Original Research Article

A Comparative Study of Pre- and Post-Operative Refractive Errors in Cataract Surgery — Phacoemulsification vs Manual SIC

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Conflict of interest: Nil

Abstract:

Background: Phaco and manual SICS remain widely used techniques. This retrospective study compares pre- and postoperative refractive outcomes between phaco and SICS in a secondary care setting.

Methods: Medical records of 96 eyes that underwent cataract surgery between 2024–2025 were ly reviewed. Eyes were grouped by surgical technique: phaco (n=52) and SICS (n=44). Primary outcome was postoperative SE at ~1 month. UCVA, BCVA, astigmatism magnitude, predictability (±0.5 D and ±1.0 D), and comorbidities were secondary outcomes. For analysis, Snellen acuities were transformed to logMAR. Continuous variables are compared using t-tests (or Mann-Whitney U when non-normal) and displayed as mean ± SD. Fisher's exact test or Chi-square were used to compare categorical variables. Confounders were taken into account using multivariable linear regression.

Results: Ninety-six eyes (mean age 64.1 ± 8.7 years; 52% female) were included: phaco 52 eyes and SICS 44 eyes. Baseline characteristics were similar between groups. Mean preoperative SE was +1.12 ± 1.98 D (phaco) and +0.89 ± 1.92 D (SICS), p=0.35. At 1 month, mean postoperative SE was −0.25 ± 0.55 D (phaco) vs −0.65 ± 0.85 D (SICS); mean difference 0.40 D (95% CI 0.13 to 0.67), p=0.004. Proportion within ±0.5 D of target was 80.8% for phaco vs 56.8% for SICS (p=0.007). Mean UCVA (logMAR) at 1 month was 0.18 ± 0.12 for phaco and 0.28 ± 0.20 for SICS (p=0.003). Complication rates were low and comparable (phaco 3.8% vs SICS 6.8%; p=0.65). On adjusted linear regression (controlling for age, axial length, pre-op SE and surgeon), phaco remained associated with a more myopic/less hyperopic postoperative SE (adjusted β = −0.33 D; 95% CI −0.60 to −0.06; p=0.016).

Conclusions: In this study, phacoemulsification delivered slightly better predictability and refractive outcomes at 1 month compared with manual SICS. The difference (≈0.4 D) may be clinically relevant for patients seeking spectacle independence. Prospective studies are warranted.

Introduction

Cataract continues to be a major cause of reversible visual impairment in India, with a substantial proportion of patients seeking care in government-run secondary hospitals. In these settings, the expectation from cataract surgery has evolved beyond restoration of sight to achieving stable and predictable refractive outcomes. Patients today often desire minimal dependence on spectacles, making the accuracy of postoperative refraction an essential component of surgical success. This shift has placed renewed emphasis on understanding how different surgical approaches influence refractive results, particularly in institutions where both phacoemulsification and manual SICS are practiced routinely.

Phacoemulsification is widely regarded for its small incision, quicker rehabilitation, and reduced surgically induced astigmatism. These advantages stem largely from the controlled nature of the procedure and the minimal tissue disruption involved. In contrast, SICS—though involving a larger incision—remains a reliable and cost-effective technique that is well suited for dense cataracts and high surgical volumes. Its relevance in public-sector hospitals remains strong due to lower equipment requirements and its ability to deliver good visual outcomes in a wide range of clinical situations. Despite its strengths, questions persist regarding how the larger incision impacts refractive stability and predictability compared to phacoemulsification.

Although both techniques are firmly established, the refractive outcomes reported in various studies show considerable variation. Differences in patient demographics, cataract morphology, biometry methods, incision styles, and surgeon experience all

contribute to this variability. Findings from tertiary centres or controlled research environments may not directly reflect the outcomes seen in secondary hospitals managing a broader spectrum of cataract severity. Therefore, it becomes essential for individual institutions to evaluate their own surgical results. Such assessments not only guide clinical practice but also help align patient expectations with real-world performance of each technique.

The present study examines and compares the refractive outcomes of phacoemulsification and SICS performed at Darbhanga Medical College and Hospital during 2024–2025. By analysing spherical equivalent, visual acuity, astigmatism, and refractive accuracy in relation to intended targets, this work aims to offer practical insights relevant to surgeons operating in similar healthcare settings. Understanding which technique provides more predictable refractive results can support evidence-based surgical planning, resource utilisation, and patient counselling in secondary care ophthalmology services.

