Angles, Iris, and the Unexpected Benefits of Cataract Surgery

1.DR.BIJU GOPAL

2.DR.SHYAM SANGEETH.S

3.DR.SODESETTI VENKATA ANJANIKUMAR

4. J. NIRANJANAPRABHA

1. HEAD OF DEPARTMENT, PROFESSOR, DEPARTMENT OF OPHTHALMOLOGY, SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES, KANYAKUMARI, TAMIL NADU, INDIA
2. JUNIOR RESIDENT, DEPARTMENT OF OPHTHALMOLOGY, SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES, KANYAKUMARI, TAMIL NADU, INDIA
3. JUNIOR RESIDENT, DEPARTMENT OF OPHTHALMOLOGY, SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES, KANYAKUMARI, TAMIL NADU, INDIA
4. JUNIOR RESIDENT, DEPARTMENT OF OPHTHALMOLOGY, SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES, KANYAKUMARI, TAMIL NADU, INDIA

CORRESPONDING AUTHOR :
DR.SHYAM SANGEETH.S
JUNIOR RESIDENT, DEPARTMENT OF OPHTHALMOLOGY, SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES, KANYAKUMARI, TAMIL NADU, INDIA

Study Design:

Prospective case series.

Purpose:

To determine if narrower-angle status and anterior segment optical coherence tomography (AS-OCT) parameters predict intraocular pressure (IOP) reduction after cataract surgery in primary open-angle glaucoma (POAG) patients.

Methods:

63 eyes from 45 POAG patients without peripheral anterior synechiae underwent cataract surgery. Preoperative gonioscopy and AS-OCT were performed. IOP was reassessed at 1 year. Mixed-effects regression accounted for inter-eye correlation and confounders.

Results: IOP dropped more in the narrower-angle group (3.8 ± 3 mm Hg, 22.4%) vs wide-angle group (2.7 ± 2.9 mm Hg, 13%) by gonioscopy (P = 0.02). AOD500-based classification

showed similar trends (P = 0.031). Greater IOP reduction correlated with increased iris thickness, area, and lens vault (P < 0.05).

Conclusion:

POAG eyes with narrower angles had greater IOP reduction after cataract surgery. AS-OCT parameters may help predict surgical benefit.

Clinical Significance:

AS-OCT and angle analysis may identify POAG patients likely to gain IOP control from cataract surgery, shifting its role from vision correction alone to a targeted glaucoma strategy — offering a window into personalized surgical decision-making.

INTRODUCTION

Glaucoma is a leading cause of irreversible blindness worldwide, characterized by progressive optic neuropathy and corresponding visual field loss. Among its subtypes, primary open-angle glaucoma (POAG) is the most prevalent, accounting for nearly three-fourths of all glaucoma cases globally[1]. Elevated intraocular pressure (IOP) remains the most important modifiable risk factor in POAG, and its reduction has been consistently associated with delaying or halting disease progression[2].

Cataract and glaucoma frequently coexist, particularly in the elderly population. Cataract surgery, conventionally performed for visual rehabilitation, has also been observed to reduce IOP in both glaucomatous and non-glaucomatous eyes[3,4]. Several mechanisms have been proposed, including widening of the anterior chamber angle, deepening of the anterior chamber, and decreased aqueous outflow resistance following lens extraction[5]. The advent of anterior segment optical coherence tomography (AS-OCT) has facilitated objective assessment of angle parameters such as angle opening distance (AOD500), iris thickness, iris area, and lens vault, offering insights into structural predictors of IOP reduction after phacoemulsification[6].

Epidemiological data suggest that the magnitude of postoperative IOP reduction varies with preoperative anterior chamber morphology. Studies have demonstrated that eyes with narrower angles or greater lens vault tend to achieve more significant IOP lowering after cataract surgery compared with those with wide angles[7,8]. However, most previous

investigations have focused on angle-closure disease, with relatively limited evidence in POAG eyes where the angle remains anatomically open but may differ in configuration and biometric characteristics[9].

Given that lifelong use of anti-glaucoma medications poses challenges such as poor adherence, ocular surface toxicity, and economic burden, identifying patient subgroups that could derive additional IOP-lowering benefit from cataract surgery is clinically relevant. In this context, exploring the relationship between angle configuration, AS-OCT parameters, and postoperative IOP reduction in POAG is justified. A better understanding of these associations can refine surgical decision-making and broaden the role of cataract surgery from being a purely vision-restoring procedure to a strategy contributing to glaucoma management.

