ORIGINAL ARTICLE

Treatment Results of Diode Laser Cyclodestruction Treatment in Refractory Glaucoma

Mine Esen Barış[1], *Suzan Güven Yılmaz*[2]

ABSTRACT

Purpose: The purpose of this study is to evaluate the treatment results of transscleral diode laser cyclodestruction (DLC) in eyes with glaucoma resistant to medical and/or surgical treatment.

Materials and Methods: A retrospective chart review was performed for patients who underwent DLC due to intraocular pressure (IOP) >21 mmHg despite maximum medical and/or surgical anti-glaucoma treatment between September 2020-August 2022 in glaucoma unit. Data regarding demographic data, glaucoma types, previous glaucoma surgeries and medical anti-glaucoma treatments, IOP measurements before the DLC and on postoperative day 1, week 1 and months 1, 3, 6 and 12.

Results: Overall, 58 eyes [17 aphakic glaucoma, 10 penetrating keratoplasty glaucoma, 7 neovascular glaucoma, 5 exfoliative glaucoma, 4 primary angle closure, 3 primary open angle, 4 congenital, 3 iridocorneoendothelial syndrome, 2 Fuchs uveitis, 2 silicone oil, 1 glaucoma secondary to penetrating injury] of 53 (30 F, 23 M) patients were included. Mean age was 45.6±26.1 (1-81) years and mean follow-up period was 20.1 months. Fifty-four (93.1%) of the eyes received maximum topical anti-glaucoma medications, 14 (24.1%) received additional systemic acetazolamide and 4 (6.9%) pediatric patients were using maximum topical treatment except for alpha-2 agonists. Thirty-eight (65.5%) of the eyes had prior glaucoma surgery. Mean cup to disc (c/d) ratio was 0.92±0.18 and mean IOP was 31.3±9.1 mmHg before DLC. IOP was measured as 25.5±11.3 mmHg (p=0.001) on month 1 and 18.8±6.6 mmHg on month 12 (p<0.001). Re-treatment was needed in 19 (%32.7) eyes.

Conclusions: DLC is an effective method that may require repeated procedures (32.7%) in refractory glaucoma treatment.

Keywords: Cyclodestruction, Diode laser, Refractory glaucoma,

INTRODUCTION

Glaucoma is one of the most common causes of irreversible blindness worldwide. Currently, the cases are considered as refractory/resistant glaucoma when intraocular pressure (IOP) cannot be controlled using anti-glaucomatous agents, laser trabeculoplasty or filtering surgery; Seton surgery or cyclodestructive procedures. It can be challenging to decide optimal method to reach target IOP in cases with refractory glaucoma. Cyclodestructive procedures are employed in eyes in which IOP is still elevated despite prolonged use of multiple anti-glaucomatous agents, history of multiple trabeculectomy procedures or Seton surgery or eyes in which surgery is avoided due to high risk for surgery or have no visual expectation but require symptomatic treatment for pain. Cyclodestruction includes several procedures which have been used since 1930s and aim to reduce humor aqueous production through ciliary body coagulation or destruction. In the process started by cyclodiathermy and cyclocryotherapy, continuous wave transscleral diode laser cyclophotocoagulation (CW-DLS) has become reference method and cyclodestruction procedure has become less invasive and more effective when compared to previous techniques[1].

Transscleral DLS exerts its effect through reduced humor aqueous production due to ciliary body damage and coagulation necrosis resulting from absorption of 810 nm (infrared) laser beam by pigment epithelium of ciliary body. In addition, there are publications that DLS improved uveoscleral humor aqueous efflux by increasing permeability in ciliary body and sclera[2].

1- Uz. Dr., Ege Üniversitesi, Göz Hastalıkları, İzmir, Türkiye

2- Doç. Dr., Ege Üniversitesi, Göz Hastalıkları, İzmir, Türkiye

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Correspondence Address:
Mine Esen Baris
Ege Üniversitesi, Göz Hastalıkları, İzmir, Türkiye
Phone: +90 506 751 6284
E-mail: mine.baris@yahoo.com

This study aimed to evaluate efficacy and safety of transscleral DLS treatment in adult and pediatric cases with refractory glaucoma.

