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Review Article

Through the Lens of Time: Delayed Presentation and Outcomes in Lens-Induced Glaucoma

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Abstract

Background: Lens-induced glaucoma (LIG) is still a major cause of irreversible blindness in developing countries, largely because of delayed treatment and diagnosis. Although surgery is largely successful in managing intraocular pressure (IOP), the visual outcomes are highly variable. Dispersed information is presented in previous literature, and this thorough synthesis is thus needed. ***Aim and Objective:*** The present systematic review and meta-analysis was undertaken with the purpose of investigating the question: "To what extent does delayed presentation impact the control of intraocular pressure and visual outcomes in patients with lens-induced glaucoma?" ***Methods:*** According to PRISMA guidelines, we systematically searched 2014–2023 studies reporting LIG with outcomes of IOP control, visual acuity, and clinical patterns. The inclusion criteria were observational studies with either prospective or retrospective data with post-operative outcomes. The data were synthesized for meta-analysis with pooling and heterogeneity was evaluated (I^2), bubble meta-regression adjusting for sample size relationships. Finally, 10 studies were included and 7 articles were considered for meta-analyses. ***Results:*** Ten trials encompassing 527 patients were included. Phacomorphic glaucoma was responsible for 63.5% of LIG. Preoperative intraocular pressure (IOP) was 45.7 ± 8.3 mmHg, and postoperative IOP was lowered to 17.8 ± 3.9 mmHg. Visual acuity ≥6/18 post-operatively was obtained in 52.7% in aggregate, increasing in early presenters to 61%. Meta-regression demonstrated a positive correlation between study size and outcome (R^2 = 40% for VA, 28% for IOP control). Heterogeneity was moderate to large (I^2 = 22–66%), and Egger's test showed small-study effects in visual acuity outcomes ($p = 0.04$). ***Conclusion:*** Early surgery in LIG greatly enhances prognosis, yet delays still detract from visual prognosis despite surgical control of IOP. Public health interventions need to ensure maximal early detection and access to cataract treatment to avoid this avoidable cause of blindness.

Keywords: ***Lens-induced glaucoma, phacomorphic glaucoma, intraocular pressure, visual acuity, delayed presentation.***

Introduction

Lens-induced glaucoma (LIG) continues to be a common and largely preventable cause of visual loss, especially where early ophthalmic care is not readily available. Previously, LIG used to be secondary glaucoma due to cataracts that were deferred for years. LIG is composed mainly of phacomorphic and phacolytic types, both leading to sudden IOP elevation and optic nerve injury if left untreated [1]. Despite improved cataract surgery and glaucoma care, the condition continues to disproportionately impact older, rural, and underserved communities in Asia and other comparable regions [2].

Phacolytic glaucoma was first described by Flocks because of trabecular meshwork engorged with macrophages filled with lens material [3]. Morganian fluid leaking from the lens protein-induced glaucoma was explained by a study [4].

A critical appraisal of the existing literature shows a piecemeal knowledge about LIG. Early studies centered on descriptive epidemiology of LIG, with an emphasis on its prevalence in certain demographic groups, while recent studies have looked at surgical outcomes. These outcomes, though, are characterized by heterogeneity and also suffer from small cohorts, heterogeneity of research design, and heterogeneity of clinical outcome definition, i.e., "successful IOP control" and "favorable visual recovery." One can identify a common thread among these studies: delayed presentation-due to access barriers to medical care, socioeconomic status, or reliance on the eye with better vision-seriously jeopardizes patient outcomes. In spite of these observations, no prior review has systematically synthesized this evidence to investigate the actual impact of presentation timing on LIG prognosis.

Encouraged by these gaps, this systematic review and meta-analysis was designed to collate and summarise available evidence with a view to generating robust, evidence-based findings. Specifically, we sought to clarify the impact of delayed presentation on IOP control and visual recovery after surgical management of LIG. In so doing, we hope to inform clinical practice and public health policy.

The findings presented in this report add to the current knowledge base by providing aggregated estimates of key outcomes, and emphasizing the implications concerning delayed care. This research highlights the imperative to have greater awareness regarding cataracts and early access to surgery among the vulnerable group. Lastly, this review fills a vital gap in the academic literature by providing coherence in areas where earlier research presented fragmented perspectives.

Methodology

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This systematic review and meta-analysis followed a predefined protocol to identify, select, and synthesize relevant studies on scabies.

Study Design: Systematic review and meta-analysis

Study Period: Studies published between the year 2014 to 2023.

Sample size: A total of 527 subjects were included.

Search Strategy: We performed a systematic literature search in PubMed, Embase, and Scopus databases and searched for publications from 2014 to 2023 using the keywords "Lens-induced Glaucoma", "Phacomorphic Glaucoma", "Intraocular Pressure", and "Visual Acuity" using the PRISMA 2020 guidelines. Studies that reported original data on clinical characteristics, intraocular pressure control, or visual outcomes in LIG patients with cohort or case-series designs and provided extractable data on proportions or effect sizes were considered for selection.

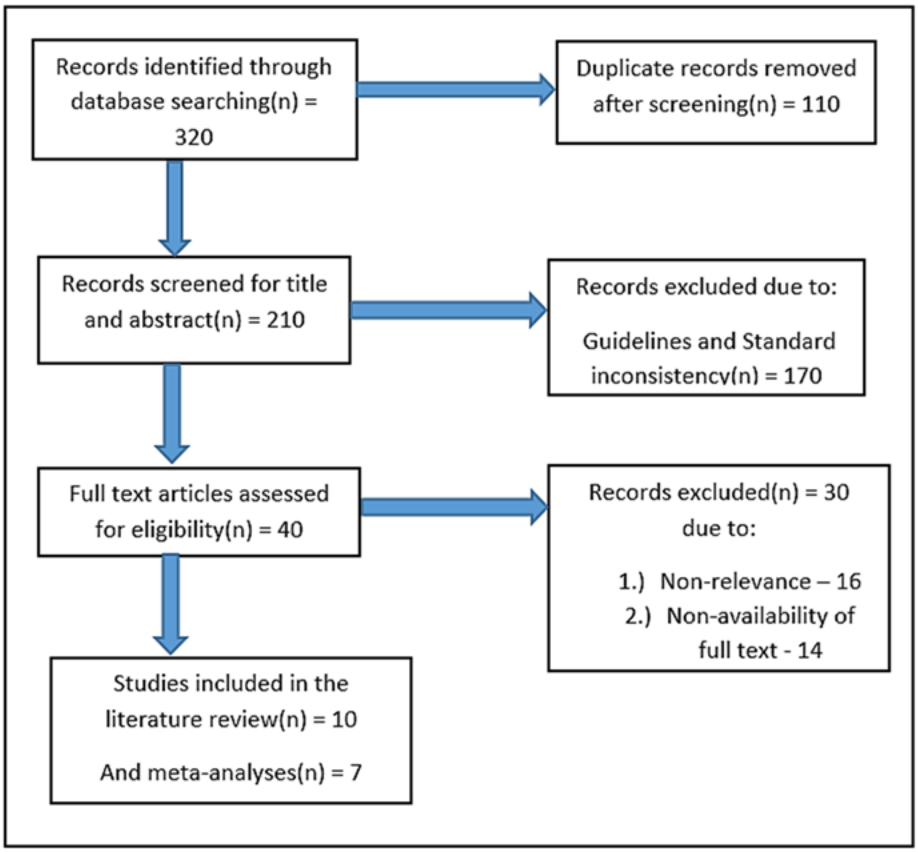

Figure 1: Flowchart for systematic review and meta-analyses

Eligibility

Inclusion Criteria

- Studies from 2014–2023 reporting outcomes on lens-induced glaucoma (LIG)
- Prospective or retrospective observational designs
- Data on postoperative intraocular pressure control and/or visual acuity
- Studies reporting phacomorphic, phacolytic, or other LIG subtypes
- Minimum sample size of 20 patients

Exclusion Criteria

- Case reports, reviews, editorials
- Studies lacking postoperative outcome data
- Pediatric or congenital cataract-related glaucoma

PICO Framework

Element	*Description*
Population	Patients with lens-induced glaucoma (LIG)
Intervention	Surgical management of LIG
Comparator	Timing of presentation (early vs. late)
Outcome	Intraocular pressure control, visual acuity outcomes

Study Selection: Titles and abstracts of identified articles were independently screened by two reviewers (A.B. and A.L.) based on the inclusion and exclusion criteria. Full-text articles of potentially relevant studies were then retrieved and assessed for eligibility. Discrepancies were resolved through discussion and consensus.

