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Original Research Article

Role of Phacoemulsification in Primary Angle-Closure Disease after Patent Peripheral Iridotomy: A Prospective Study

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Abstract

Background: Primary angle-closure disease remains an important cause of glaucomatous visual loss. Although laser peripheral iridotomy is the standard initial treatment, raised intraocular pressure and persistent angle crowding may continue after a patent iridotomy. Lens extraction has therefore emerged as a potential therapeutic strategy in selected eyes with coexisting cataract.

Methods: This prospective study included 48 eyes of 48 patients with primary angle closure (PAC, n=18) or primary angle-closure glaucoma (PACG, n=30), patent peripheral iridotomy, visually significant cataract, and raised intraocular pressure on topical antiglaucoma medication. All eyes underwent phacoemulsification through a temporal incision. Preoperative assessment included applanation tonometry, gonioscopy, A-scan biometry, and anterior segment optical coherence tomography. Patients were followed for 12 months. Outcomes included intraocular pressure, anterior chamber angle width, visual acuity, and antiglaucoma medication use.

Results: Mean preoperative intraocular pressure was 35.5 ± 4.8 mmHg and decreased to 14.6 ± 3.5 mmHg at 12 months, corresponding to a 58.9% reduction. Mean anterior chamber angle width increased from 16.4 ± 3.0° preoperatively to 29.0 ± 3.9° at 12 months, a 76.2% increase. The proportion classified under improved visual acuity increased from 4 eyes (8.33%) preoperatively to 42 eyes (87.5%) postoperatively. Antiglaucoma medication use decreased from 47 eyes (97.92%) preoperatively to 2 eyes (4.17%) postoperatively ($p < 0.001$).

Conclusion: Phacoemulsification was associated with sustained intraocular pressure reduction, marked widening of the anterior chamber angle, improved visual acuity, and substantially reduced dependence on antiglaucoma medication in eyes with primary angle-closure disease after patent peripheral iridotomy.

Keywords: Angle-closure glaucoma; phacoemulsification; intraocular pressure; anterior chamber angle; cataract surgery.

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Introduction

Primary angle-closure disease contributes substantially to glaucoma-related visual morbidity worldwide. [1] While laser peripheral iridotomy is the standard initial intervention for angle-closure disease, residual angle crowding and inadequate intraocular pressure control may persist despite a patent iridotomy. [2]

Lens-related mechanisms, including increased lens thickness and anterior lens position, have an important role in angle crowding and pupillary block. [3] This has led to growing interest in lens extraction as a therapeutic procedure in addition to its visual rehabilitation benefit. In the EAGLE trial, early lens extraction provided effective control in angle-closure disease and strengthened the rationale for a lens-based approach in appropriately selected eyes. [4]

Progression of structural and functional glaucomatous damage may continue in primary angle-closure glaucoma, emphasising the need for durable intraocular pressure control and improved anterior chamber configuration. [5] The aim of this study was to evaluate the effect of phacoemulsification on intraocular pressure, anterior chamber angle morphology, visual acuity, and antiglaucoma medication requirement in

patients with primary angle-closure disease after a patent peripheral iridotomy.

Materials and Methods

Study Design and Setting: This prospective study was conducted in the Department of Ophthalmology, Krishna Mohan Medical College & Hospital, Mathura, and Uttar Pradesh, India.

Study Duration: Patients were followed for 12 months after phacoemulsification.

Participants: The study included 48 eyes of 48 patients with primary angle closure (PAC, 18 eyes) or primary angle-closure glaucoma (PACG, 30 eyes), a patent peripheral iridotomy, visually significant cataract, and raised intraocular pressure while receiving topical antiglaucoma medication.

Inclusion Criteria: Eyes with PAC or PACG, patent peripheral iridotomy, visually significant cataract, raised intraocular pressure, and ongoing topical antiglaucoma therapy were included.

Exclusion Criteria: Eyes with secondary angle-closure glaucoma, previous intraocular surgery, media opacity preventing adequate anterior segment assessment, absence of a patent peripheral iridotomy, absence of visually significant cataract, and incomplete follow-up were excluded.

Sample Size: The study analysed 48 eyes from 48 patients.

Sampling Method: Consecutive eligible patients presenting to the Department of Ophthalmology during the study period were enrolled prospectively.

Perioperative Care Pathways: Patients underwent standard preoperative evaluation and phacoemulsification through a temporal incision.

Preoperative assessment included applanation tonometry, gonioscopy, A-scan biometry (Sonomed), and anterior segment optical coherence tomography (Topcon). Postoperative follow-up assessed intraocular pressure, angle morphology, visual acuity, and antiglaucoma medication requirement.