MATERIALS AND METHODS

In this retrospective study, we screened files of patients who underwent transscleral DLS due to glaucoma between September, 2020 and August, 2022. In all patients, demographic characteristics, glaucoma type, surgical procedures and medical anti-glaucomatous therapies, visual acuity at baseline and after DLS (on day 1, week 1 and months 1, 3, 6 and 12) and complications were recorded. The DLS indications included IOP >21 mmHg despite maximum tolerated anti-glaucomatous treatment, history of filtering and/or Seton surgery failure, high risk for surgery and pain due to elevated IOP in eyes with no visual expectation. The patients not attending control visits regularly, those with follow-up<3 months and patients underwent other surgical procedures in the same session with DLS or within first 3 months after DLS were excluded. Data obtained at post-operative period in patients who underwent other glaucoma procedures were excluded from analysis. The study was approved by Ethics Committed on Medical Research.

All DLS procedures were performed at operating room under general and local anesthesia by a single surgeon. The G probe (810 nm, OcuLight SLx, IRIS Medical Instruments, Inc., Mountain View, CA) was placed at a 1.2 mm distance to limbus. The procedure was applied to inferior 180° quadrant with maximum energy of 2.0 W for 2 seconds. When a "pop" sound was recognized in any quadrant, energy level was decreased 15 mW and procedure maintained at "pre-pop" level. The areas of scleromalacia or previous surgery were avoided. After procedure, topical 0.3% netilmicin sulfate plus 0.1% dexamethasone (every 3 hours) were prescribed to the patients. It was recommended to taper topical agents over 4 weeks. Patients continued to use topical anti-glaucomatous agents after. DLS. Systemic acetazolamide use was re-assessed according to postoperative IOP measurements. For repeated DLS, 3-months interval was awaited. The procedure was considered as successful if IOP was ≤21 mmHg after DLS or if pain was relieved in eyes without visual expectation.

Data were analyzed using SPSS version 23.0. Paired samples t test was used to compare pre- and post-DLS IOP values. A p value<0.05 was considered as statistically significant.

RESULTS

The study included 58 eyes of 53 patients. Of the patients, 30 (56.6%) were female and 23 (43.3%) were male. Mean age was 45.6±26.1 years (1-81 years). Mean follow-up period was 20.1 months (3-26 months) after DLS. Of the patients included 16 (30.1%) were younger than 18 years (18 eyes) while 37 (69.9%) were adults (40 eyes). Table 1 summarizes age, gender, glaucoma types, pre-operative and post-operative IOP values, glaucoma treatments before and after DLS. Mean pre-operative IOP and c/d values were 31.3±9.1 mmHg (21-60 mmHg) and 0.92±0.18 (0.2-1), respectively. It was found that 20 eyes (34.4%) had no history of previous surgery while 38 eyes (65.6%) previously underwent at least one glaucoma surgery. All cases with diagnosis of neovascular glaucoma had previous intravitreal bevacizumab injections and pan-retinal laser photocoagulation. and glaucoma. There was patent laser iridotomy in all cases with primary angle-closure glaucoma. Mean IOP reduction compared to baseline was 6.013.0 mmHg and 4.8±11.3 mmHg on months 1 and 3 after DLS, respectively (p<0.01). Table 2 presents IOP changes over in the study population including pediatric and adult patient subgroups. Figure 1 presents IOP values and changes at baseline and on postoperative day 1, week 1 and months 1, 3, 6 and 12. When the study population and subgroups were analyzed separately, it was found that IOP value was significantly lower at all time points when compared to baseline (p<0.001). Mean IOP was 21.6±8.5 mmHg (10-45 mmHg) on month 6 and 18.8±6.6 mmHg (10-34 mmHg). It was seen that the DLS procedure was repeated in 19 eyes (32.7%) including 13 eyes (22.4%) with one repeated procedure and 6 eyes (10.3%) with >2 repeated procedure. In all eyes, topical anti-glaucomatous treatments were maintained after DLS. The systemic acetazolamide was withdrawn in 11 (78.5%) of 14 cases after first DLS while it was maintained in 3 adult patients (21.5%). By DLS, success was achieved in 27 eyes (46.5%) on month 3, 20 eyes (34.4%) on month 6 and 11 eyes (18.9%) on month 12. In pediatric cases, number of successful eyes was 8 (44.4% on month 3, 7 (38.8%) on month 6 and 3 (16.6%) on month 12. In adult patients, IOP was maintained <21 mmHg in 15 eyes (37.5%) on month 3, 7 eyes (17.5%) on month 6 and 7 eyes (17.5%) on month 12. Glaucoma surgery was performed in 9 eyes (15.5%) after DLS. Mean time to surgery after DLS was 106.4±12.3 days. The surgical procedures included Seton revision (6 pediatric eyes), trabeculectomy bleb revision (1 adult eye) and Seton surgery (2 adult eyes) . No complication such as hyphema, hypotonia, phthisis bulbi and choroid