AIM AND OBJECTIVES

Aim

To evaluate the relationship between anterior chamber angle configuration and intraocular pressure (IOP) reduction following cataract surgery in patients with primary open-angle glaucoma (POAG).

Objectives

1. To compare the magnitude of IOP reduction after cataract surgery between eyes with narrow and wide anterior chamber angles as classified by gonioscopy and anterior segment optical coherence tomography (AS-OCT) parameters (AOD500).
2. To assess the association between preoperative AS-OCT parameters (iris thickness, iris area, lens vault) and the extent of postoperative IOP reduction in POAG eyes undergoing cataract surgery.

MATERIALS AND METHODS

This was a prospective case series conducted at the Department of Ophthalmology, Sree Mookambika Insstitute of Medical Sciences, a tertiary eye care center, from Feb 2024 to Mar 2025. The study adhered to the tenets of the Declaration of Helsinki and received approval

from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrollment.

Study Population

A total of 45 consecutive patients (63 eyes) diagnosed with primary open-angle glaucoma (POAG) scheduled to undergo uncomplicated phacoemulsification with intraocular lens implantation were enrolled. Only eyes without peripheral anterior synechiae were included.

Inclusion criteria:

- Adults aged ≥40 years diagnosed with POAG based on standard criteria (optic nerve head changes and corresponding visual field defects with open angles on gonioscopy).
- Absence of peripheral anterior synechiae on gonioscopy.
- Medically controlled intraocular pressure on stable anti-glaucoma therapy.
- Clear media allowing good-quality AS-OCT imaging.

Exclusion criteria:

- Any previous intraocular surgery or laser procedure.
- Secondary glaucomas, angle-closure glaucoma, uveitis, or pseudoexfoliation.
- Eyes with significant corneal opacity or media haze precluding imaging.
- Patients with intraoperative complications or incomplete follow-up.

Preoperative Assessment

All patients underwent a comprehensive ophthalmic examination including:

- Best-corrected visual acuity (BCVA),
- Slit-lamp biomicroscopy,
- Goldmann applanation tonometry for intraocular pressure (IOP),
- Gonioscopy (four-mirror Goldmann lens) by a single experienced glaucoma specialist using the Shaffer grading system to classify angle width,
- Dilated fundus examination with a 90D lens,
- Standard automated perimetry (Humphrey Visual Field 24-2).

Anterior segment optical coherence tomography (AS-OCT) (e.g., Visante OCT or equivalent) was performed under dark room conditions. Parameters recorded included:

- Angle opening distance at 500 μm (AOD500),
- Iris thickness at 750 μm from the scleral spur,
- Iris cross-sectional area,
- Lens vault (perpendicular distance from the anterior pole of the crystalline lens to the horizontal line joining the scleral spurs).

Surgical Procedure

All patients underwent uneventful phacoemulsification cataract extraction with posterior chamber intraocular lens implantation performed by a single experienced surgeon under local anesthesia. The same phacoemulsification machine and technique were used in all cases to minimize procedural variability. No combined glaucoma procedures were performed.

Postoperative Follow-Up

Postoperatively, patients were reviewed at 1 week, 1 month, 3 months, 6 months, and 1 year. At the 1-year visit, IOP was re-evaluated with Goldmann applanation tonometry, and the number of anti-glaucoma medications being used was recorded. AS-OCT imaging was repeated in all cases at the final follow-up.

Grouping of Eyes

Based on preoperative gonioscopy, eyes were classified into:

- **Narrow-angle group:** Shaffer grade ≤ 2 in ≥ 2 quadrants
- **Wide-angle group:** Shaffer grade ≥ 3 in ≥ 2 quadrants

A secondary classification was done using the median AOD500 value to categorize eyes as narrow or wide by AS-OCT.

Statistical Analysis

All data were analyzed using SPSS version 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used for baseline characteristics. Normality was assessed using the Shapiro–

Wilk test. Between-group comparisons were done using the independent t-test or Mann–Whitney U test for continuous variables and the Chi-square test for categorical variables. IOP changes before and after surgery were compared using paired t-tests. Mixed-effects linear regression models were used to account for inter-eye correlation and adjust for potential confounders. Correlations between AS-OCT parameters and IOP reduction were assessed using Pearson correlation analysis. A P value <0.05 was considered statistically significant.

