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Research Article

Long Term Efficacy and Safety of Endocyclophotocoagulation Combined with Phacoemulsification in Asian Eyes- A Case Series Study

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Abstract

Purposes: A case series study of the long-term efficacy and safety of Endocyclophotocoagulation combined with phacoemulsification on Asian eyes with cataract and glaucoma.

Significance: Cataract surgery alone can reduce intraocular pressure. However, many confirmed glaucoma cases withcataract that just perform cataract surgery alone cannot lower IOP enough to target pressure. Many Asian glaucomatic eyes have narrow angle component to inhibit aqueous out-flow, while angle procedures will be unable to perform. Combining cataract surgery with Endocyclophotocoagulation was reported can further reducing intraocular pressure. This study, to our knowledge, may be represents the longest follow-up of Endocyclophotocoagulation combined with phacoemulsification in Asian eyes with glaucoma.

Method: A random chart review of 41 Asian eyes of 41 patients with various types and severity of glaucoma and cataract that underwent Endocyclophotocoagulation combined with phacoemulsification from 2012 to 2024 with various period of follow up by a single surgeon at a single center with a single laser machine In Honolulu, USA. Preoperative and postoperative mean intraocular pressures (IOP) were compared.

Results: No complications related to Endocyclophotocoagulation were reported in all of the 41 eyes. IOP were checked by a single calibrated automatic non-contact tonometry two weeks before and two weeks after surgery. In order to effectively control various severities of glaucoma depending on the vision, visual field and optic nerve of the eyes, a target intraocular pressure has to be established and reached. Therefore, 44% of eyes needed eye medication and 40% need eye needed medication and further procedures after the surgery. 17% were free from medication and procedure to be on target IOP. Comparison showed those severe cases that needed medication and procedures pre-op and post -op had Endocyclophotocoagulation demonstrated statistically significant lower mean IOP.

- Mean IOP (SD) in mmHg for all subjects (n = 41): P<0.001
  Pre-op: 18.5(5.2); post-op: 14.9(3.0)
- Mean IOP (SD) in mmHg for subjects requiring postoperative medications (n = 18,44%): P<0.05
  Pre-op:19.1 (5.7); post-op:15.0 (2.8)
- Mean IOP (SD) in mmHg for subjects requiring postoperative medications and additional glaucoma procedures (n = 16,40%) :P<0.05
  Pre-op: 19.1(5.1); post-op:15.5 (3.3)
- Mean IOP for subjects free from postoperative medications and procedures (n = 7, 17%) :P<0.001
  Pre-op:15.7(3.4); post-op:13.7(3.7)

Conclusion: Endocyclophotocoagulation combine with phacoemulsification can be safe and effective for Asian eyes with narrow angle glaucoma and cataract.

Kew Words: asian; cataract; endocyclophotocoagulation; glaucoma; phacoemulsification

Introduction

Glaucoma is a leading cause of blindness worldwide. Various medications, laser, and surgical procedures are available to control intraocular pressure (IOP) within target ranges to prevent further disease progression. Glaucoma is often associated with cataracts as part of the aging process, especially for the older Asian population. While cataract surgery alone can reduce IOP in some cases, recent studies show that combining phacoemulsification with minimally invasive glaucoma surgeries (MIGS) can further lower IOP. This can reduce or eliminate the need for glaucoma medications or further surgical interventions. In addition, the combined approach can improve compliance, lower treatment costs, and minimize side-effects associated with long-term glaucoma medication use.

One type of the MIGS to treat moderate-to-severe glaucoma is the Cyclodestructive procedure, which reduces aqueous humor production through targeted ciliary body ablation. [1-3], Among them, Endocyclophotocoagulation (ECP)allows direct visualization of the ciliary processes with precise laser application and demonstrated superior safety compared to TransScleraCyclophotoCoagulation (TSCPC) [4-7]. First described by Uram in 1992, ECP delivers predictable outcomes and favorable safety profile by minimizing damage to surrounding tissues and sclera, making it suitable for a wide range of patients [8].

Previous studies have demonstrated the safety and efficacy of ECP combined with phacoemulsification [9, 10]. However, most prior studies were short-term and focused on refractory glaucoma, open-angle glaucoma, or intractable neovascular glaucoma, often with limited Asian populations [11, 12]. In Bolek's study, for instance, only 7.9 percent of cases involved narrow-angle glaucoma [13].