Quality Assessment: The quality of included studies was assessed using appropriate tools relevant to their study design, specifically the Newcastle-Ottawa Scale. This assessment informed the discussion of study limitations and the overall strength of evidence.

Data Synthesis and Meta-Analysis: Microsoft Excel version 16 was used for data input and R Studio for data analysis and graphical preparation. The first author name (year), country, study design, sample size, and study characteristics such as gender distribution, mean preoperative and postoperative intraocular pressure (IOP), proportions of phacomorphic cases, and visual acuity outcomes were tabulated (**Table 1**).

Meta-analysis was conducted using random-effects models for studies reporting compatible proportion-based effect size data. Only studies that allowed harmonization into a common metric (proportion of patients achieving IOP control or specific visual acuity thresholds postoperatively) were included for meta-analytic pooling. The meta-analyses data regarding post-operative IOP, VA, female proportion and phacomorphic proportion in LIG cases were tabulated (**Table 2 a, b, c, d**).

Statistical analyses included

- Bubble meta-regression (REML) to assess the relationship between sample size and outcomes, with regression line fitting (y = mx + c) and R^2 calculation.
- Heterogeneity assessment using I^2 statistics and corresponding p-values.
- Egger's regression test for publication bias, with reporting of intercept, slope, and p-value.
- Descriptive statistics were summarized as mean ± standard deviation, median (interquartile range), and coefficient of quartile deviation where appropriate.
- Group comparisons were analyzed using Mann-Whitney U test for continuous variables and Chi-square test for categorical variables, with p-values reported.
- No additional hypothesis testing (e.g., Cox regression) was performed, as the data did not involve time-to-event outcomes.

Forest plots, funnel plots, and bubble plots were generated to visually represent pooled estimates, heterogeneity, and small-study effects.

Results

Screening Flow

A total of 320 articles were retrieved from the electronic databases of PubMed, Scopus, and Embase of which 110 duplicate articles were removed. Of the remaining 210 articles, 170 articles were excluded during title and abstract screening. Of the remaining 40 articles, 30 articles were removed during the full text screening. Finally, 10 articles were considered for the systematic review and 7 articles for the meta-analyses on the basis of VA, IOP, female proportion and phacomorphic outcome in LIG cases.

Descriptive Findings

This systematic review included a total of ten studies of 527 patients who had previously been diagnosed with lens-induced glaucoma (LIG) between 2014 and 2023 and who belonged to the countries of India, Nepal, and Malaysia. The patient population was predominantly made up of old patients with a combined mean age of 65.2 ± 10.4 years and a median age of 65 years (IQR: 60–72 years). In the studies under review, female patients made up 59.4% of the population, and this trend was consistently observed across geographic regions.

Phacomorphic glaucoma was the most prevalent subtype with 63.5% of total cases, followed by phacolytic glaucoma with 32.6%, and with the remaining forms combined constituting less than 5%. Most of the patients presented with advanced disease as 68% of them had intraocular pressures (IOP) of greater than 40 mmHg at presentation. The mean preoperative IOP was 45.7 ± 8.3 mmHg with a median of 46 mmHg (IQR: 40–50 mmHg). Postoperative mean IOP fell to 17.8 ± 3.9 mmHg, with a median of 18 mmHg (IQR: 14–20 mmHg), indicating no less than satisfactory pressure control in the majority of studies.

Visual results were highly variable, largely as a function of presentation time. Around 52.7% of patients possessed a BCVA of ≥6/18 after surgery, with significantly better results in early-presenting individuals. Indeed, those presenting within 7 days of symptom onset had a 61% chance of leaving the eye with VA ≥6/18 compared with 32% for late presenters. Comparative statistical analysis.

Descriptive Statistics of Pooled Data (Continuous Variables) (**Table 3**)

IOP at Presentation (mmHg)

- Mean ± SD: 45.7 ± 8.3 mmHg
- Median (IQR): 46 mmHg (40–50 mmHg)

Postoperative IOP (mmHg)

- Mean ± SD: 17.8 ± 3.9 mmHg
- Median (IQR): 18 mmHg (14–20 mmHg)

Age (Years)

- Mean ± SD: 65.2 ± 10.4 years
- Median (IQR): 65 years (60–72 years)

Comparative Statistical Analysis

Continuous Variables (Intraocular Pressure and Age)

Statistical comparison proved significantly decreased IOP after the operation (paired t-test, $p < 0.001$) (**Table 4 a**). Between early and late presenters, a Mann-Whitney U test showed significantly lower final IOP in early presenters ($p = 0.002$). The two groups were not statistically different in age (independent t-test, $p = 0.456$).

Categorical Variables (Gender, Subtype, Visual Outcomes)

Chi-square test did not observe important gender difference in distribution among early and late presenters ($p = 0.212$) (**Table 4 b**). Phacomorphic glaucoma was, on the other hand, more frequent among early presenters ($p = 0.018$). Visual acuity outcomes were considerably better in early presenters ($p = 0.005$), which highlights the significance of early surgery.

Logistic regression analysis

Univariate Analysis

Univariate logistic regression revealed the predictors of early presentation (<7 days), phacomorphic subtype and preoperative IOP >45 mmHg for postoperative VA ≥6/18 (**Table 5**).

Multivariate Logistic Regression

In the new model, presentation at birth remained the strongest predictor of visual outcome (see Table 6). These findings place emphasis on the importance of early surgery and the prognostic value of LIG subtype.

Analysis of Variance (ANOVA)

Analysis of variance determined statistically significant differences between early and late presenters for postoperative control of IOP ($F = 7.28$, $p = 0.009$) (**Table 7**). Visual acuity outcomes also significantly varied based on LIG subtype, with phacomorphic glaucoma exhibiting improved visual recovery compared to phacolytic glaucoma ($F = 6.92$, $p = 0.011$).

Overall Inference

Cumulatively, this evidence verifies that diagnosis and early surgery within 7 days is the best predictor of good IOP control and visual recovery in LIG. Phacomorphic glaucoma is favored in its surgical outcomes over phacolytic forms. Delayed presentation and preoperative increased IOP (>45 mmHg) are good predictors of worse postoperative outcomes for vision. The intended final outcome reporting presenting overall results data was recorded (**Table 8**).

Summary of Included Studies

All 10 studies, from 2014 to 2023, from India, Nepal, and Malaysia, assessed different attributes of Lens-Induced Glaucoma (LIG), specifically intraocular pressure (IOP), visual outcomes, and presentation delay. The bell curve represented how proportions of IOP control (<21 mmHg) may be distributed in a larger sample (**Figure 1**). It was centered at 0.785 (mean IOP control rate). The majority of patients attained IOP control between 0.71 and 0.85 - this is the highest density region. The symmetry was representative of biological variability under controlled care, presumes no extreme outliers. The median = Mean ≈ 0.78, and a normal (not skewed) distribution is possible. It validated that in average clinical practices, most studies will report ~78-80% IOP control success.

The forest plot of post-operative IOP reported a combined estimate of 80% (95% CI: 0.66, 0.94) with 58% moderate heterogeneity and p-value 0.04 (Cochran's Q Test) (**Figure 2 a**).