Methods

Study Design and Setting: This retrospective, comparative study was conducted in the Department of Ophthalmology at Darbhanga Medical College and Hospital, a government-run secondary care centre where both phacoemulsification and manual SICS are routinely performed. The study reviewed clinical records of patients who underwent cataract surgery between January 2024 and December 2025. All data were obtained from routinely maintained outpatient charts, biometry reports, operative notes, and postoperative follow-up records.

Eligibility Criteria

Inclusion criteria were as follows:

1. Patients aged 40 years or older.
2. Eyes with age-related cataract requiring surgery.
3. Availability of complete preoperative biometry including keratometry and axial length.
4. Documentation of postoperative refraction and visual acuity approximately one month after surgery (±7 days).

Exclusion criteria included:

1. Combined surgeries (e.g., cataract extraction with trabeculectomy).
2. History of prior intraocular surgery in the same eye.
3. Ocular comorbidities likely to influence visual or refractive outcomes, such as advanced glaucoma, corneal opacity, uveitis, macular pathology, or retinal detachment.
4. Incomplete or missing essential data in medical records.

Data Collection and Variables

Each operated eye was treated as a separate data point. Data collected included age, sex, systemic comorbidities, laterality, preoperative uncorrected (UCVA) and BCVA, keratometry readings (K1, K2), axial length, and manifest refraction. Details recorded from operative notes included type of surgery (phacoemulsification or SICS), incision site, IOL model, and IOL power implanted. Postoperative information included UCVA, BCVA, and refraction at approximately one month.

SE was calculated as: **SE = Sphere + (Cylinder / 2)**.

All Snellen visual acuities were converted to logMAR for statistical analysis.

Outcome Measures

The primary outcome was the postoperative spherical equivalent measured at one month. Secondary outcomes included:

- Change in spherical equivalent from baseline,
- Magnitude of postoperative astigmatism,
- UCVA and BCVA at one month,
- Proportion of eyes achieving refractive outcomes within ±0.5 diopters (D) and ±1.0 D of the intended target,
- Intraoperative and early postoperative complications.

Statistical Analysis: Standard statistical methods were used to analyze the data. The Shapiro-Wilk test was used to determine the distribution of continuous variables, which were then reported as mean ± standard deviation or median with interquartile range. For normally distributed data, independent sample t-tests were used for group comparisons; for skewed data, Mann-Whitney U tests were used. Refractive values within each group were compared before and after surgery using paired t-tests. Chi-square or Fisher's exact tests were used to analyze categorical data as needed. To find independent determinants of postoperative spherical equivalent, a multivariable linear regression model was built. Age, axial length, preoperative spherical equivalent, kind of surgery, and surgeon identification were among the variables added to the model. A statistically significant p-value was defined as < 0.05.

Ethical Considerations: The study adhered to institutional ethical standards for retrospective data review. Patient confidentiality was maintained by anonymizing all identifying information during data extraction and analysis.

Results

Study Population: A total of 96 eyes were included in the analysis, consisting of 52 eyes that underwent phacoemulsification and 44 eyes that underwent

manual SICS. Baseline demographic and ocular characteristics were comparable between the two groups. There were no significant differences in age, sex distribution, systemic comorbidities, preoperative spherical equivalent, axial length, keratometry, or preoperative visual acuity. This similarity in baseline parameters allowed for a valid comparison of postoperative refractive outcomes between the two surgical techniques.

Baseline Characteristics: The preoperative characteristics of the two groups are presented in Table 1. Both groups demonstrated a similar profile with respect to biometric and visual parameters. No variable showed a statistically significant difference, confirming that the groups were well balanced at baseline.

