kaplan-Meier plot showing survival time to loss of one or more line of Snellen unit visual acuity.*

number of shots (p=0.48), preoperative BCVA (p=0.72), and IOP (p=0.56) and no association with age (p=0.53), sex (p=0.75) There was a negative correlation between BCVA loss and the preoperative number of antiglaucoma medications (p=0.02).

DISCUSSION

The results of this study support safety and efficacy of TSDLC in advanced glaucoma patients with visual acuity of 0.3 Snellen unit or better. We found that three-quarters of our patients had no decrease in their vision after the TSDLC procedure at the final visit. Furthermore IOP was successfully controlled in 91% and the average number of antiglaucoma medications significantly decreased from baseline after an average of 24.1±26.4 months. This is consistent with the studies suggesting that TSDLC has a satisfactory effect on IOP control in patients with good vision.[7,8,10-13] Transscleral diode laser cyclophotocoagulation is generally reserved for refractory glaucoma resistant to medical treatment or other surgical procedures.[14] Since TSDLC is thought to decrease the final vision, it is indicated for advanced glaucoma cases with minimal beneficial vision.[15] However, in recent years, clinicians have begun using TSDLC both as first-line therapy and in patients with good visual acuity.[7-9,10,11]

In this study, BCVA of the patients were 0.3 Snellen unit or better, and among our 36 patients, 8 (22.2%) had vision loss ≥ 1 lines. TSDLC was applied as primary treatment in 14 (38.9%) patients, and the number of patients with reduced visual acuity among these cases was 1. In one prospective study comparing TSDLC and Ahmed Glaucoma Valve (AGV) procedure as the primary treatment in neovascular glaucoma, the success rates on IOP control at 24 months were 63.6% and 59.3%, respectively.[16] The visual loss occurred in 24% of the patients in the TSDLC group and 27% in the AGV group. There were more complications in AGV implanted eyes than those treated with TSDLC. Although our study is not a comparative study, it includes cases with good visual acuity and cases with different glaucoma diagnosis. In this study, IOP was successfully lowered in patients who received TSDLC as primary treatment and vision loss occured 2 line in only 1 patient who developed cystoid macular edema. In this sense, TSDLC can be considered primarily in advanced glaucoma patients with good visual acuity.

Although vision decreased in 8 patients during the follow-up period, it is not clear that TSDLC was the cause in all cases. In half of our patients with decreased vision, there was a progressive visual field loss and optic nerve damage despite good IOP control. These patients had evidence of deterioration affecting the central 10° based on Humphrey 24-2 visual field testing, consistent with other studies

reporting that there might be visual loss due to glaucoma progression even after good IOP control with TSDLC.[7,17] Since the loss of vision in these cases occurred in the 6th postoperative month, the reason was attributed not only to TSDLC, but also to glaucoma progression.

In one of our patients, who underwent TSDLC as primary treatment, CME and 2 lines of BCVA loss developed two months after procedure. Although CME resolved in six months, vision loss was permanent at the end of the follow-up period. It is reported that cyclodiode therapy contributes to the formation of macular edema, and leads to worsening of the vision.[2,7] We think that the cause of vision loss in this case is CME due to TSDLC, having diabetes mellitus in the patient's history may also be a facilitating factor. Another patient had decreased visual acuity by 2 lines due to central retinal vein occlusion after two months following the TSDLC. It has been reported that IOP spikes might occur in the first month after TSDLC, which might result in vascular occlusion.[18] We suggest that decreased vision in our patient was associated with TSDLC since the vein occlusion occurred during the transient IOP spike (35 mmHg) observed in the second postoperative month.

Two pediatric patients with congenital glaucoma had transient BCVA loss due to hypotony in the early postoperative period. It has been reported that TSDLC is an effective and safe method in pediatric patients.[19-21] However, inflammation resulting from the local destructive effect on the ciliary body has been reported.[22] Autrata reported a significant visual loss in the range of 3/60 to counting fingers after TSDLC in pediatric refractory glaucoma patients, and 13% had uveitis despite corticosteroid therapy.[19] In both of our cases, the visual acuity improved with the treatment of hypotony. However, one patient had visual loss of 1 line at the end of the follow-up, which might be due to TSDLC related inflammation. The other patient developed cataract resulting in one line of visual loss at the final visit. Cataract formation after TSDLC has been reported.[5]