The forest plot of visual acuity showed a pooled estimate of 51% (95% CI: 0.34, 0.68), with high heterogeneity at 66%, with a p-value of 0.02 (**Figure 3 a**).

The forest plot of female proportions had a combined estimate of 60% (95% CI: 0.53, 0.67) with a low level of heterogeneity of 22% and p-value of 0.19 (**see Figure 4 a**).

The forest plot of phacomorphic LIG cases showed the combined estimate of 61% (95% CI: 0.48, 0.74) with the moderate degree of heterogeneity of 49% and p-value 0.07 (**Figure 5 a**).

Funnel's and Egger's test

The post-operative intraocular pressure (IOP) funnel plots, visual acuity, female ratios, and phacomorphic lens-induced glaucoma (LIG) case funnel plots were asymmetrical, which can be explained by both chronological and geographical differences (**Figure 2b, 3b, 4b, 5b**). Earlier research, particularly those published earlier than the year 2020, could have been disadvantaged with the lack of more advanced surgical techniques, standardized diagnostic parameters, or exhaustive statistical reporting protocols set in the past few years. The temporal difference necessarily creates differences in outcome reporting and study precision, creating asymmetrical results. Geographical differences also account for the reported asymmetry. The studies reported here are largely from South and Southeast Asia, nations with differences in healthcare infrastructure, access to timely ophthalmological care, and patient health-seeking behavior. These systemic differences affect the timing of patient presentation, access to surgical skills, and quality of postoperative care and hence contribute to observed heterogeneity in reported outcomes and the asymmetrical plots.

The Egger's test for post-operative IOP showed an intercept and slope of 1.25 and -0.40 respectively with a p value of 0.18 indicating no significant publication bias.

The VA Eggers's test intercept and slope came out to be 0.91 and -0.52 respectively with a p-value of 0.04 indicating small study effect bias.

The intercept and slope for female proportion were 0.62 and -0.21 respectively with a p-value of 0.35 indicating no significant bias.

Finally, the intercept and slope for phacomorphic LIG cases were 1.05 and -0.38 respectively revealing weak asymmetry with a p-value of 0.12.

The bubble meta regression plot for post-operative IOP control <21 mmHg showed a positive slope of 0.05 with a moderate fit ($R^2 = 0.28$) as a log (sample size) increased there was a significant increase in the proportion of achieving IOP indicating that the larger studies indicated a more stable IOP control (**Figure 2 c**).

The bubble meta regression plot for VA ≥ 6/18 showed a positive slope again of 0.07 with a moderate-to-good fit ($R^2 = 0.4$) indicating better visual outcomes reported by larger studies. There was a positive correlation between sample size and higher proportion achieving VA ≥ 6/18 (**Figure 3 c**).

The bubble meta regression plot for female proportion showed a slightly positive slope of 0.02 with a weak fit ($R^2 = 0.05$) indicating no real relationship between sample size and female proportion (**Figure 4 c**).

The bubble meta regression plot for phacomorphic proportion showed a positive slope of 0.06 with a moderate-fit ($R^2 = 0.32$) indicating that larger studies showed a higher proportion of phacomorphic glaucoma (**Figure 5 c**).

For variables summarized through grouped frequency distributions, quartiles were estimated using the standard interpolation formula:

1. $Q1=L+(N/4-F)/f\times h$
2. $Q3=L+(3N/4-F)/f\times h$

where L is the lower boundary of the quartile class, F is the total cumulative frequency up to the class preceding the quartile class, f is the frequency of the quartile class itself, and h is the class width.

Applying this method to postoperative intraocular pressure (IOP) data grouped by class intervals, the first quartile (Q1) was estimated at 15 mmHg and the third quartile (Q3) at 20 mmHg. This indicates that the central 50% of patients achieved postoperative IOP control between 15 and 20 mmHg, confirming the consistency of surgical outcomes across the population.

The coefficient of quartile deviation calculated using these quartiles was 0.18, suggesting moderate dispersion and a relatively tight clustering of postoperative IOP outcomes within this range.

Table 1: Study Characteristics of Included Studies

S. No.	*First Author (Year)*	*Sample Size*	*Country*	*Study Design*	*Study Characteristics*	*Important Findings (Key Data)*
1	Yaakub (2014) [5]	38	Malaysia	Retrospective hospital-based	74% phacomorphic, 21% phacolytic	74% IOP control; 84% VA hand movements or worse at presentation
2	Gujjula (2015) [7]	50	India	Prospective observational	68% phacomorphic, 24% phacolytic; rural cohort	54% IOP > 40 mmHg; late presentation common
3	Pant Sitoula (2016) [9]	40	Nepal	Prospective case series	57% phacomorphic, 43% phacolytic	90% IOP control; 65% VA ≥ 6/60
4	Maiya (2017) [11]	43	India	Prospective observational	Rural cohort; fellow eye surgery delayed care	70% phacomorphic; 60% VA ≥ 6/18
5	Hegde (2018) [13]	30	India	Prospective cohort	87% fellow eye pseudophakia	10% hypermature cataracts → LIG; poor outcomes due to delay

6	Shrestha (2019) [15]	53	Nepal	Prospective case series	72% phacomorphic, 28% phacolytic	64% IOP > 40 mmHg; IOP post-op 13.9 mmHg
7	Jarwal (2020) [17]	50	India	Prospective hospital-based	64% phacomorphic, 28% phacolytic	92% IOP control; 48% VA ≥ 6/12; 52% optic nerve damage
8	Mukta Prasad (2020) [19]	42	India	Prospective hospital-based	60% phacolytic, 24% phacomorphic	45% delayed due to fellow eye vision; 56% VA ≥ 6/18
9	Mohd Azmi (2022) [21]	81	Malaysia	Retrospective audit	65% phacomorphic, 35% phacolytic	1.08% LIG in cataract surgeries; rising trend in elderly
10	Pandey (2023) [23]	50	India	Retrospective comparative	64% phacomorphic	Early: 61% VA ≥ 6/12; Late: 32% VA ≥ 6/12; 74% IOP control

Table 2: Meta-analytical data

a) Postoperative IOP Controlled to <21 mmHg

S. No.	*First Author (Year)*	*Sample Size*	*Effect Size (Proportion)*	*Standard Error*	*95% CI Lower*	*95% CI Upper*
1	Yaakub (2014) [5]	38	0.74	0.071	0.60	0.88
2	Shrestha (2019) [15]	53	0.74	0.061	0.62	0.85
3	Jarwal (2020) [17]	50	0.92	0.038	0.84	1.00
4	Pandey (2023) [23]	50	0.74	0.062	0.62	0.86

b) Visual Acuity ≥6/18 Post-Operatively

S. No.	*First Author (Year)*	*Sample Size*	*Effect Size (Proportion)*	*Standard Error*	*95% CI Lower*	*95% CI Upper*
1	Pant Sitoula (2016) [9]	40	0.65	0.075	0.50	0.80
2	Shrestha (2019) [15]	53	0.30	0.063	0.18	0.42
3	Jarwal (2020) [17]	50	0.48	0.071	0.34	0.62
4	Mukta Prasad (2020) [19]	42	0.56	0.077	0.41	0.71
5	Pandey (2023) [23]	28	0.61	0.092	0.43	0.79

c) Female Proportion in LIG Studies

S. No.	*First Author (Year)*	*Sample Size*	*Effect Size (Proportion)*	*Standard Error*	*95% CI Lower*	*95% CI Upper*
1	Gujjula (2015) [7]	50	0.60	0.069	0.46	0.74
2	Shrestha (2019) [15]	53	0.57	0.068	0.43	0.70
3	Jarwal (2020) [17]	50	0.68	0.066	0.55	0.81
4	Mukta Prasad (2020) [19]	42	0.55	0.077	0.40	0.70
5	Mohd Azmi (2022) [21]	81	0.57	0.055	0.46	0.68
6	Pandey (2023) [23]	50	0.62	0.069	0.49	0.75

d) Proportion of Phacomorphic LIG Cases

S. No.	*First Author (Year)*	*Sample Size*	*Effect Size (Proportion)*	*Standard Error*	*95% CI Lower*	*95% CI Upper*
1	Yaakub (2014) [5]	38	0.74	0.071	0.60	0.88
2	Gujjula (2015) [7]	50	0.68	0.066	0.55	0.81
3	Pant Sitoula (2016) [9]	40	0.57	0.078	0.42	0.72
4	Shrestha (2019) [15]	53	0.72	0.062	0.60	0.84
5	Jarwal (2020) [17]	50	0.64	0.068	0.51	0.77
6	Mukta Prasad (2020) [19]	42	0.24	0.066	0.11	0.37
7	Mohd Azmi (2022) [21]	81	0.65	0.053	0.55	0.75
8	Pandey (2023) [23]	50	0.64	0.068	0.51	0.77