Table 1: *Demographic and clinical characteristics in pediatric and adult cases included*

Characteristics	Pediatric cases, n(%)	Adult cases, n (%)
Number of eyes	18 (31.0)	40 (68.9)
Number of patients	16 (30.1)	37 (69.9)
Female	7 (43.7)	20 (54.1)
Male	9 (56.3)	17 (45.9)
Age, years, mean±SD (min.-max.)	10.1± 5.9 (1-18)	61.3±13.1(31-82)
Pre-operative IOP	31.2±6.4 (24-44)	31.4±9.8(22-60)
Glaucoma type		
Aphakic glaucoma	13 (72.2)	4 (10)
Glaucoma secondary to penetrating keratoplasty	0	10 (25)
Neovascular glaucoma	0	7 (17.5)
Exfoliative glaucoma	0	5 (12.5)
Primary angle-closure glaucoma	0	4 (10)
Congenital glaucoma	4 (22.2)	0
Primary open-angle glaucoma	0	3 (7.5)
Iridocorneoepithelial syndrome	1 (5.6)	2 (5)
Fuchs' uveitic syndrome	0	2 (5)
Silicon oil glaucoma	0	2 (5)
Glaucoma secondary to penetrating injury	0	1 (2.5)
Previous glaucoma therapies		
Medical treatment alone	3 (16.7)	17 (42.5)
Surgery plus medical treatment	15 (83.3)	23(57.5)
SLT	0	2 (5)
Trabeculectomy	12 (66.6)	19 (47.5)
Ex-Press implant	1 (5.6)	3 (7.5)
Seton	8 (44.4)	2 (5)
Cyclocryotherapy	8 (44.4)	2 (5)
Pre-DLS medical treatment		
• B-blocker+CAI+ Alpha agonist+ PGA	11 (61.1)	29 (72.5)
• B-blocker+CAI+ PGA	4 (22.2)	0
• B-blocker+CAI+ Alpha agonist+ PGA+oral CAI	3 (16.6)	11 (27.5)
Post-DLS glaucoma treatment		
Medical treatment alone	10 (55.5)	25 (62.5)
Repeated DLS±medical treatment	6 (33.3)	13 (32.5)
Surgery±medical treatment	5 (16.6)	4 (10)

DLS: Diode laser cyclodestruction, IOP: intraocular pressure, min: minimum, max: maximum, SLT: Selective laser trabeculoplasty, CAI: carbonic anhydrase inhibitor, PGA: prostaglandin analogs

detachment was observed in any eye after DLS while mild anterior chamber reaction was observed in 2 eyes (3.4%), which regressed topical corticosteroid therapy.