Data Collection and Variables: Recorded variables included age, sex, systemic comorbidities, diagnosis category (PAC or PACG), intraocular pressure, lens thickness, anterior chamber angle width, visual acuity status, and antiglaucoma medication use. Intraocular pressure was assessed preoperatively and at 2 weeks, 4 weeks, 3 months, 6 months, and 12 months postoperatively. Anterior chamber angle width was assessed preoperatively and at 1 month, 3 months, 6 months, and 12 months postoperatively.

Outcome Measures: The primary outcomes were change in intraocular pressure and change in anterior chamber angle width after phacoemulsification. Secondary outcomes were postoperative visual acuity improvement and reduction in antiglaucoma medication use. Failure was defined as an intraocular pressure greater than 21 mmHg requiring another intervention, including trabeculectomy, and/or an increase in the number of required antiglaucoma medications by more than one.

Statistical Analysis: Continuous variables were expressed as mean ± standard deviation and categorical variables as frequency and percentage. Serial postoperative changes in intraocular pressure and anterior chamber angle width were summarised across follow-up visits. Preoperative and postoperative categorical variables were compared, and $p < 0.05$ was considered statistically significant.

Ethical Considerations: Written informed consent was obtained from all participants. The study was approved by the institutional ethical committee and adhered to the tenets of the Declaration of Helsinki.

Results

Baseline demographic and preoperative characteristics: Forty-eight eyes of 48 patients were analysed. The cohort comprised 18 eyes with PAC and 30 eyes with PACG. There were 20 male patients (41.67%) and 28 female patients (58.33%). The mean age was 64.5 ± 8.3 years. Hypertension was present in 24 patients (50.0%), diabetes mellitus in 16 (33.33%), and other comorbidities in 12 (25.0%). Mean lens thickness was 4.72 ± 0.45 mm.

Table 1: Baseline demographic and clinical characteristics of the study cohort

Characteristic	Value
Total patients, n	48
Diagnostic category, n	PAC: 18, PACG: 30
Male, n (%)	20 (41.67%)
Female, n (%)	28 (58.33%)
Age, mean ± SD (years)	64.5 ± 8.3
Hypertension, n (%)	24 (50.0%)
Diabetes mellitus, n (%)	16 (33.33%)
Other comorbidities, n (%)	12 (25.0%)
Lens thickness, mean ± SD (mm)	4.72 ± 0.45

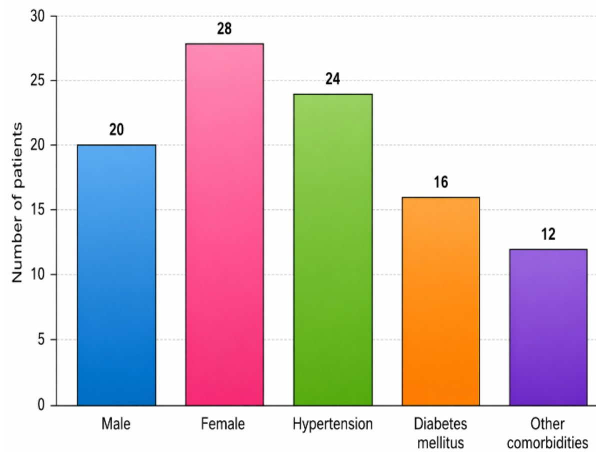

Figure 1: Demographic and comorbidity profile of the study cohort.

Preoperative intraocular pressure profile: All study eyes had preoperative intraocular pressure above 21 mmHg. Twelve eyes (25.0%) had an intraocular pressure of 22-30 mmHg, 20 eyes (41.67%) had 31-40 mmHg, and 16 eyes (33.33%) had values greater than 40 mmHg.

Table 2: Distribution of preoperative intraocular pressure in the study cohort

Preoperative IOP range (mmHg)	Number of eyes	Percentage
≤21	0	0%
22-30	12	25.0%
31-40	20	41.67%
>40	16	33.33%

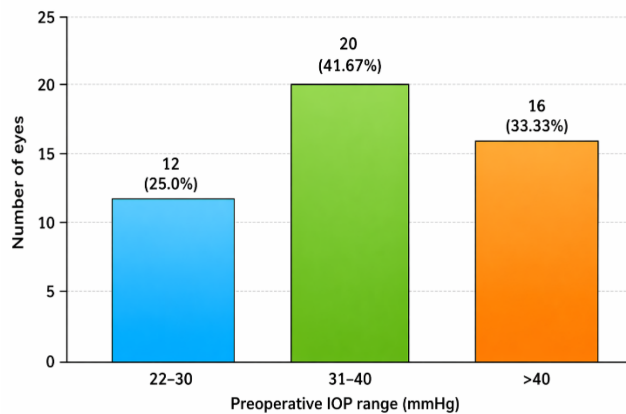

Figure 2: Distribution of preoperative intraocular pressure by range.