Since Asian patients are more likely to present with narrow or partial narrow angle glaucoma with concurrent cataract, focusing on this particular population is paramount. Moreover, because the non-pigmented ciliary epithelium can regenerate after laser ablation, long-term studies are necessary to confirm sustained efficacy [16,18].

Moreover, narrow-angle glaucoma is not feasible with Selective Laser Trabeculoplasty (SLT) and angle-based implants. In such cases, ECP is especially advantageous as it may serve as a safe, effective, and economical treatment option, particularly performed alongside phacoemulsification. This combined procedure requires only a single incision and may therefore be especially advantageous. In the era of interventional glaucoma treatment to reduce medication, combining ECP with phacoemulsification certainly should be considered on most glaucoma patients with cataract [16,18].

This study reviews over 12 years of consecutive cases of ECP combined with phacoemulsification performed in Asian eyes with glaucoma, with follow-up periods ranging from 3 to 12 years.

Materials and Methods

This is a randomized case series study of 41 consecutive Asian eyes from 41 patients who underwent Endocyclophotocoagulation (ECP) combined with phacoemulsification cataract surgery between 2012 and 2024. All procedures were performed by a single surgeon (Dr. Ming Chen) at a single surgical center (SugicalSuite) in Honolulu, Hawaii, using a single ECP laser system.

Patients were between 58 to 88 years old (mean = 74 years), consisting of 18 males and 23 females. All patients (n = 41) were Asian with cataracts and glaucoma of varying severity. All consecutive patients undergoing ECP combined with phacoemulsification for cataract and glaucoma, regardless of stage and the majority of cases were narrow angle glaucoma (68.20%) were included to be reviewed.

The data collected were preoperative and postoperative mean intraocular pressure (IOP), ranging from 3 to 12 years (mean 6.4 years) of follow-up periods. Further data collected were the need for postoperative glaucoma medication and additional glaucoma procedures.

Phacoemulsification was done by Dr. Ming Chen with all cases under topical anesthesia. After cataract extraction and implantation of intraocular lens, the preservative free lidocaine was injected into the posterior chamber. Then, viscoelastic was used to fill and expand the space between the implant and iris to expose the ciliary process. An ECP probe (EndoOptiks, Beaver-Visitec, Waltham, MA, USA) was inserted into the posterior chamber and aimed at the ciliary processes under illumination. Lastly, diode laser was delivered to 200° to 250° of the ciliary processes until whitening of ciliary tissue was observed. The laser was set at 200mW to 250mWand and adjusted as needed.

Cataract Type	% of Eyes
Age-related nuclear cataract	82.90%
Cortical cataract	4.90%
Combined form	4.90%
Posterior subcapsular cataract	2.40%
Cortical senile cataract	2.40%
Morgagnian cataract	2.40%
Mature cataract	2.40%

Table 1: Pre-operative Cataract Types

Glaucoma Type	% of Eyes
Chronic angle-closure glaucoma	48.70%
Primary open-angle glaucoma	43.90%
Intermittent angle-closure glaucoma	19.50%
Low-tension glaucoma	9.80%
Hypersecretion glaucoma	4.90%
Psudoexfoliation glaucoma	2.40%
Severe-stage glaucoma	2.40%
Capsular glaucoma with psudoexfoliation	2.40%

Table 2: Glaucoma Types

Other vision related diagnosis included were leukoma, pterygium, cystoid macular degeneration, dry eye disease, age-related macular degeneration, ptosis, and macula puckering.

Vision data were not reported due to vision can be variable by above reasons and can be confounding.

Statistical Methods:

IOP measurements were recorded before and after treatment. Analyses included the overall cohort of 41 patients who underwent ECP with phacoemulsification (ECP + Phaco, All), along with three mutually exclusive subgroups based on postoperative treatment needs: [1], patients requiring medications only (ECP + Phaco + Meds) [2] patients requiring both medications and additional glaucoma procedures (ECP + Phaco + Meds + Surg), and [3], patients requiring no further treatment (ECP + Phaco Only).

Descriptive statistics (mean, standard deviation, and mean difference) were computed for IOP before and after intervention in each group. Paired t-tests were used to assess the significance of within-group changes in IOP. A two-sided p-value < 0.05 was considered statistically significant. Confidence intervals (95%) for mean differences were also computed. All analyses were performed using R software.