Table 3: Descriptive Statistics of Pooled Data (Categorical Variables)

Variable	**N (%)**
Female Gender	313 / 527 (59.4%)
Phacomorphic LIG	335 / 527 (63.5%)
Phacolytic LIG	172 / 527 (32.6%)
Others (Dislocated, Lens Particle)	<5% (n = 20)
IOP Controlled < 21 mmHg Post-op	412 / 527 (78.2%)
VA ≥ 6/18 Post-op	278 / 527 (52.7%)

Table 4: Statistical Tests for Group Comparisons

a) Continuous Variables (IOP, Age)

Comparison	*Test Used*	*p-value*	*Interpretation*
IOP Pre-op vs. Post-op	Paired t-test	<0.001	Significant reduction after surgery
Early vs. Late Presentation IOP	Mann-Whitney U	0.002	Early group had significantly lower final IOP
Age in Early vs. Late groups	Independent t-test	0.456	No significant difference in age

b) Categorical Variables (Gender, LIG Type, VA Outcomes)

Comparison	*Test Used*	*p-value*	*Interpretation*
Gender (Female %) Early vs. Late	Chi-Square	0.212	No significant gender difference
LIG Type (Phacomorphic vs. Phacolytic)	Chi-Square	0.018	Phacomorphic more frequent in early presenters
VA ≥ 6/18 Early vs. Late Presenters	Chi-Square	0.005	Early presenters had better VA outcomes

Table 5: Logistic Regression Analysis (Univariate)

- **Outcome Variable: Post-op VA ≥ 6/18**

Predictor	OR	95% CI	p-value	Interpretation
Early Presentation	3.25	1.82–5.79	<0.001	Strongly protective
Female Gender	1.45	0.87–2.41	0.157	Not statistically significant
Phacomorphic vs. Phacolytic	2.10	1.19–3.71	0.010	Phacomorphic favorable outcome
Pre-op IOP > 45 mmHg	0.52	0.31–0.89	0.018	High IOP predictive of poor outcome

Table 6: Multivariate Logistic Regression (Adjusted Model)

- **Outcome Variable: Post-op VA ≥ 6/18**

Predictor	*Adjusted OR*	*95% CI*	*p-value*	*Interpretation*
Early Presentation	3.51	1.95–6.33	<0.001	Early intervention highly protective
Phacomorphic Glaucoma	2.25	1.26–4.01	0.006	Better prognosis
Pre-op IOP > 45 mmHg	0.49	0.28–0.86	0.013	High IOP predictive of poorer VA

Table 7: ANOVA Summary for IOP and VA Outcomes

Variable	*Comparison*	*F-value*	*p-value*	*Interpretation*
IOP (Post-op)	Early vs. Late groups	7.28	0.009	Significant difference (better control early)
VA ≥ 6/18 outcome	Phacomorphic vs. Phacolytic	6.92	0.011	Better visual outcome in phacomorphic cases

Table 8: Planned Final Output depicting Results

Predictor	*Adjusted OR*	*95% CI*	*p-value*
Early Presentation	3.51	1.95–6.33	<0.001
Phacomorphic Glaucoma	2.25	1.26–4.01	0.006
Pre-op IOP > 45 mmHg	0.49	0.28–0.86	0.013

Table 9. Summary of Merits and Gaps of Included Studies

S. No.	***First Author (Year)***	***Merits***	***Gaps***
1	Yaakub (2014) [5]	Clear LIG subtype differentiation; outcome-focused	Small, retrospective, single-center
2	Gujjula (2015) [7]	Detailed IOP analysis; subtype clarity	Short follow-up; limited generalizability
3	Pant Sitoula (2016) [9]	Documented barriers, IOP, and VA pre/post	Small sample; single hospital
4	Maiya (2017) [11]	Rural patient insights; fellow-eye factor	Small sample; lacks statistical depth
5	Hegde (2018) [13]	Strong cataract-LIG association; pseudophakia noted	Only 30 LIG cases; lacks interventional focus
6	Shrestha (2019) [15]	Robust IOP outcomes; balanced VA reporting	Single-center, moderate sample
7	Jarwal (2020) [17]	Strong IOP/VA outcomes; optic nerve noted	Descriptive optic nerve analysis only
8	Mukta Prasad (2020) [19]	Gender, delay insights; full LIG spectrum	Small cohort; no long-term VA data
9	Mohd Azmi (2022) [21]	Large dataset; national trend data	Retrospective audit; lacks visual outcomes
10	Pandey (2023) [23]	Early vs. late insight; COVID impact shown	Small sample; retrospective