Primary outcome: change in intraocular pressure: Mean preoperative intraocular pressure was 35.5 ± 4.8 mmHg. It declined to 23.9 ± 3.5 mmHg at 2 weeks, 19.1 ± 3.0 mmHg at 4 weeks, 17.3 ± 3.0 mmHg at 3 months, and 14.6 ± 3.5 mmHg at both 6 and 12 months. The mean intraocular pressure reduction was 11.6 ± 3.0 mmHg at 2 weeks, 16.4 ± 2.7 mmHg at 4 weeks, 18.2 ± 3.3 mmHg at 3 months, and 20.9 ± 4.1 mmHg at 6 and 12 months.

The corresponding percentage reduction reached 32.7%, 46.2%, 51.3%, and 58.9%, respectively.

Table 3: Serial postoperative changes in intraocular pressure after phacoemulsification

Time point	Mean IOP ± SD (mmHg)	IOP reduction ± SD (mmHg)	Percentage reduction
Preoperative	35.5 ± 4.8	–	–
2 weeks	23.9 ± 3.5	11.6 ± 3.0	32.7%
4 weeks	19.1 ± 3.0	16.4 ± 2.7	46.2%
3 months	17.3 ± 3.0	18.2 ± 3.3	51.3%
6 months	14.6 ± 3.5	20.9 ± 4.1	58.9%

12 months	14.6 ± 3.5	20.9 ± 4.1	58.9%

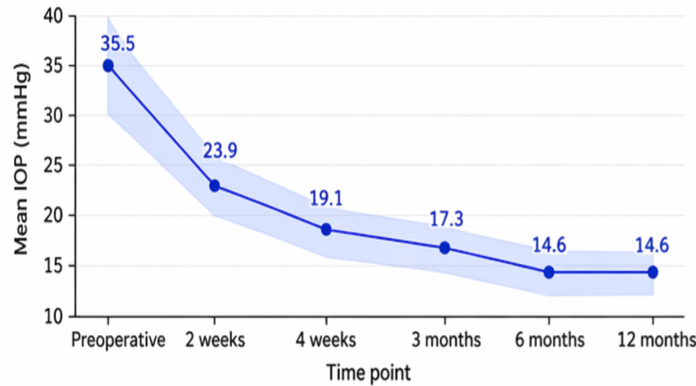

Figure 3: Serial reduction in mean intraocular pressure after phacoemulsification. Shaded area represents ± standard deviation.

Change in anterior chamber angle width: Mean anterior chamber angle width increased from 16.4 ± 3.0° preoperatively to 23.1 ± 2.8° at 1 month, 25.2 ± 3.2° at 3 months, 27.4 ± 3.5° at 6 months, and 29.0 ± 3.9° at 12 months. This represented percentage increases of 40.9%, 53.7%, 67.6%, and 76.2% across the respective follow-up intervals.

Table 4: Serial changes in anterior chamber angle width after phacoemulsification

Time point	Mean ACA width ± SD (degrees)	Percentage change
Preoperative	16.4 ± 3.0	–
1 month	23.1 ± 2.8	+40.9%
3 months	25.2 ± 3.2	+53.7%
6 months	27.4 ± 3.5	+67.6%
12 months	29.0 ± 3.9	+76.2%

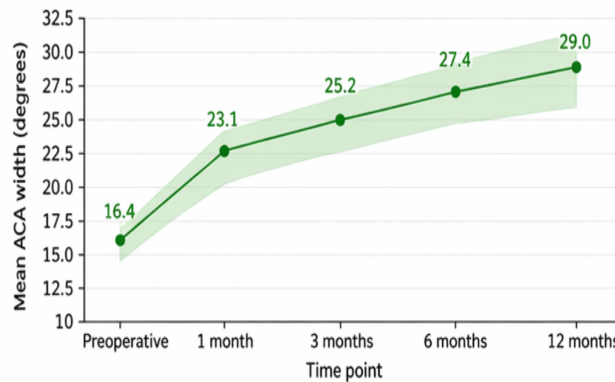

Figure 4: Progressive widening of mean anterior chamber angle width after phacoemulsification. Shaded area represents ± standard deviation.

Visual acuity and antiglaucoma medication requirement: The proportion classified under improved visual acuity increased from 4 eyes (8.33%) preoperatively to 42 eyes (87.5%) postoperatively ($p < 0.001$). Antiglaucoma medication use decreased from 47 eyes (97.92%) preoperatively to 2 eyes (4.17%) postoperatively ($p < 0.001$).