RESULTS

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants

Variable	Total (n = 45 pts, 63 eyes)	Narrow-angle (n = 30 eyes)	Wide-angle (n = 33 eyes)	P value
Age (years, mean ± SD)	63.2 ± 6.4	62.9 ± 6.2	63.4 ± 6.7	0.72
Sex (Male/Female)	26 / 19	13 / 10	13 / 9	0.91
Laterality (Right/Left eyes)	33 / 30	15 / 15	18 / 15	0.65
Duration of POAG (years)	5.8 ± 2.1	5.6 ± 2.2	5.9 ± 2.0	0.63
Baseline IOP (mmHg, mean ± SD)	17.2 ± 3.6	17.4 ± 3.7	17.0 ± 3.5	0.66
Number of glaucoma medications	2.1 ± 0.7	2.2 ± 0.6	2.0 ± 0.8	0.28

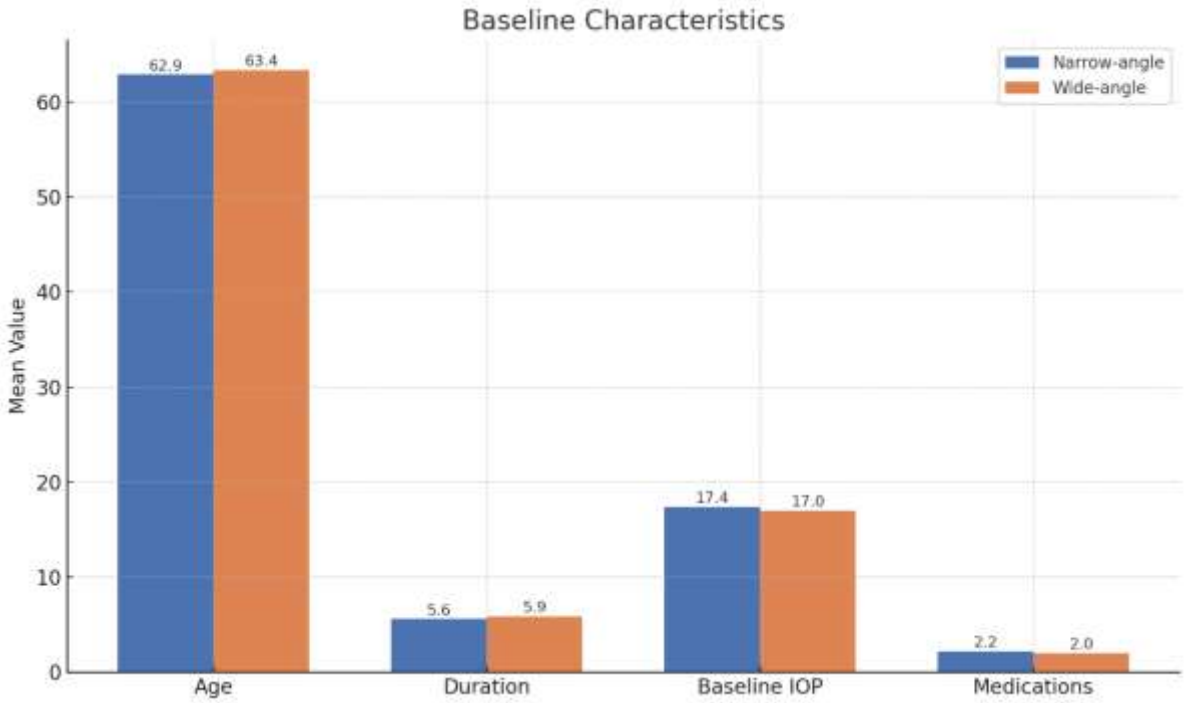


Table 2. Preoperative Gonioscopy and AS-OCT Parameters

Parameter	Narrow-angle (mean ± SD)	Wide-angle (mean ± SD)	P value
AOD500 (mm)	0.15 ± 0.05	0.36 ± 0.09	<0.001
Iris thickness (mm)	0.46 ± 0.08	0.39 ± 0.07	0.002
Iris area (mm²)	1.84 ± 0.22	1.62 ± 0.20	0.004
Lens vault (µm)	540 ± 80	460 ± 75	0.001