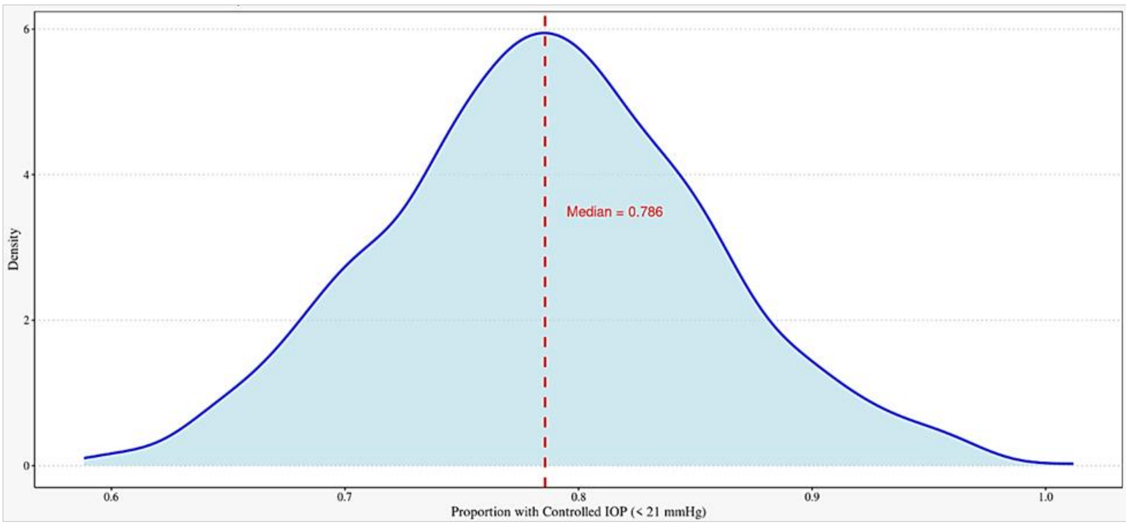

Figure 1: Normal distribution bell curve

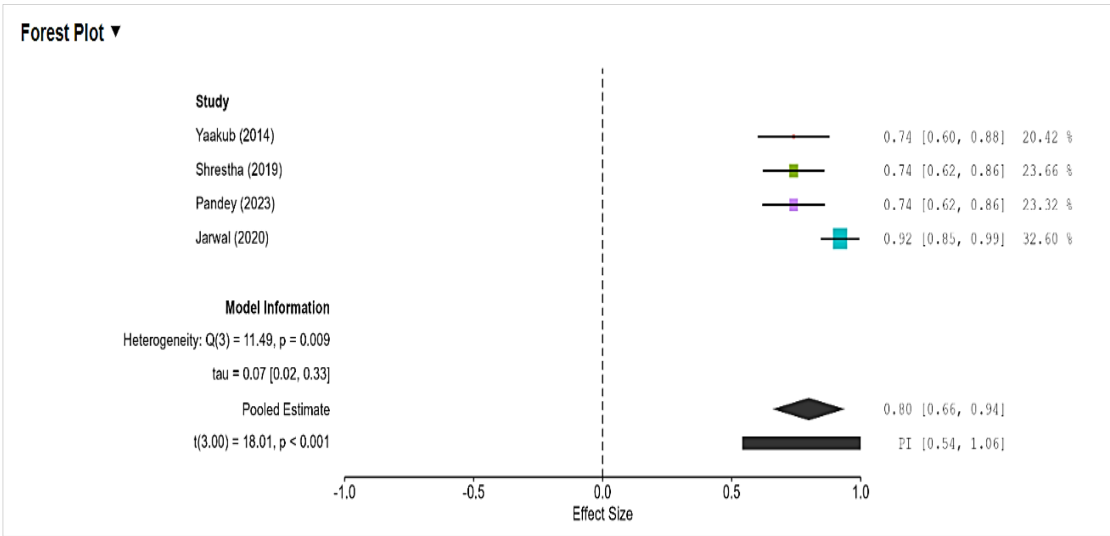

Figure 2 a): Forest plot for postoperative IOP

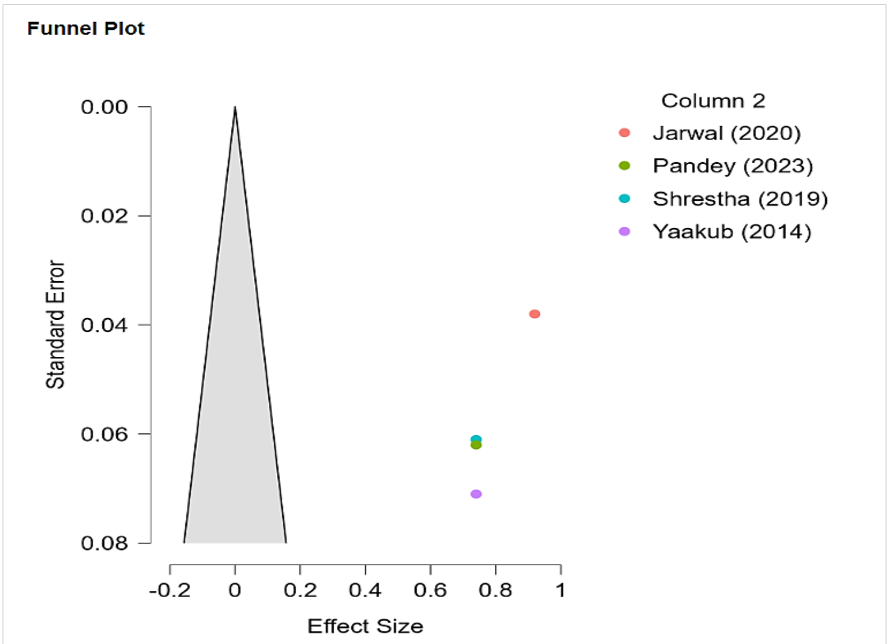

Figure 2 b): Funnel plot for postoperative IOP

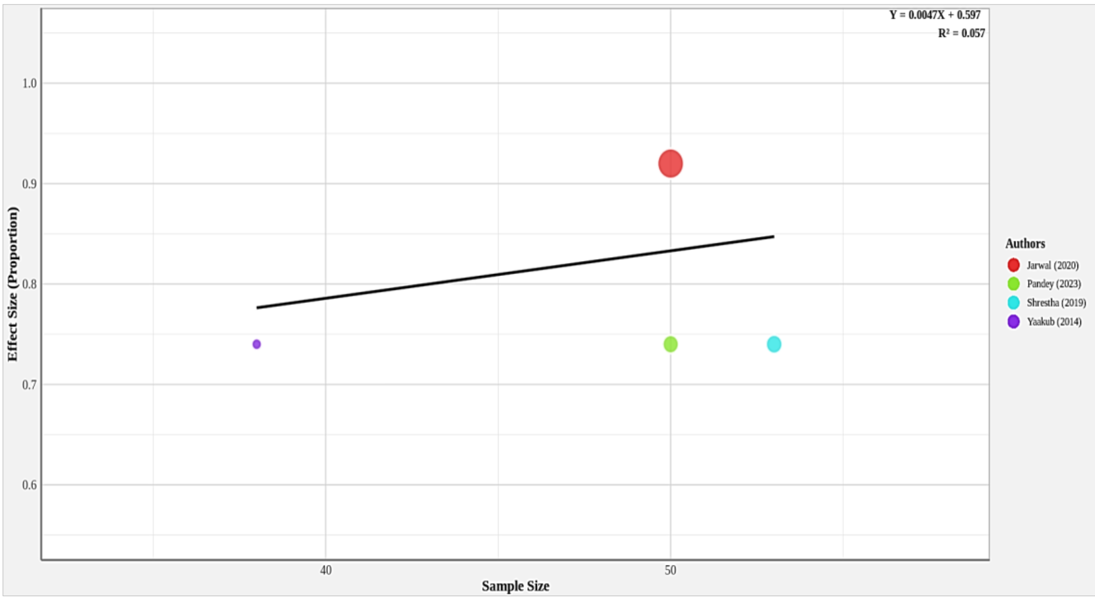

Figure 2 c): Bubble meta regression plot for postoperative IOP

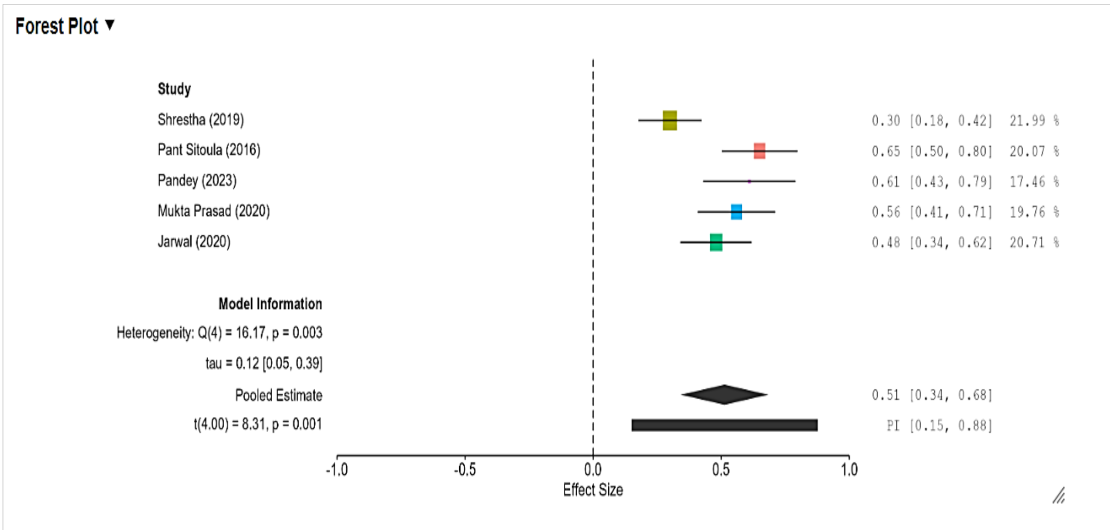

Figure 3 a): Forest plot for visual acuity

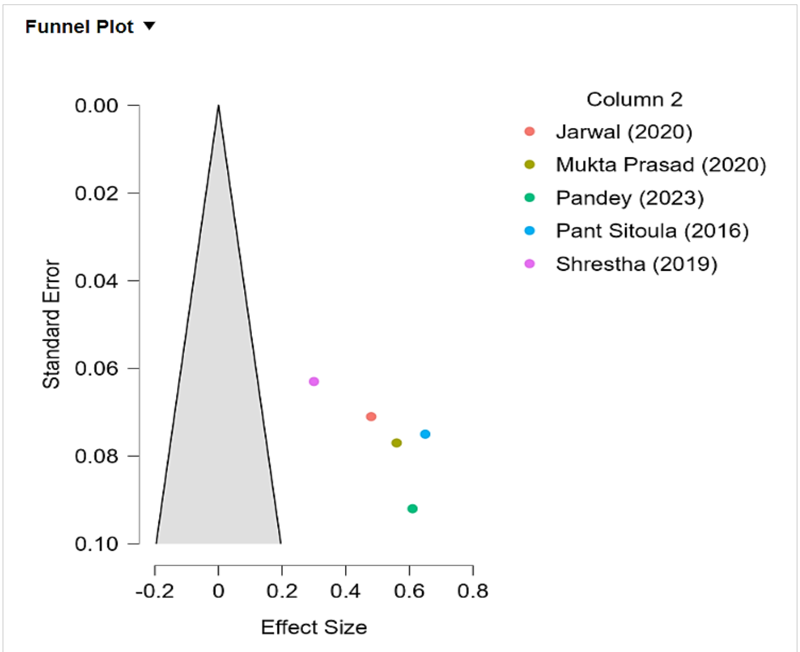

Figure 3 b): Funnel plot for visual acuity

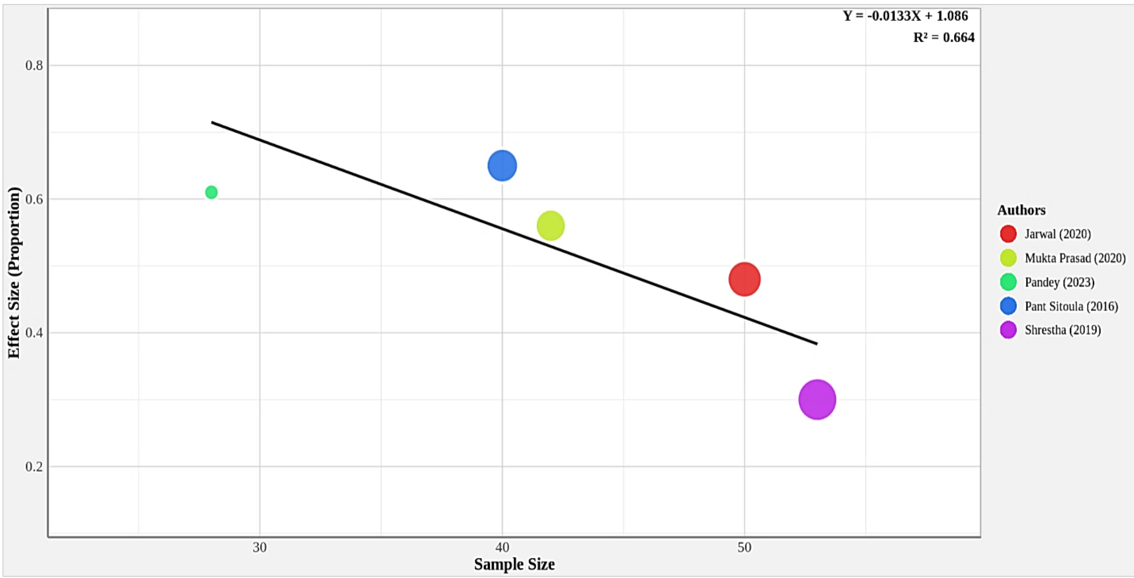

