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A prospective observational study of visual outcome and intraocular pressure control after cataract surgery in lens-induced glaucoma.

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Abstract

Background:

Lens-induced glaucoma (LIG) remains an important cause of avoidable visual morbidity in developing regions, particularly where delayed cataract extraction is common. Elevated intraocular pressure (IOP), uveal inflammation, and optic nerve compromise contribute significantly to poor outcomes.

Objectives:

To evaluate the clinical profile, etiological patterns, preoperative IOP characteristics, intraoperative events, and postoperative visual outcomes in patients with LIG undergoing cataract surgery.

Methods:

This prospective observational study included 50 consecutive patients diagnosed with LIG at a tertiary eye hospital. Detailed clinical examination, IOP measurement, etiological classification, and B-scan evaluation were performed. All patients underwent small-incision cataract surgery with IOL implantation, followed by standardized postoperative care. Visual acuity and IOP were recorded up to six weeks. Statistical analysis was conducted using Chi-square tests, with $p < 0.05$ considered significant.

Results:

The mean age of participants was 59.6 ± 7.9 years, with female predominance (58%). Phacomorphic glaucoma was the most common etiological subtype (68%), followed by phacolytic glaucoma (24%). A majority of patients (54%) presented with markedly elevated preoperative intraocular pressure (>40 mmHg), and 58% reported symptom duration of less than one week. Posterior capsular rent with vitreous loss occurred in 12% of surgeries. Early postoperative anterior chamber inflammation was observed in 22% of cases, predominantly among phacolytic glaucoma. At six-week follow-up, 44% achieved good visual acuity (6/6–6/12), while 22% had poor visual outcomes (>6/60). Early presentation and lower preoperative intraocular pressure were significantly associated with favorable visual recovery ($p = 0.001$ and $p = 0.04$, respectively).

Conclusion:

Timely diagnosis and early cataract extraction significantly improve visual recovery and IOP stabilization in LIG. Elevated preoperative IOP, delayed presentation, and intraoperative complications remain major determinants of poor outcomes.

Recommendations:

Greater emphasis on community-based cataract screening, patient education on early symptom recognition, and prompt referral pathways are essential.

Keywords: Lens-induced glaucoma; Phacomorphic; Phacolytic; Cataract surgery; Intraocular pressure; Visual outcome; Small Incision Cataract Surgery; Vitreous loss; Optic nerve protection
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Introduction

Lens-induced glaucoma (LIG) remains an important cause of preventable visual impairment, particularly in regions where cataract surgery is often delayed due to socioeconomic and accessibility barriers. Studies from South Asia have consistently documented poor outcomes when hypermature cataracts progress to secondary glaucomatous damage, emphasizing the magnitude of this problem in developing countries [1,3]. India's substantial cataract backlog further contributes to the frequency of LIG, with hypermature lenses capable of causing abrupt intraocular pressure (IOP) elevation through protein leakage, pupillary block, or inflammatory trabecular obstruction [1,4].

Among the different clinical forms of LIG phacomorphic, phacolytic, lens-particle, and glaucoma secondary to subluxation phacomorphic and phacolytic glaucomas remain the most frequently encountered in tertiary care settings [3,4]. These entities typically arise in elderly individuals who postpone surgery because of limited awareness, restricted healthcare access, or reliance on better vision in the fellow eye. Such delays allow cataracts to advance to a stage where acute pain, redness, corneal edema, and markedly elevated IOP become the initial presenting features [3].

Prompt cataract extraction is fundamental to restoring aqueous outflow and preventing irreversible optic nerve injury. Evidence shows that early surgical intervention not only improves visual prognosis but also contributes to long-term IOP stabilization in eyes with secondary glaucoma [1,2,5]. Even in primary angle-closure disease, lens removal significantly alters anterior chamber configuration and reduces IOP, supporting its therapeutic role in pressure control [6].

Despite advances in cataract surgery, lens-induced glaucoma continues to present with higher rates of intraoperative difficulty, postoperative inflammation, and variable visual prognosis compared with routine cataract extraction [3,4]. The severity of optic nerve compromise is often influenced by symptom duration, magnitude of intraocular pressure elevation, and the specific pathophysiological mechanism of lens-induced obstruction. A comprehensive understanding of these clinical determinants is essential for improving surgical planning, perioperative management, and patient counselling in resource-limited settings. The study evaluated the clinical characteristics of lens-induced glaucoma, assessed visual and intraocular pressure outcomes following small-incision cataract surgery, and identified predictors influencing postoperative recovery.