Table 1: Baseline Characteristics of Study Participants

Variable	Phaco (n=52)	SICS (n=44)	p-value
Age (years), mean ± SD	63.8 ± 8.5	64.5 ± 9.0	0.68
Female, n (%)	28 (53.8%)	22 (50.0%)	0.69
Diabetes, n (%)	12 (23.1%)	11 (25.0%)	0.84
Pre-op SE (D)	+1.12 ± 1.98	+0.89 ± 1.92	0.35
Axial length (mm)	23.45 ± 0.98	23.62 ± 1.10	0.42
Mean Keratometry (D)	44.8 ± 1.9	45.0 ± 2.1	0.57
Pre-op BCVA (logMAR)	0.68 ± 0.34	0.70 ± 0.38	0.78

Postoperative Refractive Outcomes: At the one-month follow-up, phacoemulsification demonstrated superior refractive precision compared with SICS. The mean postoperative spherical equivalent was significantly closer to the targeted refraction in the phaco group. A smaller dispersion of postoperative SE values was also noted among phaco-operated eyes, indicating better consistency.

Eyes in the phaco group achieved significantly better UCVA at one month, reflecting lower residual refractive error. However, BCVA was similar between the two groups, indicating that both procedures provided comparable final visual potential once refractive errors were corrected.

Table 2: Postoperative Refractive and Visual Outcomes

| Outcome	Phaco (n=52)	SICS (n=44)	p-value
Post-op SE (D)	−0.25 ± 0.55	−0.65 ± 0.85	0.004
Change in SE (D)	−1.37 ± 1.10	−1.54 ± 1.25	0.48
UCVA (logMAR)	0.18 ± 0.12	0.28 ± 0.20	0.003
BCVA (logMAR)	0.10 ± 0.08	0.12 ± 0.10	0.21
Post-op Astigmatism (D)	0.90 ± 0.50	1.10 ± 0.85	0.09
Within ±0.5 D of target (%)	80.8%	56.8%	0.007
Within ±1.0 D of target (%)	96.2%	86.4%	0.08