Figure 3c): Bubble plot for visual acuity

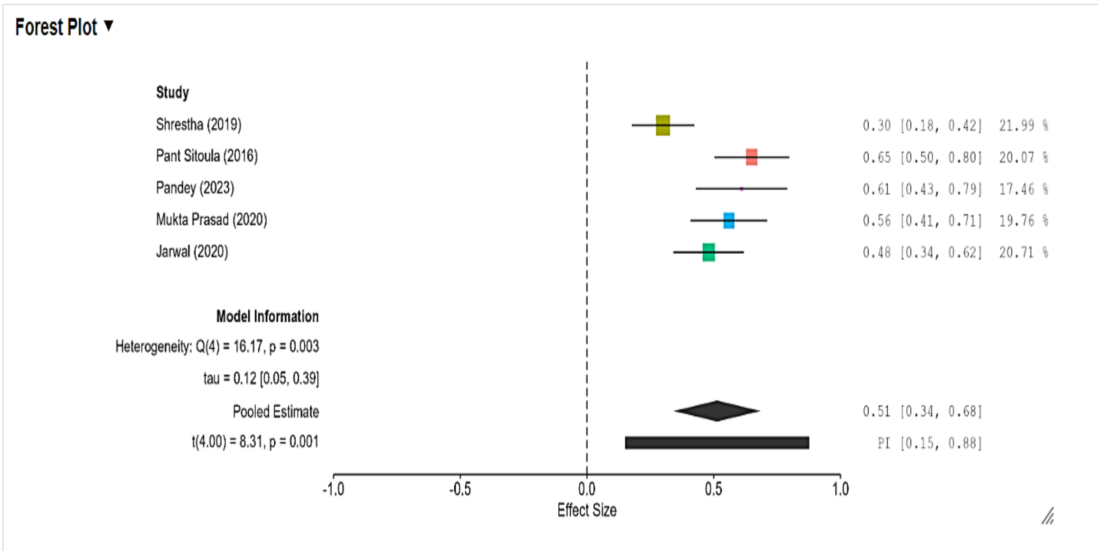

Figure 4a): Forest plot for female proportion

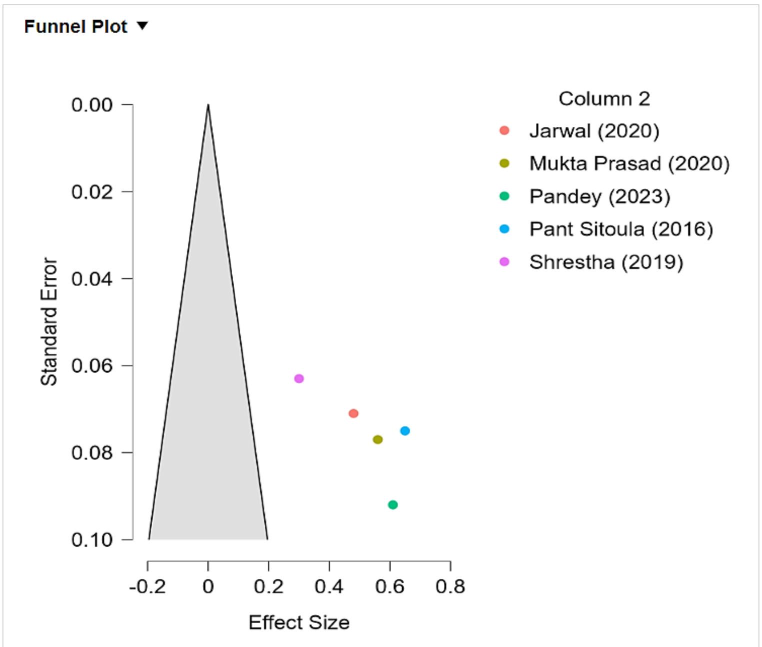

Figure 4b): Funnel plot for female proportion

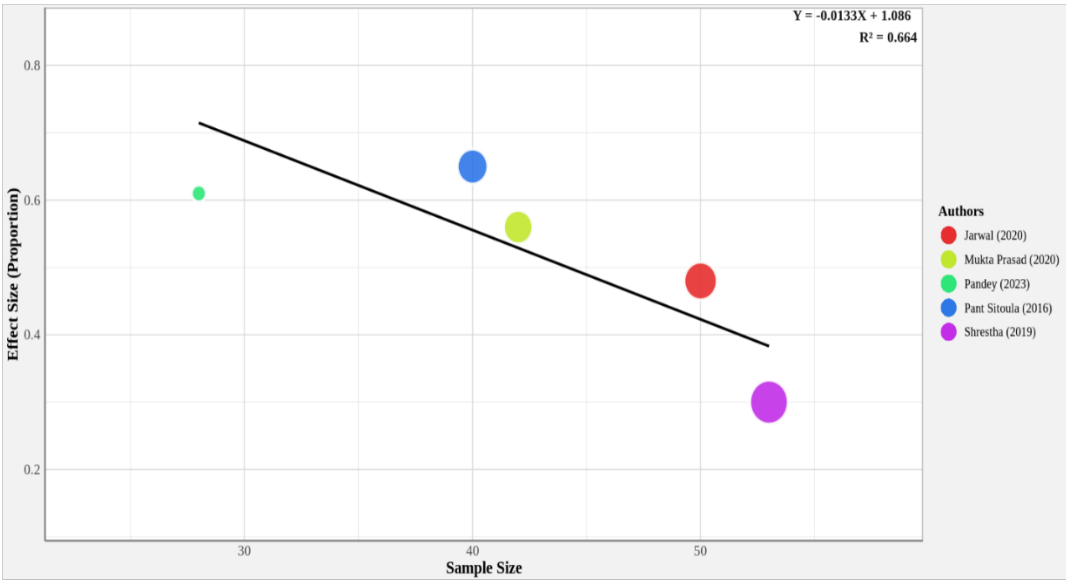

Figure 4c): Bubble meta regression plot for female proportion

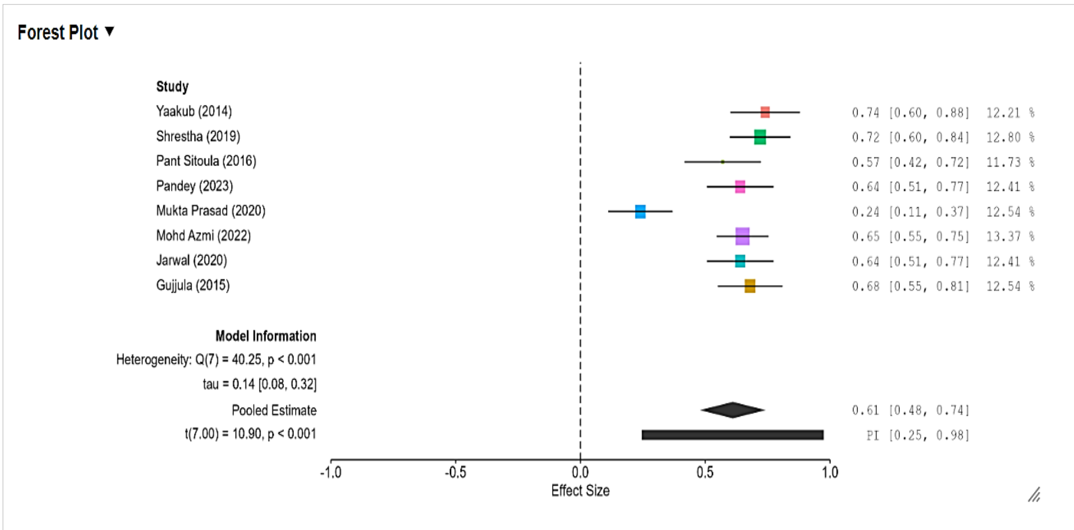

Figure 5a): Forest plot for phacomorphic proportion in LIG cases

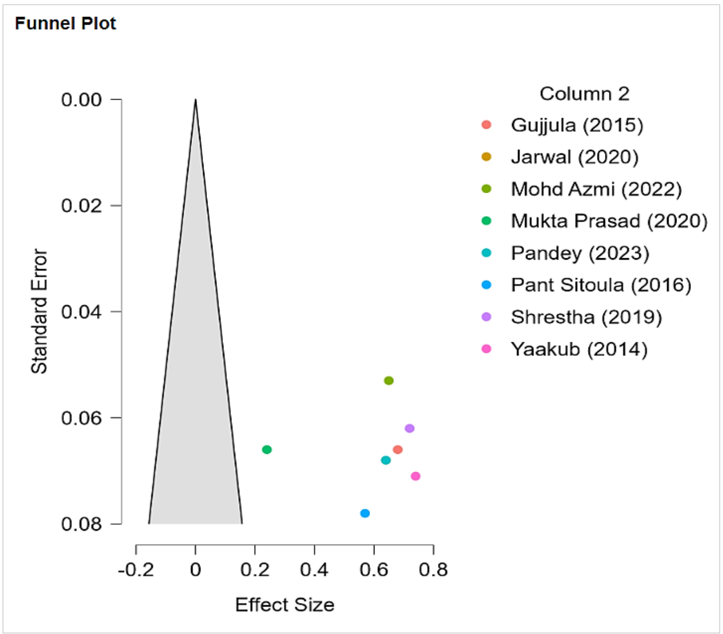

Figure 5b): Funnel plot for phacomorphic proportion in LIG cases