Methodology

Study Design

This study was conducted as a hospital-based prospective cohort study. Patients diagnosed with lens-induced glaucoma were followed from presentation through surgical intervention and up to six weeks postoperatively to assess intraocular pressure control and visual outcomes.

Study Setting

The study was carried out at the Regional Eye Hospital, Warangal, Telangana, India, a tertiary referral ophthalmic center serving urban and rural populations of Warangal district and adjoining regions. The hospital provides comprehensive ophthalmic services including cataract surgery, glaucoma management, corneal services, medical retina, pediatric ophthalmology, and community outreach screening programs. It functions as a high-volume cataract surgery center and a teaching institution for postgraduate ophthalmology trainees. A considerable proportion of patients belong to socioeconomically disadvantaged communities, contributing to delayed cataract presentation and advanced secondary glaucomatous complications.

Study Duration

The study was conducted over a defined study period during which all eligible patients presenting with lens-induced glaucoma were prospectively enrolled and followed for six weeks after surgery.

Study Population and Sampling

The study population consisted of patients clinically diagnosed with lens-induced glaucoma presenting during the study period. A consecutive sampling technique was used. All eligible patients fulfilling inclusion criteria were enrolled sequentially until the required sample size was achieved. No

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randomization was performed, as the study was observational in nature.

Sample Size Calculation

Sample size was estimated using the single population proportion formula:
$n = Z^2 \times p \times q / d^2$
Where Z = 1.96 at 95% confidence level, p = 0.5 (assumed proportion of favorable visual outcome based on previous regional studies to maximize sample size), q = 1 − p, and d = 0.14 (absolute precision).
Substituting the values:
$n = (1.96)^2 \times 0.5 \times 0.5 / (0.14)^2$
$n \approx 49$
The minimum required sample size was 49 patients. Considering feasibility and complete enrollment during the study period, the final sample size was rounded to 50 patients.

Inclusion Criteria

Patients clinically diagnosed with phacomorphic glaucoma (shallow anterior chamber, intumescent cataract, raised intraocular pressure), phacolytic glaucoma (hypermature cataract, deep anterior chamber, elevated intraocular pressure with inflammatory cells and flare), lens-particle glaucoma (capsular rupture with dispersed cortical material), or glaucoma secondary to lens subluxation or dislocation were included.

Exclusion Criteria

Patients with primary glaucomas associated with cataract, pseudoexfoliative glaucoma, significant anterior or posterior segment pathology affecting visual prognosis, and aphakic or pseudophakic glaucoma were excluded.

Variables

Primary outcome variables were postoperative best-corrected visual acuity at six weeks and postoperative intraocular pressure control. Secondary variables included age, sex, duration of symptoms, etiological subtype of lens-induced glaucoma, preoperative intraocular pressure levels, intraoperative complications such as posterior capsular rent with vitreous loss, and postoperative anterior chamber inflammation.

Data Collection and Measurements

Data were collected prospectively using a structured and standardized proforma. A detailed ocular history was recorded including symptom duration, pain, redness, vision loss, trauma, or prior surgery. Best-corrected visual acuity was assessed using a Snellen chart. Slit-lamp biomicroscopy was performed for anterior segment evaluation and anterior chamber depth assessment. Intraocular pressure was measured using a Schiotz tonometer and reassessed after intravenous mannitol administration in cases of corneal edema. Fundus examination was performed when media clarity permitted, and B-scan ultrasonography was used when visualization was not possible. The fellow eye was also examined thoroughly.

Preoperative Management

Patients received medical therapy to reduce intraocular pressure and control inflammation, including intravenous mannitol, oral acetazolamide, topical beta-blockers, corticosteroids, mydriatics, and analgesics. Pupillary dilation was achieved using tropicamide (0.8%) combined with phenylephrine (5%).

Surgical Procedure

After achieving adequate intraocular pressure control, all patients underwent manual small-incision cataract surgery with posterior chamber intraocular lens implantation under peribulbar anesthesia. A sclerocorneal tunnel incision was constructed. Capsulotomy was performed using continuous curvilinear capsulorhexis or can-opener technique depending on intraoperative findings. The nucleus was delivered by viscoexpression, followed by cortical cleanup and intraocular lens placement in the capsular bag or sulcus. Intraoperative complications, including posterior capsular rent and vitreous loss, were documented.

