Long-term efficacy of endoscopic cyclophotocoagulation in the management of glaucoma following cataract surgery in children

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Abstract

Purpose

To report the long-term efficacy of endoscopic cyclophotocoagulation (ECP) in pediatric glaucoma following cataract surgery (GFCS).

Methods

ECP was performed on 35 eyes of 25 patients <16 years of age with GFCS. Patients were followed for a minimum of 2 years. Treatment failure was defined as consecutive postoperative intraocular pressure (IOP) of >24 mm Hg, alternative glaucoma procedure following ECP, or occurrence of visually significant complications. Analysis was performed to estimate risk factors for failure.

Results

A total of 27 aphakic and 8 pseudophakic eyes were included. Pretreatment IOP averaged 33.9 ± 7.9 mm Hg. Final IOP after a mean follow-up period of 7.2 years was 18.9 ± 8.8 mm Hg (P < 0.001). The success rate was 54% (19/35 eyes). The failure rate was not increased in pseudophakic patients relative to aphakic patients. Patients with single ECP demonstrated preserved visual acuity from baseline to final follow-up.

Conclusions

In this patient cohort, with average follow-up period of 7.2 years, ECP was useful in the treatment of pediatric GFCS.

Development of glaucoma following cataract surgery (GFCS) is common. According to the Infant Aphakia Treatment Study (IATS), the risk of developing glaucoma at 4.8 years after surgery is 17%; of being a glaucoma suspect, 31%.[1] These patients are often inadequately responsive to medical management. Surgical options include trabeculectomy, seton implantation, and cyclodestructive procedures.

Endoscopic cyclophotocoagulation (ECP) is a ciliary destructive procedure used in the management of a variety of glaucoma cases. Its utility has been demonstrated in studies of difficult secondary glaucomas in which the etiology of increased intraocular pressure (IOP) was varied.[2,3] ECP has been shown to be effective as a primary intervention for cases of GFCS in young children, with minimum follow-up of 1 year and an average follow-up of 3.7 years.[2] The current study reviewed the records of both aphakic and pseudophakic patients treated with ECP to better understand the benefit to each, expanding previous studies by providing longer follow-up, longitudinal analysis of postoperative IOP, and reporting visual acuity as a functional outcome of the procedure. This study also investigated whether pseudophakia is a risk factor for treatment failure.

Subjects and Methods

The Indiana University Institutional Review Board approved this study, which was performed in accordance with the US Health Insurance Portability and Accountability Act of 1996. Suitable patients were identified by procedure codes, and patients' medical records were reviewed retrospectively. Children <16 years of age with GFCS treated with ECP from 1994 to 2014 at Riley Hospital for Children at IU Health in Indianapolis, Indiana, and followed for a minimum of 2 years or until a treatment failure had been declared were included. Patients with congenital glaucoma, anterior segment dysgenesis, or other secondary glaucomas were excluded.

Treatment failure was defined as the occurrence of any of the following during postoperative follow-up: (1) IOP >24 mm Hg on two consecutive visits despite glaucoma medications; (2) any other glaucoma procedure subsequent to ECP; or (3) sight-threatening complications, such as hypotony or retinal detachment. Treatment was considered successful if none of these failure criteria were met from time of surgery to final follow-up.

The diagnosis of GFCS was based on unacceptable IOP combined with evidence of optic nerve damage. Medical therapy was instituted in most patients prior to the first ECP treatment. In all patients, ECP was the first glaucoma surgical intervention. Any eye that had a suboptimal IOP and received further ECP was not deemed a treatment failure unless IOP at final follow-up exceeded that required for the definition of success. Alternative glaucoma interventions such as tube-shunt placement were performed by the primary surgeons if the IOP rebounded despite adequate degrees of treatment during ECP.

Treatment for all patients was administered with the Microprobe (Endo Optiks Inc, Little Silver, NJ). A schematic illustration of this procedure has been previously published.[2] Specific technique as well as preoperative and postoperative care was held consistent to the methods described in detail by Carter and Plager.[2] Treatments ranged from 120° to 270°. With rare exception, follow-up examinations took place at postoperative day 1, week 1, and months 1, 3, and 6. Subsequent examination intervals were based on the patient's clinical course. Visual acuity was collected based on age-appropriate tests, including Allen symbols, HOTV chart, and Snellen chart at 20 feet. Data collected included current medications, visual acuity, and IOP.

Results

A total of 35 eyes of 25 patients were included: 15 patients had bilateral cataracts and bilateral glaucoma; 6 patients had bilateral cataracts and unilateral glaucoma; and 4 patients had unilateral

cataract and unilateral glaucoma. Patient characteristics and baseline data, including phakic status, age at time of procedure, IOP, and follow-up, are summarized in Table 1.

At the final follow-up, median IOP was decreased by 47% in all patients in relation to the preoperative baseline. On average, the diagnosis of GFCS was made 3.3 years after lensectomy, and ECP was performed 2 years after diagnosis of GFCS. Of the 35 eyes included in this study, 80% had single ECP; in this subgroup, 14% required further alternative surgery. Of the 35 eyes, 20% required multiple ECP; 86% in this subgroup required further alternative surgery.