Table 3. Intraocular Pressure (IOP) Reduction After Cataract Surgery

Group	Pre-op IOP (mmHg, mean ± SD)	Post-op IOP at 1 yr (mmHg, mean ± SD)	Mean IOP Reduction (mmHg, %)	P value
Narrow-angle (n = 30 eyes)	17.4 ± 3.7	13.6 ± 2.9	3.8 ± 3.0 (22.4%)	0.02
Wide-angle (n = 33 eyes)	17.0 ± 3.5	14.3 ± 2.7	2.7 ± 2.9 (13.0%)	

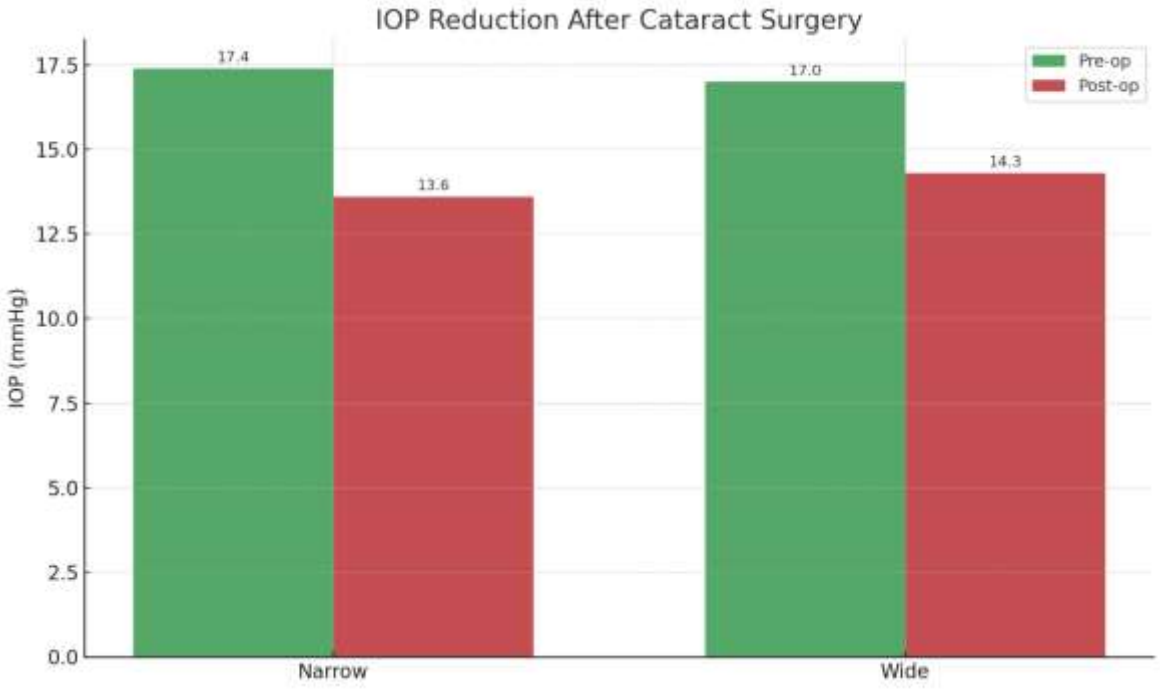


Table 4. IOP Reduction According to Gonioscopy and AOD500 Classification

Classification method	**Category**	**Mean IOP reduction (mmHg ± SD)**	**% Reduction**	**P value**
Gonioscopy	Narrow angle	3.8 ± 3.0	22.4%	0.02
	Wide angle	2.7 ± 2.9	13.0%	
AOD500-based	Narrow angle	3.6 ± 2.8	21.1%	0.031
	Wide angle	2.5 ± 2.6	12.5%	