Postoperative Care and Follow-up

Topical antibiotic–steroid combination drops were prescribed in tapering doses over six weeks. Patients were evaluated on postoperative day 1, week 2, week 4, and week 6. At each visit, slit-lamp examination, intraocular pressure measurement, and best-corrected visual acuity testing were performed.

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Bias Control

Selection bias was minimized through consecutive enrollment of eligible patients. Measurement bias was reduced by using standardized examination protocols and uniform intraocular pressure assessment techniques. Surgical technique was standardized to reduce performance variability. Predefined outcome criteria were used to limit observer bias. Although referral bias inherent to tertiary care settings cannot be completely excluded, consistent inclusion criteria were applied throughout the study.

Statistical Analysis

Data were compiled and analyzed using Chi-square tests to assess associations between clinical predictors and visual outcomes. A p-value less than 0.05 was considered statistically significant.

Ethical Considerations

Institutional Ethics Committee approval was obtained prior to commencement of the study. Written informed consent was secured from all participants. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

Results

Participants

During the study period, 58 patients with suspected lens-induced glaucoma were screened for eligibility. Of these, 54 patients fulfilled the clinical diagnostic criteria. Four patients were excluded (two had primary glaucoma associated with cataract, one had pseudoexfoliative glaucoma, and one had significant posterior segment pathology affecting visual prognosis). A total of 50 eligible patients consented and were enrolled in the study. All 50 patients underwent manual small-incision cataract surgery with posterior chamber intraocular lens implantation. Complete six-week follow-up was achieved in all enrolled participants, and all 50 cases were included in the final analysis.

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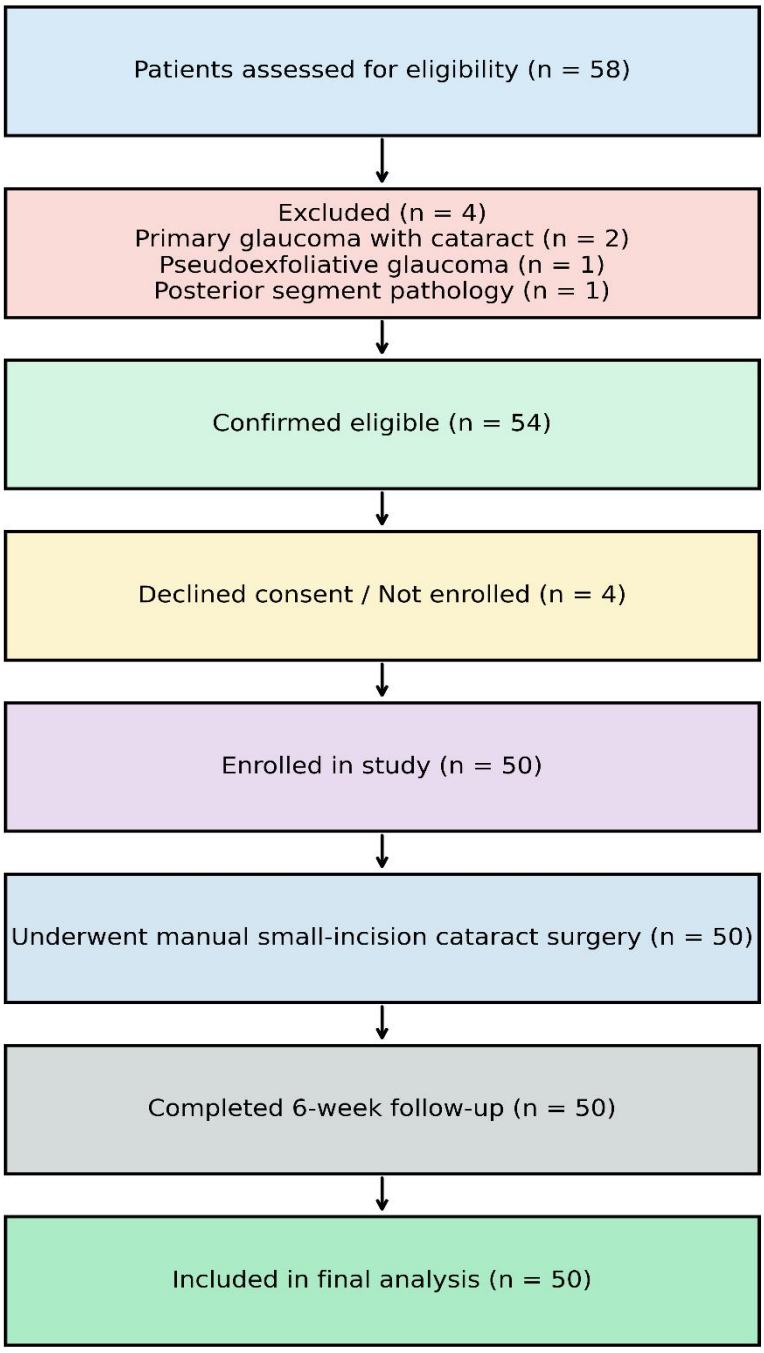