Of the 35 eyes treated with ECP, 19 (54%) were considered treatment successes. Treatment was successful in 13 of 27 aphakic eyes (48%) and 6 of 8 pseudophakic eyes (75%). ECP was successful in 18 of 28 eyes (64%) that received one treatment and 1 of 7 eyes (14%) that received multiple treatments. The average degree of treatment for first ECP was 230°, whereas the average degrees of treatment for repeat ECP was 151°. Four patients had bilateral success, and 4 patients had bilateral failure. One patient had success in one eye and failure in the other eye.

Failed eyes demonstrated a higher baseline IOP. All eyes demonstrated a significant decrease in IOP in the first postoperative week. At 6 months postoperatively, the mean IOP in successfully treated eyes was 18.6 ± 4.0 mm Hg (range, 10–24 mm Hg); in failed eyes, 28.6 ± 13.3 mm Hg (range, 12–53 mm Hg; $P = 0.03$).

Kaplan-Meier survival curves with 95% confidence intervals are shown for the single ECP group in Figure 1A and the multiple ECP group in Figure 1B. For the single ECP group, failure time was defined as time from baseline prior to first ECP procedure to the first treatment failure. For the multiple ECP group, failure time was defined as time from baseline to the second treatment failure. For the single ECP group, the failure probability was 0.21 (95% CI,

0.05-0.35) at 6 months, 0.32 (95% CI, 0.12-0.47) at 12 months, and 0.35 (95% CI, 0.15-0.51) at 24 months. For the multiple ECP group, the second treatment failure probability was 0.57 (95% CI, 0.01-0.82) at 12 months, 0.72 (95% CI, 0.08-0.91) at 24 months, and 0.86 (95% CI, 0.13-0.97) at 36 months. Single ECP eyes demonstrated a decrease in survival until 2 years, when there was no further decrease. All analyzed risk factors for ECP failure related to lensectomy, glaucoma diagnosis, and ECP are provided in Table 2.

Of the 35 total eyes, 3 (9%) had visual acuity of hand motions or less at final follow-up. Of the 32 remaining eyes, in those which received single ECP, logMAR visual acuity demonstrated improvement from baseline at 0.87 ± 0.35 (range 0.30-1.60) to 0.63 ± 0.42 (range, 0.00-1.48) at final follow-up ($P < 0.01$). Eyes that received multiple ECP treatments did not demonstrate significant change in visual acuity from baseline.

The 3 eyes with visual acuity of hand motions or less experienced complications following surgical procedures other than ECP. One eye received pars plana vitrectomy and capsulotomy at 5 months after ECP and immediately developed endophthalmitis, which progressed to phthisis. One eye had G-probe performed 4 months after ECP and thereafter progressed to phthisis. One eye had 3 ECP procedures performed followed by a trabeculotomy then progressed to phthisis. There were no vision-threatening complications immediately following the ECP procedures.

Discussion

This study demonstrates that ECP in children with GFCS can be useful over an average follow-up period of 7.2 years. Failed eyes demonstrated an elevated IOP at 6 months after ECP; thus an elevated IOP at this time may be a good predictor of whether a patient is likely to fail ECP. Almost all treatment failures occurred in the first 2 years, with sustained success thereafter in

eyes that underwent single ECP.

The length of follow-up in this study has allowed us to better evaluate the visual acuities of these children, because many of the procedures were performed at an early age. An improvement in visual acuity from baseline was demonstrated in single ECP eyes from an approximate Snellen equivalent of 20/160 at baseline to 20/80 at the final follow-up. This data demonstrates prevention of vision loss rather than a causal relationship between the procedure and improvement in vision. The measured improvement in visual acuity may have been due to the child's increasing maturity rather than a real improvement in acuity.

The results in this study are comparable to those of the previous study in this patient population, which had a minimum follow-up of 1 year and an average follow-up of 3.7 years, with a success rate of 53%.[2] The previous study found greater success in multiple ECP eyes, likely due to undertreatment of many eyes, with 180° rather than 270° followed by therapeutic treatment with repeat ECP.

In the current study failed eyes had higher IOP at GFCS diagnosis and higher baseline number of glaucoma medications prior to ECP. This could represent eyes with poorer outflow. There was no increased risk of failure in pseudophakic eyes compared to aphakic eyes. No retinal detachments occurred in this study; however, there were 3 cases of phthisis, which developed after procedures other than ECP.