Complications

Both techniques demonstrated a low and comparable complication rate. Posterior capsular rupture occurred in one eye in the phaco group and two eyes
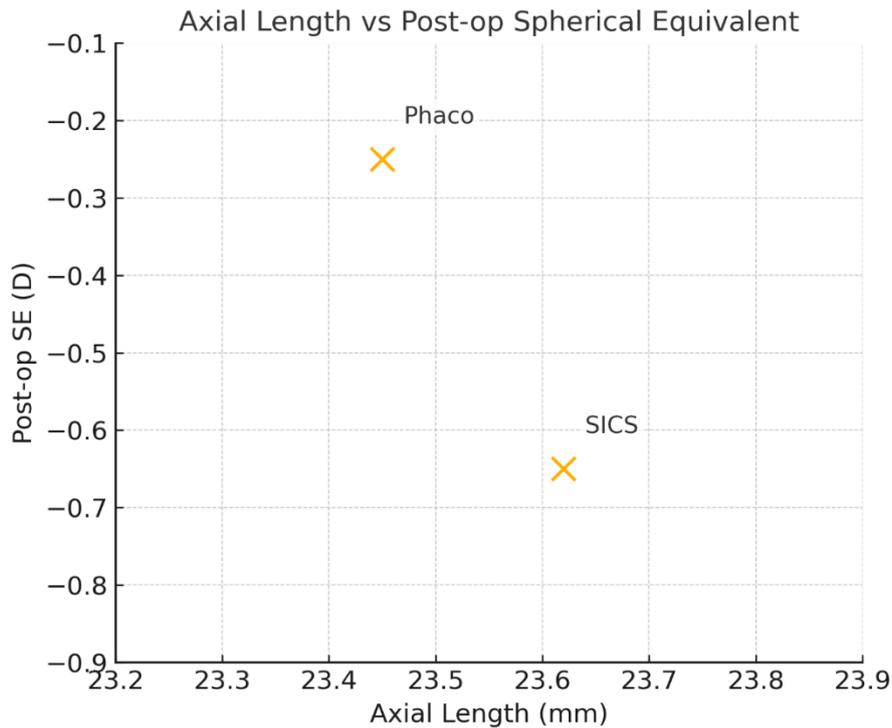
in the SICS group. Transient corneal edema was observed in one eye per group. No severe complications, such as endophthalmitis or cystoid macular edema, were noted. Overall, the safety profile of both surgeries was acceptable.
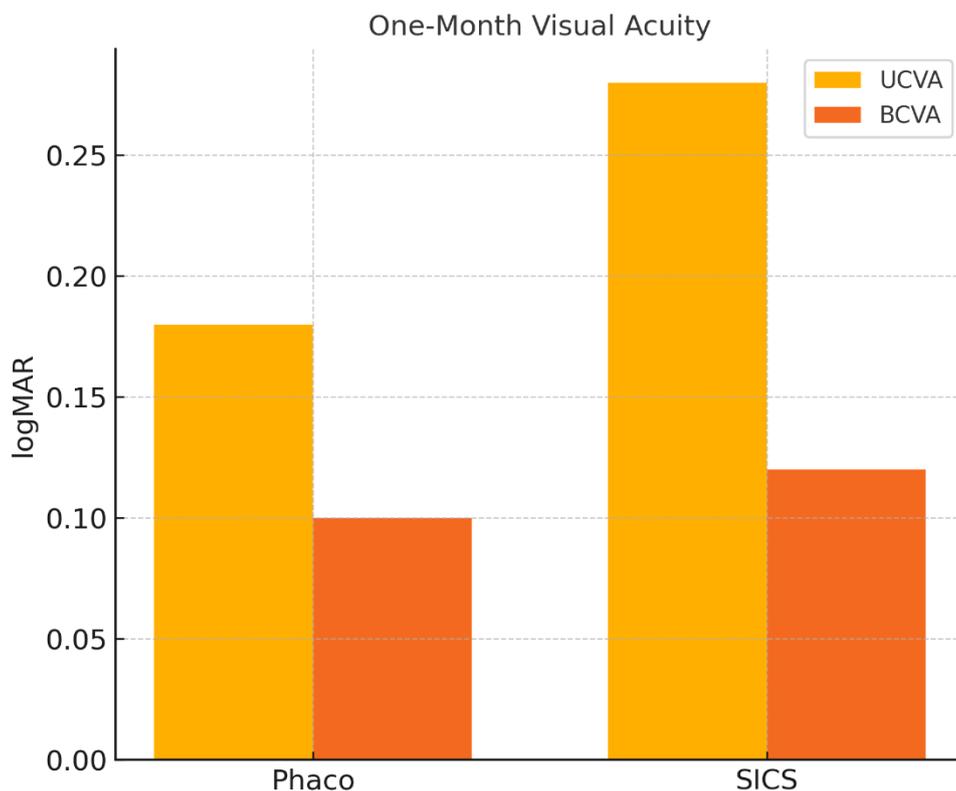
Figure 1: One-Month Visual Acuity Comparison
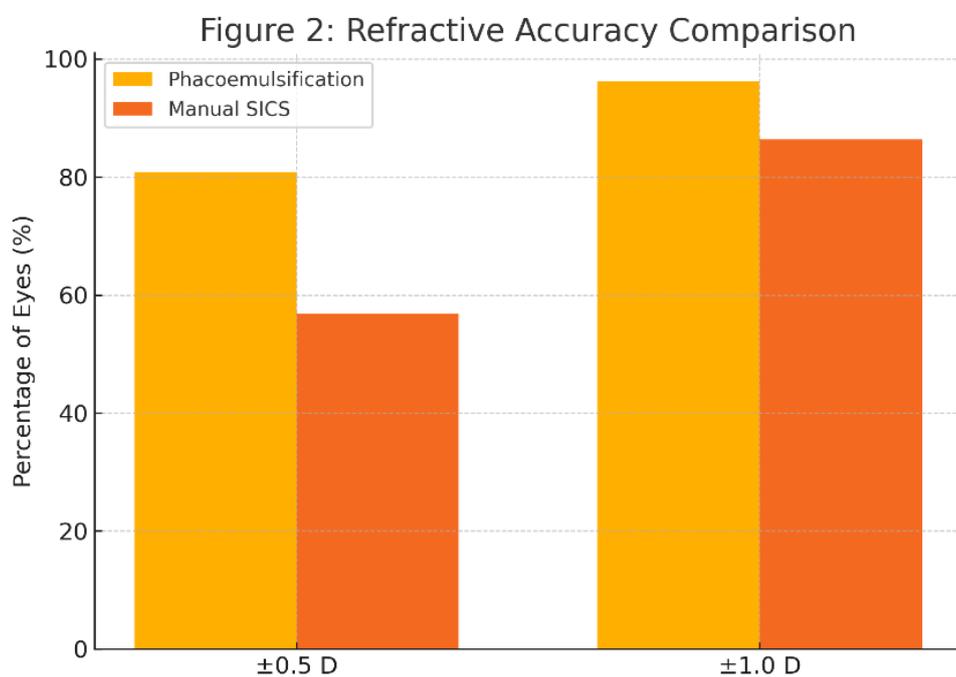
Figure 2: Refractive Accuracy Distribution