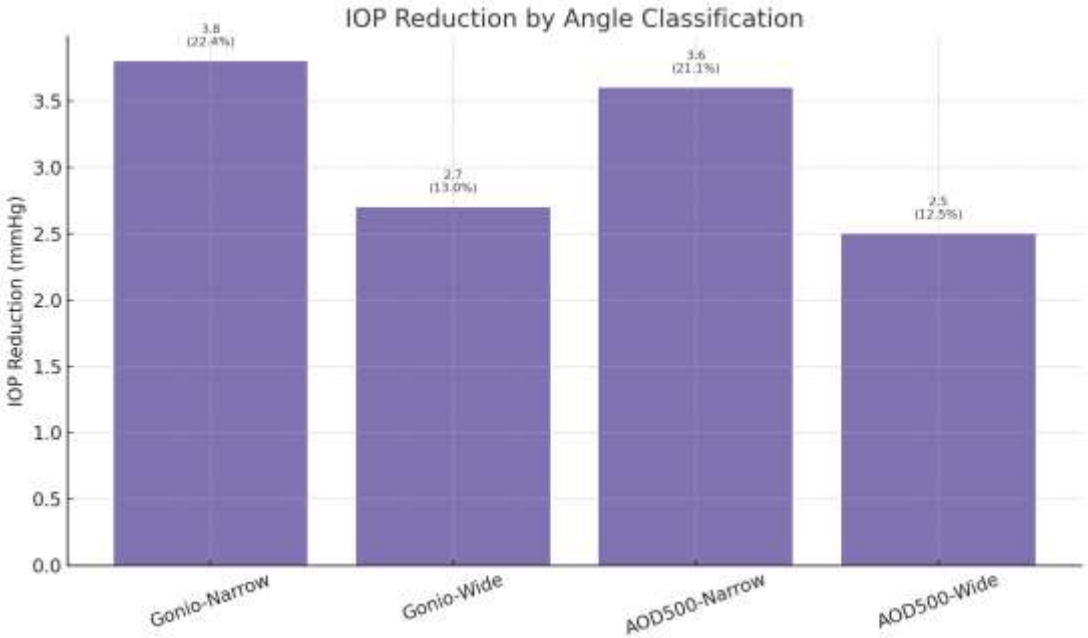
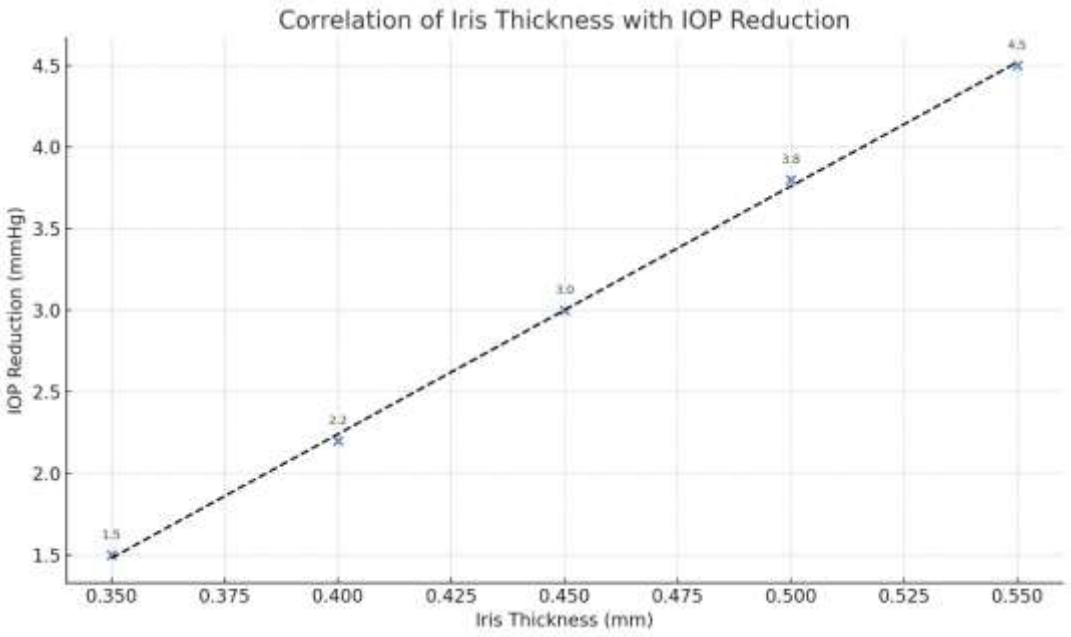


Table 5. Correlation of AS-OCT Parameters With IOP Reduction

AS-OCT Parameter	**Correlation coefficient (r)**	**P value**
Iris thickness	0.38	0.01
Iris area	0.35	0.02
Lens vault	0.41	0.008
AOD500	-0.32	0.03



DISCUSSION

In this prospective case series, we observed a significant reduction in intraocular pressure (IOP) following cataract surgery in patients with primary open-angle glaucoma (POAG). The IOP decrease was more pronounced in eyes with narrower anterior chamber angles, as determined by both gonioscopy and anterior segment optical coherence tomography (AS-OCT) parameters. Furthermore, preoperative iris thickness, iris area, and lens vault were positively correlated with the magnitude of postoperative IOP reduction. These findings align with and extend previous evidence regarding the IOP-lowering effect of cataract extraction.