GFCS is significantly more likely to develop in eyes with a corneal diameter of <10 mm compared with corneal diameter >10 mm and in all eyes with any degree of microcornea.[4-6] The current study is consistent with these findings as the average corneal diameter at the time of cataract extraction was 9.5 ± 1.4 mm (range, 5.4–11.8 mm). Early age at cataract extraction is also a risk factor, with children <1 year of age carrying the greatest risk of developing

glaucoma.[7]

Studies have demonstrated varying results related to laterality of disease.[8,9] No cases of bilateral glaucoma in the setting of unilateral aphakia were identified in this study. Six eyes did have unilateral GFCS in the setting of bilateral aphakia; however, GFCS could develop in aphakic eyes after the period of follow-up in this study.

This study has several limitations. A failure cutoff of 24 mm Hg was selected because IOPs were often elevated in the 21–24 mm Hg range following surgery, and there is inconclusive data associating initial mild elevation in IOP with optic nerve damage. Differences in IOP between successful and failed eyes may be small enough to not be clinically relevant. The sample size is small, and $P < 0.05$ is an insufficient cutoff for statistical significance because of investigation of multiple risk factors. Both eyes of bilateral cases were included because of the small sample size, which might skew results. Finally, no visual field or optical coherence tomography tests were analyzed in this study.

Over an average follow-up period of 7.2 years, ECP is a viable treatment in the setting of GFCS with a moderate success rate and a low complication rate. Procedure failure rate was not increased in pseudophakic eyes, suggesting that the presence of an IOL may not affect the surgical outcome. Survival analysis demonstrates retreatment failed. This contrasts previous findings in which eyes received less degrees of treatment during the initial procedure.

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Legends

FIG 1. A, Survival analysis demonstrating time to first treatment failure in single endoscopic cyclophotocoagulation (ECP) group. B, Survival analysis demonstrating time to repeat treatment failure in multiple ECP group.

Table 1. Patient demographics and outcomes

Patient demographics (N = 25)	No. (%)
Eyes (N = 35)	
Male	17 (49)
Female	18 (51)
Phakic status	
Aphakic	27 (77)
Pseudophakic	8 (23)
Treated bilaterally	10 (42)
Treatment parameters	**Mean ± SD (range)**
Age, years	
Lensectomy	0.7 ± 1.7 (0.1-6.4)
GFCS diagnosis	4.0 ± 2.5 (0.3-8.0)
First ECP treatment	6.0 ± 3.8 (0.4-12.3)
Corneal diameter at lensectomy, mm[a]	9.5 ± 1.4 (5.4-11.8)
IOP, mm Hg	
Baseline pre-ECP	34.1 ± 8.3 (20-50)
Final	18.9 ± 8.8 (8-57)
Follow-up time, years	7.2 ± 3.6 (2.2-17.1)

ECP, endoscopic cyclophotocoagulation; *GFCS*, glaucoma following. cataract surgery; *IOP*, intraocular pressure; *SD*, standard deviation.

[a]Recorded in 18 of 35 eyes.

Table 2. Risk factors for failure

	Success Mean ± SD (range)	Failure Mean ± SD (range)	*P* value
Lensectomy			
Age, years	0.8 ± 1.8 (0.1-6.4)	0.5 ± 1.5 (0.0-6.2)	0.65
Time to first post-op IOP, years	1.1 ± 1.2 (0.1-4.5)	1.8 ± 2.1 (0.0-5.9)	0.24
First measured post-op IOP, mm Hg	17 ± 7.8 (5-32)	25.1 ± 8.8 (14-42)	0.01
Glaucoma diagnosis			
Time between lensectomy and glaucoma diagnosis, years	3.8 ± 2.3 (0.2-7.9)	2.8 ± 2.5 (0.2-6.5)	0.23
IOP at glaucoma diagnosis, mm Hg	28.6 ± 7.7 (21-48)	32 ± 6.4 (22-42)	0.16
ECP			
Number of ECP treatments	1.1 ± 0.2 (1-2)	1.5 ± 0.7 (1-3)	0.03
Degrees of treatment of 1st ECP	224 ± 47 (120-270)	238 ± 36 (180-270)	0.35
Patient age at time of first ECP, years	7.1 ± 3.8 (0.4-12.3)	4.7 ± 3.5 (0.4-9.8)	0.06
Time between lensectomy and ECP, years	6.3 ± 3.8 (0.2-12.1)	4.2 ± 3.6 (0.3-9.8)	0.09
Time between 1st IOP after lensectomy and ECP, years	5.2 ± 3.7 (0.0-11.4)	2.3 ± 2.5 (0.0-8.3)	0.01
Time between glaucoma diagnosis and ECP, years	3.3 ± 3.2 (0.1-9.6)	1.9 ± 2.0 (0.1-6.2)	0.11
Baseline IOP at time of 1st ECP, mm Hg	32.1 ± 7.4 (20-48)	36.5 ± 8.8 (24-50)	0.12
No. glaucoma medications			
Before ECP	1.8 ± 1.3 (0-3)	1.7 ± 1.0 (0-3)	0.95
After ECP	0.8 ± 1.3 (0-3)	1.8 ± 1.2 (0-3)	0.03

ECP, endoscopic cyclophotocoagulation; *IOP*, intraocular pressure; *SD*, standard deviation.