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Figure 1: Participant Flow Diagram

Table 1. Demographic Profile and Symptom Characteristics (n = 50)

Variable	Category	n (%)
Age (years)	45–55	10 (20)
	56–65	16 (32)
	66–75	20 (40)
	>75	4 (8)
Sex	Male	21 (42)
	Female	29 (58)
Laterality	Right eye	19 (38)
	Left eye	31 (62)
Duration of symptoms	<1 week	29 (58)
	1–2 weeks	11 (22)
	>2 weeks	10 (20)

A total of 50 patients with lens-induced glaucoma were included in the analysis. The demographic and symptomatic characteristics are summarized in Table 1. The mean age of the cohort was 59.6 ± 7.9 years, with the highest proportion of patients belonging to the 66–75-year group (40%). Females represented 58% of the study population. All cases were unilateral, and the left eye was more frequently involved (62%). A majority of patients (58%) presented within the first week of symptom onset, whereas 20% reported symptoms for more than two weeks.

Table 2. Etiological Distribution and Fellow-Eye Status

Parameter	Category	n (%)
Etiology of LIG	Phacomorphic	34 (68)
	Phacolytic	12 (24)
	Lens-particle	2 (4)
	Subluxation/dislocation	2 (4)
	Phacoanaphylactic	0
Condition of fellow eye	Normal lens	1 (2)
	Immature/Mature cataract	21 (42)
	Pseudophakia	22 (44)
	Aphakia	6 (12)
Fellow-eye BCVA	6/6–6/12	14 (28)
	6/18–6/60	16 (32)
	>6/60	20 (40)

The etiological distribution of lens-induced glaucoma is presented in Table 2. Phacomorphic glaucoma was the predominant subtype, accounting for 68%, followed by phacolytic glaucoma at 24%. Lens-particle glaucoma and glaucoma secondary to subluxation/dislocation each comprised 4% of cases. In the fellow eye, pseudophakia (44%) and cataract (42%) were the most frequent findings, and 40% of patients had visual acuity worse than 6/60.

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Table 3. Preoperative IOP and Intraoperative/Postoperative Events

Parameter	Category	n (%)
Preoperative IOP (mmHg)	22–30	3 (6)
	30–40	20 (40)
	>40	27 (54)
Intraoperative PCR + Vitreous Loss	Phacomorphic	3 (6)
	Phacolytic	2 (4)
	Lens-particle	1 (2)
	Total	6 (12)
Postoperative AC reaction (Day 1)	Phacomorphic	3 (8.8)
	Phacolytic	6 (50)
	Lens-particle	2 (100)
	Total	11 (22)

Preoperative intraocular pressure (IOP) values and operative findings are detailed in Table 3. More than half of the patients (54%) presented with IOP values exceeding 40 mmHg, while only 6% recorded pressures below 30 mmHg. The highest documented IOP was 78 mmHg. Intraoperatively, posterior capsular rent with vitreous loss (PCR + VL) occurred in 6 patients (12%), with phacomorphic glaucoma contributing the largest proportion of these events. On postoperative day one, 22% exhibited anterior chamber inflammation, which was most common among phacolytic glaucoma cases.