DISCUSSION

Transscleral DLS has been used in refractory glaucoma cases over 30 years. In the literature, it was reported that IOP could be reduced below 22 mmHg in 63-89% of eyes[3-6]. Mistlberger et al.[7] reported DLS success (IOP<22 mmHg or pain relief) in refractory glaucoma while Kılınç et al.[8] reported success rate as 70.5%. Kara et al.[9] reported surgical success rate (IOP<21 mmHg/reduction in the number of anti-glaucomatous agents) as 84% on month 6. Bitirgen et al.[10] reported rate of eyes with IOP<22 mmHg as 40.5% at final control visit (beyond month 6). The maximum energy and field in single pulse were 3000 mW/270° in the study by Mistlberger et al.[7] and 2500 mW/180-270° in the study by Kılınç et al.[8] In our study, surgical success rate was 46.5% on month 3. We think that the lower success rate compared to literature might

Table 2: *Changes of intraocular pressure in pediatric cases, adult cases and whole study population*			
IOP, mean±SD (min. -max)	**Pediatric Cases**	**Adult Cases**	**All Cases**
Pre-operative	31.2±6.4	31.4±9.8	31.3±9.1
Post operative day 1	21.3±6.9	24.6±10.3	23.6±9.4
Post operative week 1	19.1±7.4	24.2±9.1	22.6±8.8
Post operative month 1	25.0±12.5	25.9±10.8	25.5±11.3
Post operative month 3	25.0±11.0	27.0±10.9	26.3±10.8
Post operative month 6	9.0±10.4	22.1±9.5	21.6±8.5
Post operative month 12	9.3±12.5	15.3±3.6	18.8±6.6
IOP: intraocular pressure, SD: Standard deviation, min: minimum, max: maksimum			

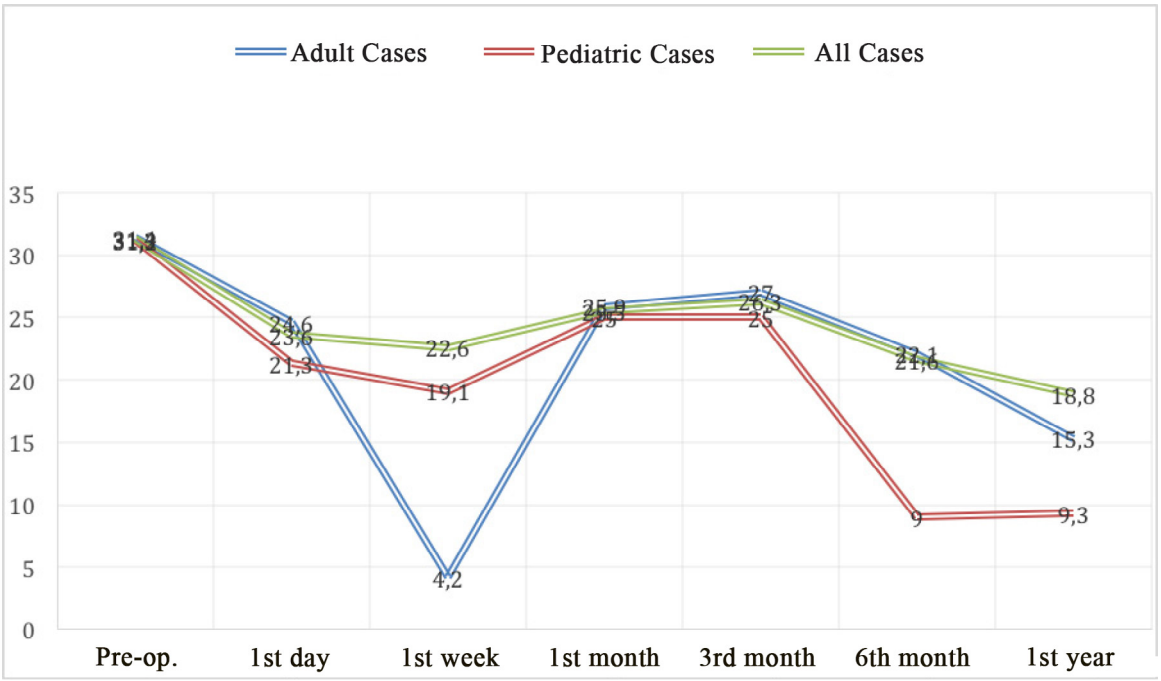

Figure 1: *Changes in intraocular pressure at preoperative and postoperative period in pediatric and adult patients as well as whole study population*