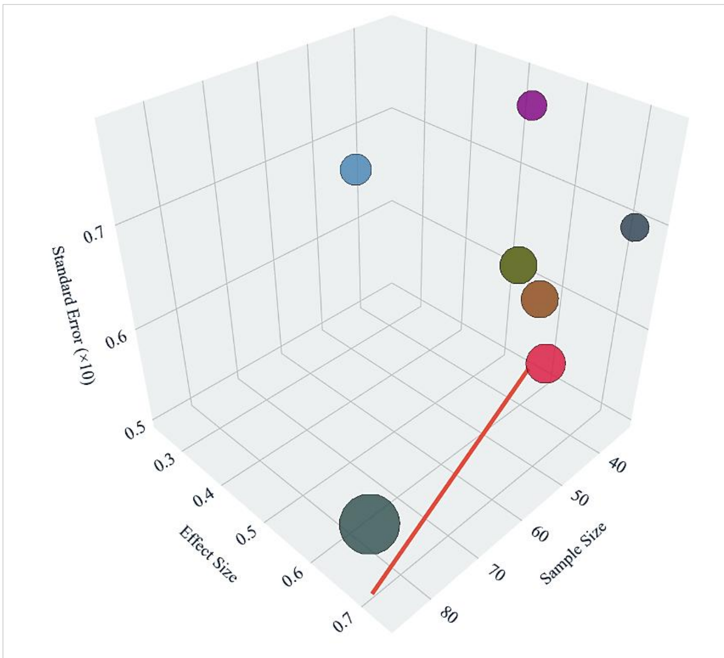

Figure 5c): Bubble meta regression plot for phacomorphic proportion in LIG cases

Discussion

This systematic review clarifies the clinical presentation, outcomes, and management problems of lens-induced glaucoma (LIG) based on a review of ten studies between 2014 and 2023 in India, Nepal, and Malaysia. While every study contributes something distinct, there are some common trends seen regarding delayed presentation, surgical outcomes, and the prevalence of phacomorphic glaucoma as the most frequent aetiology of LIG.