Results:

A total of 41 eyes underwent Endocyclophotocoagulation (ECP) combined with phacoemulsification. There were no complications related to ECP in all 41 eyes. Postoperatively, some patients required additional treatments to achieve target IOP. Among these patients, 18 required further treatment with IOP-lowering medications (44%), 16 required both medications and additional glaucoma procedures (40%), and 7 did not need any further treatment beyond the initial combined procedure (17%).

- Mean IOP (SD) in mmHg for all subjects (n = 41):
  Pre-op: 18.5 (5.2); post-op: 14.9 (3.0); $P < 0.001$
- Mean IOP (SD) in mmHg for subjects requiring postoperative medications (n = 18, 44%):
  Pre-op: 19.1 (5.7); post-op: 15.0 (2.8); $P = 0.009$
- Mean IOP (SD) in mmHg for subjects requiring postoperative medications and additional glaucoma procedures (n = 16, 40%):
  Pre-op: 19.1 (5.1); post-op: 15.5 (3.3); $P = 0.025$
- Mean IOP for subjects free from postoperative medications and procedures (n = 7, 17%):
  Pre-op:15.7 (3.4); post-op:13.7 (3.7); $P < 0.001$

There was a statistically significant decrease in IOP post ECP combined with phacoemulsification in all groups. Seventeen percent of patients remained free from any medication or additional glaucoma procedures postoperatively.

Overall IOP Trends

Figure 1 shows box plots of intraocular pressure (IOP) before and after intervention for the overall cohort (n = 41) and the three mutually exclusive postoperative subgroups. All groups demonstrated significant reductions in IOP, with p-values annotated on the figure.

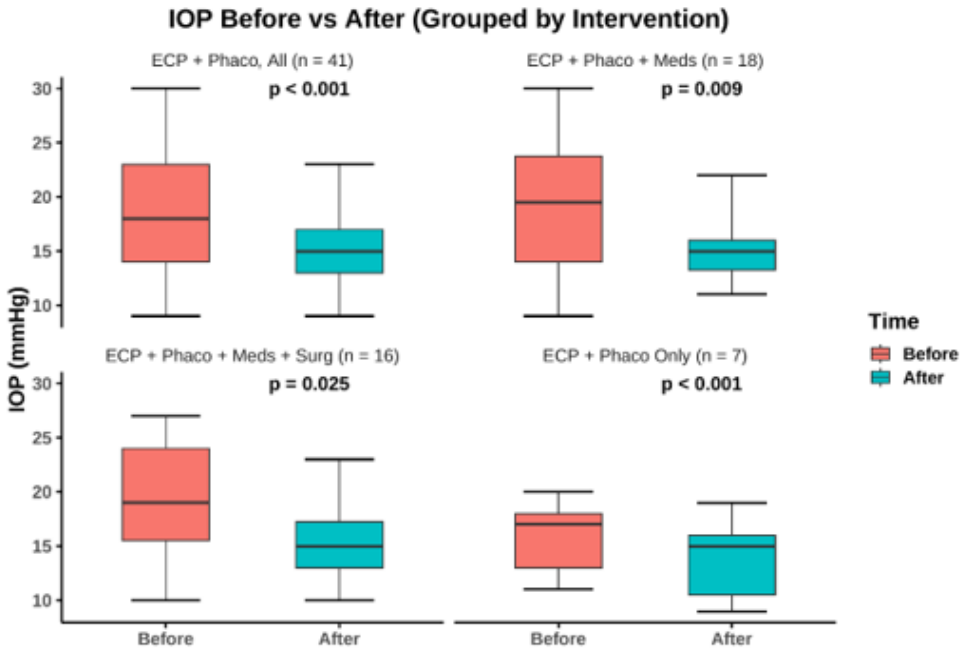

Figure 1: Box plot of IOP before vs. after for overall cohort and Subgroups

Group	Mean IOP Before (SD)	Mean IOP After (SD)	Mean Diff (SD)	95% CI	*p*-value
ECP + Phaco, All	18.5 (5.2)	14.9 (3.0)	-3.6 (5.3)	−5.25, −1.92	< 0.001
ECP + Phaco + Meds	19.1 (5.7)	15.0 (2.8)	-4.1 (5.9)	−7.07, −1.15	0.009
ECP + Phaco + Meds + Surg	19.1 (5.1)	15.5 (3.3)	-3.6 (5.7)	−6.60, −0.52	0.025
ECP + Phaco Only	15.7 (3.4)	13.7 (3.7)	-2.0 (0.8)	−2.76, −1.24	< 0.001