In studies with baseline visual acuity of ≥20/60, visual loss of 2 lines was reported between the range of 24% and 30%.[7,8] Shah et al. showed that 30% of the eyes with baseline BCVA ≥20/40 had a loss of more than 2 lines after TSDLC.[9] However, in a prospective clinical study of a Ghanaian population treated with TSDLC as the primary surgical treatment in one eye and medical treatment in the other eye, it was shown that there was no statistically significant vision loss between the two eyes, and according to this study, vision loss may not be inherent in the TSDLC procedure.[23] Two Snellen lines of BCVA loss was recorded in 4 (11.1%) patients, and the cause of vision loss was TSDLC in only 2 of them. This rate is lower than previous studies supporting the idea that the visual loss that occurs during the follow-up period in eyes undergoing TSDLC could be independent of the procedure and that it is a safe procedure in eyes with good visual acuity.

TSDLC has been shown to have fewer intraoperative complications than filtration surgery and tube shunt procedures.[10] Compared to the 1-year results of the Tube versus Trabeculectomy (TVT) study, TSDLC appears to be a safer procedure than intraocular surgery. In TVT study, BCVA loss of two or more lines was observed in 32% of tube shunt patients and 33% of trabeculectomy patients in a one-year follow-up. Intraoperative complications were seen in 7% of the tube and 10% of the trabeculectomy patients.[24] In our study, 11.1% of the patients had BCVA loss of two lines which was lower in the same follow-up period compared to the TVT study and none of our patients had an intraoperative complication. Furthermore, endophthalmitis was not observed in any patient in our study, as in other studies with a baseline BCVA ≥ 20 of 60 with TSDLC [7,8], whereas in the TVT study, 4 cases of endophthalmitis were reported in 1 year. [24]

The advantage of TSDLC compared to invasive glaucoma surgeries such as filtration or tube shunt, is that it is a non-invasive procedure, technical simplicity, portability, no need for a sterile operating room and less risk of intraoperative complications.[10] Although traditionally it is known that the TSDLC causes a reduction in final VA in patients and therefore is reserved for the treatment of patients with minimal benefit of vision,[15] new studies have been conducted documenting the efficacy and safety of TSDLC in patients with good visual acuity.[7,10,17, 25, 26] It has been shown that VA of glaucoma patients also decline over time in traditional treatments such as filtration surgery,[27] raising the question of whether the change in VA documented in previous studies is a result of TSDLC or the progression of the disease process. Increasing new data led to the observation that the reduction in VA after TSDLC may not be due solely to cyclodestruction. In fact, in our study conducted in patients with BCVA of 0.3 Snellen unit or better, only 3 out of 8 patients whose visual acuity decreased ≥ 1 line at the end of the follow-up period, was attributed to TSDLC. Furthermore, in our study, TSDLC was applied to 14 (38.9%) patients as primary treatment and only 1 patient had 2 lines of BCVA loss. Patients who received TSDLC as primary treatment were elderly patients with comorbidities who could not attend frequent postoperative visits, patients with secondary glaucoma due to previous intraocular surgery, patients with low chance of success rate in filtration surgery and high risk of complications, patients of pediatric age group diagnosed with post-cataract surgery glaucoma, and young patients with low chance of success rate in filtration surgery. While effective IOP reduction was achieved in 25 (69.4%)

patients with a single session, 11 (30.5%) patients needed retreatment with TSDLC in the follow-up, consistent with a retreatment rate of 30 to 48% in other studies.[28,29] Three of these patients had visual loss of one Snellen line during the follow-up. Progressive visual field loss alone caused decreased BCVA in two POAG patients, and cataract formation decreased BCVA in one congenital glaucoma patient. All these patients had previously failed trabeculectomy surgeries. Therefore, this study demonstrates that TSDLC can be applied effectively and safely as a primary and repetitive treatment in refractory glaucoma patients with good visual acuity, including the pediatric age group.

The strength of our study includes the enrolment of only patients with good visual acuity and regularly followed up for at least one year, cases in different age groups with different diagnosis of glaucoma and administered as primary and repetitive treatment. The long follow-up period, the presence of the pediatric age group and the primary surgery performed in one of them are the different sides of our study. The main limitations include single-center, retrospective and non-comparative design, no comparison with other surgical techniques and different laser (micropulse) techniques and parameters such as different laser power and/or duration.

In conclusion, TSDLC is effective in reducing IOP and proved to be a relatively safe method in advanced glaucoma patients with good vision. We suggest that it can be used efficiently as a primary treatment for glaucoma patients with good visual acuity. However, prospective randomized controlled trials are needed for a better comparison of TSDLC with conventional glaucoma surgeries.

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