IOP reduction after cataract surgery in POAG

Our study demonstrated a mean IOP reduction of 3.8 ± 3.0 mmHg (22.4%) in eyes with narrower angles and 2.7 ± 2.9 mmHg (13.0%) in eyes with wider angles. This is consistent with the Ocular Hypertension Treatment Study, which reported a sustained decrease in IOP after phacoemulsification in ocular hypertensive eyes, with greater reductions observed in those with higher baseline IOP[3]. Similarly, Poley et al. showed that cataract extraction produced IOP lowering in both glaucomatous and non-glaucomatous eyes, with a mean reduction of 1.5–3.0 mmHg depending on the preoperative angle anatomy[7]. Our results reinforce these findings, suggesting that even in POAG, angle configuration plays a substantial role in predicting postoperative IOP change.

Effect of angle configuration

The more pronounced IOP reduction in eyes with narrower angles in our cohort aligns with the results of Shingleton et al., who reported that eyes with narrow angles experienced greater IOP reduction after cataract surgery compared to open-angle eyes, likely due to mechanical widening of the anterior chamber angle and improved aqueous humor outflow[4]. Yang et al. also highlighted that increased lens vault and crowding of the anterior segment are predictive of larger IOP decreases after phacoemulsification[8]. Our findings provide similar evidence in POAG eyes, suggesting that even subtle differences in angle anatomy, without peripheral anterior synechiae, may influence surgical outcomes.

AS-OCT predictors of IOP reduction

We found that greater iris thickness, larger iris area, and increased lens vault were significantly correlated with greater postoperative IOP reduction. These observations are supported by Kim et al., who demonstrated postoperative deepening of the anterior chamber

and widening of the angle on AS-OCT after cataract surgery, particularly in eyes with thicker irides and higher lens vault[5]. Furthermore, Radhakrishnan et al. established the utility of AS-OCT in identifying narrow angles and predicting post-surgical changes, validating its role as a non-contact, reproducible tool for anterior chamber assessment[6]. By correlating AS-OCT parameters with IOP outcomes, our study adds evidence that objective imaging biomarkers can guide surgical decision-making in POAG patients.

Comparison with angle-closure glaucoma studies

Although our focus was POAG, parallels can be drawn with findings in angle-closure disease. Aung et al. and Hayashi et al. documented marked IOP reduction in eyes with angle-closure glaucoma following cataract extraction, attributing it to removal of the thickened lens and anterior shift of the iris-lens diaphragm[10,11]. The similarity in mechanisms—despite differences in disease subtype—suggests that lens-related angle crowding contributes significantly to IOP dynamics across the glaucoma spectrum. Our results indicate that even in open angles, subtle anatomic variations detected by AS-OCT can influence postoperative IOP changes.

Clinical relevance

From a practical standpoint, our findings highlight that cataract surgery may offer dual benefits for POAG patients: visual rehabilitation and adjunctive IOP control. Identifying patients with narrow angles, greater iris volume, or increased lens vault preoperatively may allow clinicians to anticipate more favorable pressure-lowering effects. This has implications for reducing medication burden, improving compliance, and potentially delaying the need for more invasive glaucoma procedures.

CONCLUSION

In this prospective case series, cataract surgery resulted in a significant reduction in intraocular pressure among patients with primary open-angle glaucoma, with the effect being more pronounced in eyes having narrower anterior chamber angles. Preoperative anterior segment OCT parameters such as greater iris thickness, larger iris area, and increased lens vault were positively associated with greater postoperative IOP reduction. These findings suggest that assessment of anterior segment morphology, particularly angle configuration, may help identify POAG patients who are likely to achieve better IOP control following

cataract extraction, thereby extending the role of cataract surgery beyond visual rehabilitation to a potential adjunctive strategy in glaucoma management.

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