Table 5: Visual acuity status and antiglaucoma medication use before surgery and after phacoemulsification

Parameter	Preoperative	Postoperative	p value
Improved visual acuity, n (%)	4 (8.33%)	42 (87.5%)	<0.001
AGM use, n (%)	47 (97.92%)	2 (4.17%)	<0.001

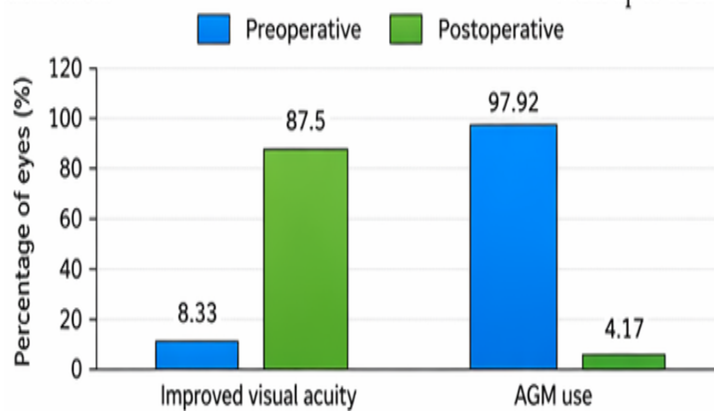

Figure 5: Changes in improved visual acuity and antiglaucoma medication use before and after phacoemulsification.

Discussion

Phacoemulsification in eyes with PAC or PACG, patent peripheral iridotomy, visually significant cataract, and raised intraocular pressure was associated with sustained intraocular pressure reduction over 12 months. The procedure was also accompanied by progressive widening of the anterior chamber angle, substantial reduction in antiglaucoma medication requirement, and improvement in visual acuity.

The observed improvement in intraocular pressure after lens extraction is consistent with the lens-based pathophysiological model of angle closure described by Nongpiur et al. [3] By removing the crystalline lens from an anatomically crowded anterior segment, phacoemulsification can relieve pupillary block and reduce angle crowding.

These findings are also aligned with the therapeutic rationale supported by the EAGLE trial, in which early lens extraction showed benefit over standard care in angle-closure disease. [4] The persistence of disease progression after peripheral iridotomy reported in earlier studies further supports the need for additional interventions in selected eyes with residual risk after iridotomy. [2] Primary angle-closure glaucoma has been associated with progressive visual field loss in prior reports, underscoring the importance of interventions that achieve stable intraocular pressure control. [5]

The marked widening of the anterior chamber angle from 16.4° to 29.0° over 12 months provides an anatomical explanation for the corresponding reduction in intraocular pressure and medication dependence. In eyes with coexisting visually significant cataract, phacoemulsification addresses both the lens component of angle crowding and the optical effect of lenticular opacity.

The improvement in visual acuity together with the marked fall in medication use suggests that phacoemulsification may offer simultaneous structural, functional, and treatment-burden benefits in appropriately selected patients with primary angle-closure disease after a patent iridotomy.

Strengths and Limitations: The strengths of this study include its prospective design, predefined postoperative follow-up, and concurrent assessment of anatomical and clinical outcomes, including intraocular pressure, anterior chamber angle width, visual acuity, and medication requirement.

The study is limited as it is a single-centre design, modest sample size, and the absence of a comparison group. Subgroup-specific outcomes for PAC and PACG were not analysed separately.

Conclusion

Phacoemulsification was associated with significant and sustained intraocular pressure reduction, progressive widening of the anterior chamber angle, improvement in visual acuity, and marked reduction in antiglaucoma medication use over 12 months in eyes with primary angle-closure disease after a patent peripheral iridotomy.

These findings support the role of lens extraction as an effective management strategy in selected eyes with coexisting visually significant cataract and uncontrolled intraocular pressure.

Declarations

Acknowledgments: The authors acknowledge the patients who participated in the study and the support provided by the Department of Ophthalmology, Krishna Mohan Medical College & Hospital, Mathura, Uttar Pradesh, India.

Author contributions

- Paridhi Gupta contributed to study conduct, data acquisition, and manuscript drafting.
- Ravi Soni contributed to data collation, manuscript revision, and correspondence.
- Meemansha Maheshwari contributed to supervision and critical review of the manuscript.

- M.K. Taneja contributed to study oversight, manuscript review, and final approval of the submitted version.

Ethics approval and consent to participate: Written informed consent was obtained from all participants. The study was approved by the institutional ethical committee and adhered to the tenets of the Declaration of Helsinki.

Availability of data and materials: The data supporting the findings of this study are available from the corresponding author on reasonable request.

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