Table 4. Visual Outcomes in Relation to Symptoms and Preoperative IOP

Predictor	Category	Good BCVA (6/6–6/12)	Useful (6/18–6/60)	Poor (>6/60)
Duration of symptoms	<1 week	18	7	4
	1–2 weeks	4	5	2
	>2 weeks	0	5	5
Preoperative IOP (mmHg)	22–30	2	0	1
	30–40	10	6	4
	>40	10	11	6

Final visual outcomes in relation to symptom duration and preoperative IOP are presented in Table 4. Overall, 44% of patients achieved good visual acuity (6/6–6/12) at six weeks, while 22% remained in the poor-vision category (>6/60). Early presentation was strongly associated with better outcomes; among those presenting within one week, 62% attained good vision, compared with none of those presenting after two weeks. A similar trend was observed with IOP: patients with pressures below 40 mmHg demonstrated better visual recovery than those with preoperative IOP >40 mmHg.

The association between duration of symptoms and final best-corrected visual acuity was statistically significant ($\chi^2 = 13.82$, df = 4, $p = 0.001$). Patients presenting within one week demonstrated significantly better visual outcomes compared to those presenting after two weeks.

Similarly, a statistically significant association was observed between preoperative intraocular pressure and final visual outcome ($\chi^2 = 9.76$, df = 4, $p = 0.04$). Patients with intraocular pressure below 40 mmHg achieved superior postoperative vision compared to those with higher pressures.

Discussion

The present prospective cohort study evaluated the clinical profile, intraocular pressure characteristics, surgical outcomes, and predictors of visual recovery

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in patients with lens-induced glaucoma undergoing manual small-incision cataract surgery. The key findings were: (1) phacomorphic glaucoma was the predominant subtype (68%), followed by phacolytic glaucoma (24%); (2) more than half of the patients presented with markedly elevated preoperative intraocular pressure (>40 mmHg); (3) early presentation was significantly associated with favorable postoperative visual outcome ($\chi^2 = 13.82$, $p = 0.001$); (4) lower preoperative intraocular pressure was significantly associated with better visual recovery ($\chi^2 = 9.76$, $p = 0.04$); and (5) 44% of patients achieved good visual acuity at six weeks, while 22% had poor outcomes.

The predominance of phacomorphic glaucoma in this cohort reflects the natural progression of untreated mature cataracts leading to lens intumescence, anterior chamber shallowing, and secondary angle closure. This pattern is consistent with prior studies from similar tertiary care settings,

where phacomorphic glaucoma constituted the majority of lens-induced glaucoma cases [12].

Advanced cataract enlargement mechanically narrows the anterior chamber angle, impairing aqueous outflow and resulting in acute intraocular pressure elevation. The high proportion of phacomorphic cases in this study likely reflects delayed surgical uptake in resource-limited populations.

Phacolytic glaucoma was the second most common subtype, accounting for nearly one-quarter of cases. These finding parallels earlier reports describing hypermature cataracts releasing high-molecular-weight lens proteins into the anterior chamber, thereby obstructing trabecular outflow and inducing inflammatory responses [12]. The higher incidence of postoperative anterior chamber inflammation observed among phacolytic cases in this study further supports the protein-mediated inflammatory mechanism described in previous literature.

A statistically significant association was observed between shorter symptom duration and better postoperative visual outcome ($\chi^2 = 13.82$, $p = 0.001$). Patients presenting within one week were substantially more likely to achieve good visual acuity compared to those presenting after two weeks. This finding is biologically plausible, as sustained intraocular pressure elevation is known to accelerate optic nerve damage and retinal ganglion cell loss. Previous evidence has demonstrated that prolonged pressure elevation contributes to faster visual field deterioration in glaucomatous eyes [10]. Early lens extraction has been shown to stabilize intraocular pressure and potentially limit progressive optic nerve compromise [11]. Therefore, timely surgical intervention appears critical in preserving functional vision in lens-induced glaucoma.

Preoperative intraocular pressure was another significant predictor of outcome. Patients with pressures exceeding 40 mmHg had poorer visual recovery compared with those presenting with lower values ($\chi^2 = 9.76$, $p = 0.04$). Similar observations have been reported in studies evaluating cataract surgery in glaucomatous eyes, where higher baseline intraocular pressure was associated with reduced postoperative improvement and increased risk of structural damage [8,13]. Elevated preoperative pressure likely reflects both severity and duration of trabecular compromise. Moreover, intraoperative pressure fluctuations during cataract extraction may further challenge already compromised optic nerves, as highlighted in prior investigations [7]. These findings emphasize the importance of adequate preoperative intraocular pressure reduction and meticulous intraoperative management.