be due to relatively limited maximum energy and field (2000 mW/180° in our study. In addition, the success rate reflects outcomes on month 3 with single DLS procedure since it was avoided to repeat DLS before 3 months. The success rate with single session rate was reported as 77.4% by Frezotti et al.,[3] 64.8% by Bitirgen et al. and 68.8% by Rodrigez-Garcia et al.[12]

On the other hand, there is limited number of study on pediatric patients with lower success rates of 62-66%.[13-15] Kraus et al.[16] reported DLS success as 57.7% in refractory pediatric patients and failure rate as 45% in the first session. In our study, success rate with single session was 44% on month 3. To best of our knowledge, this is the first study reporting transscleral DLS outcomes in refractory pediatric glaucoma cases in Turkey. Similarly, Abdelrahman et al.[17] reported success rate for transscleral DLS as 46% in pediatric cases.

In the study by Singh et al.,[11] it was reported that IOP was decreased by 58.5% on month 9 in refractory glaucoma cases while Kara et al.[9] reported IOP reduction by48.% in eyes with silicone oil glaucoma. Although the IOP reduction was 23.5% (6.0±13.0 mmHg) on month 1 and 18.2% (4.8±11.3 mmHg) on month 3, it was 69.6% on month 6 and 60.6% on month 12 in our study. The greater IOP reduction at advancing months suggests that the likelihood of success is enhanced when DLS is repeated at least once. enhances the likelihood of success. In the study by Mistlberger et al.[7], it was reported that the number of repetition had no significant correlation with outcome

or success. In the literature, IOP reduction by DLS was reported to be 28.6-67.0% in pediatric patients.[16, 17] In our study, IOP reduction was 20% on month 3, 70% on month 6 and 70% on month 12 in pediatric cases. In the literature, it was shown that repeated DLS procedure increased success with success rate up to 72-79 in pediatric cases.[14, 15]

Mistleberger et al. reported that at least one DLS repetition was required in 16% of cases while this rate was reported as 39.2% by Kılınç et al.[8], 33.3% by Kara et al.[9] and 35.2% by Bitirgen et al.[10]. In our study, 58% of eyes required repeated treatment during 12-months follow-up. Higher retreatment rate might be due to relatively limited energy and field in each session. The limited energy and field parameters resulted in lack of complication in both pediatric and adult patients after procedure. In the literature, there are publications reporting complications such as corneal graft rejection, hypotonia, hyphema or fibrin reaction.[8,12] The complication incidence is increased in pediatric age group. In pediatric patients, DLS complications included retinal detachment (2.9-3.9%), choroid detachment (5.8%), severe inflammation (6.2-13%).[14, 15]

In a study by Singh et al.,[13] it was suggested that transscleral DLS can be used for safe surgery in eyes with extremely high IOP. In our study, surgical intervention could be performed after IOP reduction by DLS in 15.5% of eyes. Although surgical procedures mainly included previous revision surgeries, it is thought that the fact that DLS was generally performed to inferior 180° quadrant might be helpful to spare superior quadrant for potential surgeries in the future.

In our study, it was found that transscleral DLS is safe and effective treatment modality. Low complications rates showed that it can be safely performed and repeated not only in cases without visual expectation but also in pediatric patients and patients with high risk for surgery and that In eligible cases, it is safe and preferable to perform glaucoma surgery following IOP reduction by DLS.

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