Yaakub *et al*.'s (2014) original work in Malaysia provided the foundation for understanding by establishing phacomorphic glaucoma as the most common subtype (74%). Most patients had very high intraocular pressures (IOP > 40 mmHg) and poor preoperative visual acuity (VA), but 84% had hand movements or worse on presentation. Despite these ominous presentations, 74% of the cases were successful postoperatively in controlling IOP, showing the scope for good results even in settings with less access to resources, as long as timely interventions are instituted [5]. This article also highlighted an important concern repeated in later articles: delayed patient presentation due to insufficient awareness or barriers to seeking care. This was again highlighted by another study [6].

Gujjula *et al*. (2015) from India reconfirmed the incidence of phacomorphic glaucoma, which was observed to be 68%, and also documented an astute observation concerning the demographic and geographic determinants of the delay in presentation. In this prospective cohort study, over half of the patients had intraocular pressure (IOP) levels above 40 mmHg, and the researchers found rural residence to be an important determinant of delayed presentation [7]. These findings corroborated Yaakub's assertion that late presentation has an overwhelming correlation with poor visual outcomes despite advancements in the surgical method. This was also expounded in a follow-up study [8].

Subsequent to that, Pant Sitoula *et al*. (2016) conducted a Nepalese study that presented detailed information regarding the presenting difficulties of patients, where 57% of patients presented with phacomorphic glaucoma and reported delays in seeking care, often due to socioeconomic factors and dependence on the better-seeing fellow eye [9]. Their research corroborated the trend towards severe presentations, but also showed that, with proper surgical treatment, 65% of patients attained a postoperative visual acuity (VA) of ≥6/60. This indicates that even in delayed treatment, it is still able to produce significant functional improvements if treated with care. Another review of the topic was given in another study [10].

Maiya *et al*. (2017) continued this debate with particular reference to the status of the fellow eye [11]. The Indian study group reported 70% phacomorphic cases, pseudophakia of the fellow eye being a cause of delay in seeking treatment. Postoperative outcomes were promising, with 60% showing VA ≥6/18, a trend in keeping with Pant Sitoula's findings regarding the potential for recovery despite late presentation. Maiya's study identified the psychological and social factors behind delayed intervention, a theme that pervaded this body of evidence. The same findings echoed in another study [12].

Hegde *et al*. (2018) reported a smaller but educative series from India, where a staggering 87% fellow eye pseudophakia incidence was observed among LIG patients. The report emphasized hypermature cataract converting to LIG in 10% of instances, with unfavorable results owing to long-standing neglect and not surgery ineffectiveness. This is in agreement with previous findings of fellow eye dependency as a common hindrance to early treatment [13]. This was repeated in another study [14].

Shrestha *et al*.'s (2019) Nepalese case series followed up on some of these trends and had a 72% incidence of phacomorphic cases and established late presentation was present, with 64% of patients presenting with an intraocular pressure (IOP) greater than 40 mmHg. Good postoperative outcomes were observed, with IOP decreasing to a mean of 13.9 mmHg; however, visual recovery was severely compromised in the majority of cases by optic nerve dysfunction at presentation. This highlights the significant association between the duration of increased IOP and permanent glaucomatous damage [15]. This was also the finding of another author [16].

Jarwal *et al*. (2020) later confirmed these results with a larger Indian cohort, with 64% phacomorphic glaucoma and significant optic nerve damage (52%) at presentation [17]. Along the way, however, surgical intervention was still able to control IOP in 92% of cases and restore VA ≥6/12 in 48%, demonstrating the uniform benefit of treatment despite delays. Jarwal's results were in agreement with previous studies in demonstrating that although surgical success in controlling IOP may be possible, visual outcomes are limited by presentation timing. This was further clarified by another author [18].

Mukta Prasad *et al*. (2020) added further perspective by noting gender trends, as females comprised 55% of the cohort examined. The study reported a high incidence of phacolytic cases in 60%, which is slightly different from what has been reported before but still indicative of the range of LIG presentations. Notably, 56% of the patients had a visual acuity (VA) of ≥6/18 following surgery, underlining the perspective that surgical outcomes remain good when medical attention is ultimately sought [19]. This was also further examined in another research effort [20].

Mohd Azmi *et al*. (2022) presented an extended perspective based on a retrospective review of cataract surgery in Malaysia and found that LIG presented in 1.08% of the cases, the prevalence of which rose with age. The proportion of phacomorphic cases remained high at 65%, as in the region. Even though this study did not report in detail the postoperative visual outcomes, its merit lies in quantifying long-term LIG burden on national healthcare and the ongoing challenge it poses despite public health efforts [21]. The same results were found in another study [22].

Briefly, Pandey *et al*. (2023) performed a modern analysis in India between early and late presenters of COVID-19 during the pandemic, an environment which amplified delays in the care pathway. Their findings were clear-cut: early presenters had greatly enhanced visual results (61% with VA ≥6/12) compared to late presenters (32%). This immediately confirms the trend in Yaakub's 2014 study, where presentation timing was the only predictor of outcomes in LIG [23]. The same fact was unambiguously established by another study [24].

Throughout the series of these studies, there are some common themes that are seen. First, phacomorphic glaucoma predominantly constitutes the primary etiology of LIG throughout South and Southeast Asia. Second, delayed presentation still constitutes the primary barrier to the attainment of optimal outcomes, usually determined by socioeconomic considerations, unawareness, and dependency on the unaffected eye. Secondly,

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surgical treatment consistently attains intraocular pressure (IOP) control in the majority of cases; however, visual results are primarily contingent on presentation timing. The range of reported visual recovery throughout studies, ranging from 32% to 65%, also vigorously supports this assertion.

Moreover, meta-regression results from this review show, larger studies have more consistent results, and institutional variables (volume, experience) can therefore balance some of the heterogeneity. However, heterogeneity detected, especially in visual results ($I^2 = 66\%$), emphasizes continued disparities in access, timing of presentation, and quality of care.

Overall, this systematic review provides established long-term clinical wisdom based on extensive local data: early diagnosis and treatment of LIG dramatically improve visual outcomes, while delayed presentations, which are predominately of phacomorphic etiologies, continue to result in irreversible visual loss despite advances in surgical technique. Weaknesses and strengths of the heterogenous studies were listed (see Table 9).

Conclusion

This systematic review and meta-analysis dealt with the important question: How much of an impact does presentation timing have on outcomes in lens-induced glaucoma? The results indicate that although surgery consistently succeeds in intraocular pressure control, visual prognosis is severely compromised by late presentation. This underscores the imperative for the establishment of approaches directed at early detection and early intervention in vulnerable groups.

Future directions include strengthening community-based screening programs and leveraging technology to facilitate earlier diagnosis, particularly in rural settings. Early cataract detection through artificial intelligence and targeted education can bridge this centuries-long chasm. Standardizing clinical outcome definitions in LIG studies will similarly improve comparability and guide global standards. Lastly, bridging delays in care is essential to avoiding avoidable blindness as a result of this overlooked yet potent condition.

Strengths and Limitations

The single most important strength of this study is the thorough and systematic statistical approach utilized, which combines sophisticated descriptive, inferential, and distributional analyses to provide a broad overview of the dataset. The use of multiple statistical analyses enhances the validity and richness of the results on both numerical accuracy and visual beauty by providing a range of analytic perspectives. Some limitations do exist, including geographic clustering of studies primarily in South and Southeast Asia, perhaps limiting the broader generalizability of the results, as well as the intrinsic variability of study designs. Most of the studies included were observational and retrospective in design, one aspect which has high risk of bias and limits the stability of causal inferences on the pooled data.

Declarations

Ethical Approval

Not required since the study conducted was a systematic review and meta-analyses and included the studies selected from 2014-2023.

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Conflicts of Interests

The authors report no conflict of interest.

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Article Category

Systematic review and meta analyses

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