The incidence of posterior capsular rent with vitreous loss in this study was 12%, which is within the range reported in complex cataract surgeries involving lens-induced glaucoma [12]. Eyes with phacomorphic and phacolytic mechanisms frequently exhibit shallow anterior chambers, corneal edema, capsular fragility, and zonular instability. These anatomical and inflammatory alterations increase surgical complexity and predispose to intraoperative complications. Postoperative inflammation was also more frequent in phacolytic cases, likely due to persistent inflammatory mediator activity from lens protein leakage.

Despite the severity of presentation, 44% of patients achieved good visual acuity at six weeks, indicating that manual small-incision cataract surgery remains an effective intervention even in advanced cases. However, the persistence of poor visual outcomes in 22% of patients underscores the irreversible structural damage that may occur with delayed treatment. Prior studies have demonstrated that

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Original Article

cataract extraction in glaucomatous eyes can improve intraocular pressure control and potentially slow disease progression when performed early [9,10,11]. The lower proportion of favorable outcomes in this cohort compared to routine cataract surgery likely reflects advanced optic nerve compromise at presentation.

Collectively, these findings reinforce that delayed cataract intervention remains the principal modifiable risk factor in lens-induced glaucoma. Early symptom recognition, prompt referral, and rapid surgical management significantly influence visual prognosis. The statistically significant associations observed in this study provide objective evidence supporting early intervention strategies. Strengthening community-based screening programs and improving access to cataract surgery may substantially reduce the burden of preventable visual impairment due to lens-induced glaucoma.

Generalizability

The findings of this study are applicable to clinical settings in regions where delayed cataract surgery and limited eye-care access contribute to a higher burden of lens-induced glaucoma. The patterns of presentation, IOP elevation, and surgical challenges observed here closely mirror those reported in similar low-resource environments. Therefore, the results can be reasonably generalized to comparable populations across South Asia and other developing healthcare systems.

Conclusion

This study underscores that lens-induced glaucoma remains a significant, yet preventable cause of visual impairment in regions with delayed cataract intervention. Phacomorphic and phacolytic glaucomas constituted the major burden, often presenting with markedly elevated intraocular pressure and advanced inflammation. Early recognition of symptoms, rapid IOP reduction, and timely cataract extraction were key factors associated with favourable postoperative vision. Higher preoperative IOP, delayed presentation, and intraoperative complications consistently predicted poorer outcomes. Although surgical management effectively restored functional vision in many patients, the proportion of irreversible visual loss highlights the need for strengthened community awareness, improved accessibility to cataract services, and proactive screening strategies to reduce the preventable progression to LIG.

Limitations

This study was conducted in a single tertiary hospital with a relatively small sample size, which restricts broader applicability. Follow-up was limited to six weeks, preventing long-term assessment of visual stability and IOP control. Advanced presentations were common, reducing insight into early disease stages. Imaging-based evaluations were not uniformly available for all patients.

Recommendations

Strengthening community awareness about cataract progression and the risks of delayed treatment is essential to reduce the burden of lens-induced glaucoma. Primary health workers need targeted training to recognize early cataract changes and refer patients promptly. Expanding access to affordable cataract surgery, particularly in rural areas, can significantly lower advanced presentations. Routine screening for elderly individuals should be integrated into existing health programs. Standardized protocols for rapid IOP reduction before surgery improve safety and visual outcomes. Enhanced surgical training for managing complex cataracts further reduces intraoperative complications. Collaboration between public health systems and eye-care institutions supports timely intervention and prevents avoidable visual loss.

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Abbreviations

AC – Anterior Chamber
BCVA – Best Corrected Visual Acuity
IOP – Intraocular Pressure
LIG – Lens-Induced Glaucoma
LA – Local Anaesthesia
mmHg – Millimetres of Mercury
ACIOL – Anterior Chamber Intraocular Lens
PCIOL – Posterior Chamber Intraocular Lens
SFIOL – Scleral Fixation Intraocular Lens
PCR – Posterior Capsular Rent
VL – Vitreous Loss
POD – Postoperative Day
SICS – Small Incision Cataract Surgery
KPs – Keratic Precipitates

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The study had no funding.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

KD-Concept and design of the study, results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript. **PT**-Concept and design of the study, results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript. **GN**-Concept and design of the study, results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript.

Data availability

Data available on request

Author Biography

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