Table 3: Descriptive Statistics and Paired Comparisons

Individual Patient Trajectories

Figure 2 presents patient-level IOP trajectories across the overall cohort and the three postoperative outcome subgroups. The ECP + Phaco Only group showed consistently tight responses, while greater variability was observed in patients who required medications or additional surgery.

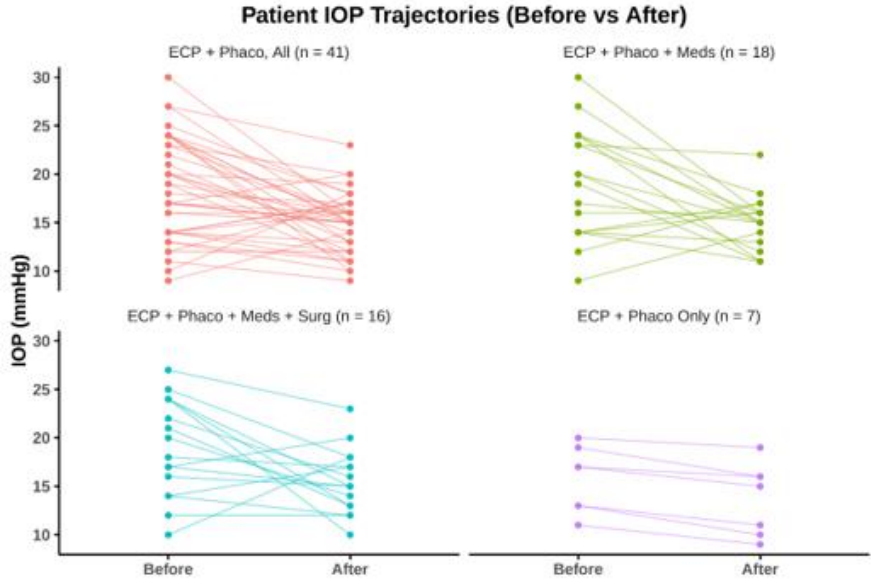

Figure 2: Individual IOP Trajectories Before and After Intervention

Secondary Outcomes

Vision for subjects consisted of preoperative 20/30 to count finger and postoperative 20/20 to count finger. However, it is important to note that there were other ocular pathologies that may affect vision outcomes.

Interpretations

All four groups showed a statistically significant reduction in IOP following intervention. In the overall cohort (ECP + Phaco, All), mean IOP decreased by 3.6 mmHg with a 95% confidence interval of −5.25 to −1.92 ($p < 0.001$), indicating a consistent and significant reduction.

The subgroup that required additional medications (ECP + Phaco + Meds) showed the largest mean reduction of 4.1 mmHg (95% CI: −7.07 to −1.15; $p = 0.009$), suggesting that pharmacological intervention post-surgery provided additional benefit in IOP control.

Patients who required both medications and additional glaucoma procedures (ECP + Phaco + Meds + Surg) also experienced a significant mean IOP reduction of 3.6 mmHg (95% CI: −6.60 to −0.52; $p = 0.025$), though with slightly less precision as reflected in the wider confidence interval.

Interestingly, the group that required no further treatment beyond the initial procedure (ECP + Phaco Only) showed the most precise and consistent response, with a mean IOP reduction of 2.0 mmHg (95% CI: −2.76 to −1.24; $p < 0.001$), despite the smallest standard deviation.

These findings support the effectiveness of ECP combined with phacoemulsification in reducing IOP, with additional interventions tailored to patient needs providing further IOP control as necessary.

Discussions

This study highlights that Endocyclophotocoagulation (ECP) combined with phacoemulsification results in a significant and durable reduction in intraocular pressure (IOP) among Asian patients with various types of glaucoma, with follow-up ranging from 3 to 12 years. Importantly, the procedures were all well tolerated with no complications, supporting its safety profile in the Asian population.