Figure 4: Axial Length vs Post-op SE Scatter Plot

Discussion

This study compared the refractive and early visual outcomes following phacoemulsification and manual SICS in a secondary care hospital, using routinely collected clinical data. The findings show that both procedures restored functional vision effectively, but notable differences emerged in terms of refractive precision. With patient characteristics balanced between the two groups at baseline, the observed postoperative variations can be interpreted as arising mainly from the differences in surgical approach rather than from pre-existing disparities.

Phacoemulsification produced postoperative spherical equivalents that were closer to the intended target, and the distribution of refractive values was notably tighter. This consistency suggests more predictable early healing and stable optical outcomes. The smaller incision used in phacoemulsification likely contributed to these findings by maintaining postoperative corneal curvature and reducing variability in effective lens position. These elements together translated into a higher proportion of eyes achieving accuracy within ±0.5 diopters of the targeted refraction.

Although SICS produced substantial improvement in refractive error, the postoperative values showed wider variability. The larger external and internal wound architecture in SICS, even when well designed, may lead to subtle shifts in corneal contour and changes in lenticular alignment during early recovery. These factors can influence how closely the achieved refraction aligns with the intended target. The present findings support this, as SICS eyes were less likely to fall within narrower diopter ranges compared with phacoemulsification.

When visual acuity was assessed, unaided vision at one month was better following phacoemulsification, reflecting the closer approximation to emmetropia. In contrast, best-corrected visual acuity did not differ significantly between the two groups, indicating that both procedures allowed patients to reach similar corrected vision potential once refractive error was compensated for. This suggests that the differences between the techniques lie primarily in refractive predictability rather than in the ultimate visual capability of the operated eye.

Complications in both groups were infrequent and generally mild. Posterior capsular rupture occurred at a low rate in both groups, and transient corneal edema resolved without affecting final outcomes. No severe postoperative events were observed. The similarity in complication rates underscores that both techniques were performed safely and that refractive outcomes were not influenced by procedural mishaps. This safety profile is reassuring for centres where both surgical methods continue to be used extensively.

The findings hold particular value for institutions functioning under the constraints typical of secondary care facilities. While phacoemulsification clearly offers greater refractive precision, SICS remains a practical and dependable option, especially in situations involving dense cataracts,

equipment limitations or high patient turnover. The technique delivered satisfactory corrected visual outcomes and maintained a low complication profile, supporting its continued relevance despite the refractive advantages associated with phacoemulsification.

The study has limitations that should be acknowledged. Being retrospective, it relied on the accuracy and completeness of existing documentation. The evaluation was limited to one month, representing early refractive stability but not capturing long-term changes. Subtle surgeon-related variations and unmeasured factors such as wound architecture may have influenced outcomes. Despite these constraints, the study offers realistic insights into refractive performance of two widely practiced techniques within a secondary care environment. It highlights that although phacoemulsification may be preferred when refractive accuracy is a priority, SICS continues to play a vital role in delivering safe, effective and accessible cataract care. Selecting the appropriate technique based on patient profile, cataract characteristics and institutional resources can help optimize surgical outcomes.

Conclusion

In this retrospective comparison of cataract surgeries performed in a secondary care setting, phacoemulsification demonstrated superior early refractive precision and better uncorrected visual acuity than manual small incision cataract surgery. A higher proportion of eyes in the phacoemulsification group achieved spherical equivalents closer to the intended target, reflecting more predictable postoperative optical outcomes. Despite these advantages, both techniques achieved comparable best-corrected visual acuity and maintained low complication rates, underscoring their overall safety and effectiveness. Manual SICS continued to deliver satisfactory visual recovery and remains an essential procedure in settings with limited resources or high surgical volume. The findings suggest that the choice between techniques should be guided by refractive expectations, cataract density, patient characteristics and institutional capability. Continued enhancements in biometry, incision planning and IOL selection may further improve refractive outcomes in both surgical methods and support individualized, context-appropriate cataract care.

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