Previous studies from Chen and Francis had similarly reported the safety and efficacy of ECP, either alone or in combination with cataract surgery 14, 15. Francis further demonstrated that phacoemulsification with ECP produced greater mean IOP reduction compared with phacoemulsification alone in controlled glaucoma patients, with sustained effects at two years. 15The study of Wu targeting narrow-angle glaucoma reported significant reduction of IOP at one year, while Yap's three-year study included only 10 percent Asian participant.16, 17Yip's study specifically studied Asian patients undergoing ECP without phacoemulsification, showing effectiveness and safety. However, outcomes were less robust compared to those reported predominantly Caucasian population in a 15-month study. 18Collectively, these prior studies support the findings of the present work for the Asian population with narrow-angle glaucoma with cataract, though the current study is distinguished by its exclusively Asian cohort and substantially longer follow-up.

The results of this study have important clinical implications. As the ECP started as early as 1992, various new minimally invasive glaucoma surgeries (MIGS) developed and young ophthalmologists were more focused on utilizing newer devices, causing them to possibly under-appreciate the benefits of ECP. More recently, however, ECP has regained popularity due to increasing recognition of chronic glaucoma eye drop use which induces a complication of superficial corneal disease as well as the importance of treating chronic narrow-angle glaucoma.

The strengths of this study include its exclusively Asian cohort, focus on narrow-angle glaucoma, and the longest reported follow-up to date for combined phacoemulsification and ECP. This study showed no complication, which may be due to the experienced surgeon for phacoemulsification and conservative laser power setting in the early years of ECP. The limitations of this study include the retrospective design, relatively small sample size, and heterogeneity of glaucoma types.

Furthermore, visual outcomes were not analyzed in detail, due to confounding variables that also affect vision changes like various ocular conditions unrelated to glaucoma or cataract.

With proper techniques, ECP outcomes can be enhanced, although the results can be confounded by factors such as the smoothness of the phacoemulsification procedure and the reliability of the laser machine at the time of the procedure. Other possible confounding factor that limited the validity of this study is its long follow-up duration, during which some patients underwent additional procedures aimed at aggressively controlling intraocular pressure (IOP). However, complication rates remained low, and the reusability of the ECP probe provides a significant cost advantage compared to other MIGS devices that require expensive disposable components. ECP is a versatile procedure for narrow-angle and other glaucoma with cataracts and can also be combined with other MIGS procedure to further lower IOP for the long-term [19].

ECP combined with phacoemulsification also effective in surgically naïve patients and those with poor compliance, allowing management of both cataract and glaucoma in a single procedure.17In Bolek's five-year study, which only included 7.9 percent of patients with narrow-angle glaucoma, satisfactory results led to the recommendation that when a cataract is operable, a combined procedure should be considered even if glaucoma is under control, as it can reduce the number of medication needed [13].

We believe that revitalizing the role of ECP combined with cataract surgery for general ophthalmologists can be a "win-win "scenario for patients, doctor and insurance companies. The procedure is effective, safe and cost-efficient, treatment of cataract and glaucoma in a single surgery under topical anesthesia. In particular, this procedure is valuable in developing countries and rural areas where glaucoma specialists and financial resources are limited. For glaucoma specialists, this combined approach has the potential to reduce additional glaucoma procedures and decrease the long-term use of potentially toxic glaucoma medications.

While the procedure consistently lowered intraocular pressure (IOP), vigilant long-term management remains necessary, as some patients required additional medications or therapies to maintain target IOP. Importantly, these findings suggest that ECP combined with cataract surgery should not be viewed as limited only to moderate or severe glaucoma; rather, this method should be utilized as a versatile option across a broader spectrum of disease severity. Wider adoption of this procedure by cataract surgeons may improve patient outcomes, reduce medication burden, and expand access to effective and interventional glaucoma care.

Conclusion

In this 3 to 12-years follow up case series, combined endoscopic cyclophotocoagulation (ECP) with phacoemulsification demonstrated to be a safe and effective treatment for Asian eyes that have angle narrow component with coexisting cataract and glaucoma.

All patients signed consent form. As this is a case series study, Mr. Jacob Kowalski of IRB coordinator, University of Hawaii confirmed that under University of Hawaii - Human Studies Program (HSP) policy, series of case studies would not meet the HSP definition of human subject research and would not require HSP review and approval.

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