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Research Article

Compare Pre- and Post-Operative Refractive Errors in Patients Undergoing Cataract Surgery via Phacoemulsification (PHACO) Versus Manual Small Incision Cataract Surgery (SICS)

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Abstract

Purpose: To compare pre- and post-operative refractive errors in patients undergoing cataract surgery via phacoemulsification (PHACO) versus manual small incision cataract surgery (SICS). **Methods:** A prospective comparative study was conducted on 48 patients (24 in each group) with senile cataracts. Pre-operative and post-operative (at 6 weeks) refractive errors were assessed. Statistical analysis was performed using paired and unpaired t-tests. **Results:** The mean pre-operative spherical equivalent (SE) was comparable between groups (PHACO: -0.75 ± 1.25 D vs. SICS: -0.82 ± 1.30 D, p=0.85). Post-operatively, PHACO showed better refractive outcomes (SE: -0.25 ± 0.50 D) compared to SICS (SE: -0.65 ± 0.75 D) (p=0.02). Astigmatism was significantly lower in the PHACO group (0.50 ± 0.25 D vs. 1.25 ± 0.50 D, p<0.01). **Conclusion:** PHACO provides superior refractive outcomes with less post-operative astigmatism compared to manual SICS.

Keywords: Cataract surgery, Phacoemulsification, Manual SICS, Refractive error, Astigmatism

INTRODUCTION

Cataract remains the leading cause of reversible blindness worldwide, with surgery being the only definitive treatment.[1] Over the years, cataract surgical techniques have evolved from conventional extracapsular cataract extraction (ECCE) to more advanced methods such as **phacoemulsification (PHACO)** and **manual small incision cataract surgery (SICS)**. While PHACO is considered the gold standard in developed nations due to its precision and rapid recovery, SICS remains widely practiced in resource-limited settings because of its cost-effectiveness and minimal instrumentation requirements.[2]

The primary goal of modern cataract surgery is not just the removal of the opaque lens but also the restoration of optimal visual function with minimal refractive error. Post-operative refractive outcomes are influenced by multiple factors, including surgical technique, incision size and location, intraocular lens (IOL) power calculation accuracy, and wound healing.[3] **PHACO**, with its smaller (2.2–3.0 mm) corneal or limbal incision, typically induces less surgically related astigmatism compared to **SICS**, which involves a larger (5.5–6.5 mm) sclero-corneal tunnel incision.[4] However, SICS offers advantages in dense cataracts and settings where expensive phaco machines are unavailable.[5]

Several studies have compared visual outcomes between PHACO and SICS,[6,7] but there remains a need for more focused research on **pre- and post-operative refractive errors**, particularly in populations with varying cataract densities and surgical expertise. Understanding these differences can help surgeons select the most appropriate technique based on patient needs and available resources.[8]

This study aims to **compare pre-operative and post-operative refractive errors**—including spherical equivalent and induced astigmatism—between PHACO and manual SICS in a controlled sample of 48 patients. The findings may contribute to evidence-based decision-making in cataract surgical planning, particularly in regions where both techniques are in practice.

METHODOLOGY

Research Design

Prospective comparative study interventional study was conducted at the department of Ophthalmology (RIO), Indira Gandhi Institute of Medical Sciences, Patna, from April 2019-March 2020.

Inclusion Criteria:

- Age-related cataract (LOCS III classification: NO2–NC4, C2–C5, P2–P4).
- Best-corrected visual acuity (BCVA) ≤6/18 due to cataract.
- No other visually significant ocular pathology (e.g., macular degeneration, advanced glaucoma).

Exclusion Criteria:

- Previous ocular surgery (e.g., trabeculectomy, vitrectomy).
- Corneal opacity or irregular astigmatism.
- Intraoperative complications (e.g., posterior capsular rupture) requiring exclusion.

Sample Size Calculation

- **Formula:** Based on comparing two means (refractive error difference) with:
  - **Assuming Effect size (d):** 0.8
  - **Power (1-β):** 80%
  - **Significance level (α):** 0.05
- **Calculated sample size:** 24 per group (total $N = 48$) using G*Power software.

Procedure for Data Collection

- **Pre-operative:**

1. Comprehensive ophthalmic examination (slit-lamp, fundoscopy).
2. Autorefraction (Topcon KR-800) and keratometry.
3. Biometry (IOLMaster 700) for IOL power calculation.

- **Intraoperative:**
  Standardized surgical protocols for PHACO (2.8 mm incision) and SICS (6.0 mm scleral tunnel).
- **Post-operative:**

1. Refractive assessment at **6 weeks** using autorefractor/keratometer.
2. Documentation of complications (e.g., corneal edema, posterior capsular opacification).

Statistical Analysis:

SPSS v26.0 for: Descriptive statistics (mean ± SD). Paired t-test (pre- vs. post-op within groups). Independent t-test (PHACO vs. SICS). $p < 0.05$ considered significant.

RESULTS

Table 1: Baseline Demographic and Pre-Operative Characteristics

Parameter	PHACO (n=24)	SICS (n=24)	p-value
Age (years), Mean ± SD	65.2 ± 8.5	67.3 ± 7.8	0.36
Gender (Male:Female)	14:10	12:12	0.78
Pre-op BCVA (LogMAR)	0.82 ± 0.25	0.85 ± 0.30	0.71
Axial Length (mm)	23.5 ± 1.2	23.3 ± 1.1	0.55
Pre-op SE (D), Mean ± SD	-0.75 ± 1.25	-0.82 ± 1.30	0.85
Pre-op Astigmatism (D)	1.00 ± 0.50	1.10 ± 0.60	0.72

The study outcomes are presented across four key tables summarizing demographic, refractive, and safety data. Table 1 demonstrates comparable baseline characteristics between groups, with no significant differences in age (PHACO: 65.2±8.5 vs SICS: 67.3±7.8 years, p=0.36), gender distribution (p=0.78), or preoperative visual parameters including spherical equivalent (-0.75±1.25D vs -0.82±1.30D, p=0.85) and astigmatism (1.00±0.50D vs 1.10±0.60D, p=0.72).

Table 2: Post-Operative Refractive Outcomes at 6 Weeks

Parameter	PHACO (n=24)	SICS (n=24)	p-value
Post-op SE (D), Mean ± SD	-0.25 ± 0.50	-0.65 ± 0.75	**0.02**
Induced Astigmatism (D)	0.50 ± 0.25	1.25 ± 0.50	**<0.01**
UCVA (LogMAR)	0.20 ± 0.10	0.35 ± 0.15	**0.01**
BCVA (LogMAR)	0.10 ± 0.05	0.15 ± 0.08	0.06

Postoperative refractive outcomes in Table 2 revealed superior results in the PHACO group, with significantly better spherical equivalent (-0.25±0.50D vs -0.65±0.75D, p=0.02) and lower induced astigmatism (0.50±0.25D vs 1.25±0.50D, p<0.01) at 6 weeks.

Table 3: Comparison of Refractive Error Changes (Pre- vs. Post-Op)

Group	Pre-op SE (D)	Post-op SE (D)	Mean Change (D)	p-value
PHACO	-0.75 ± 1.25	-0.25 ± 0.50	+0.50	**0.01**
SICS	-0.82 ± 1.30	-0.65 ± 0.75	+0.17	0.18

Table 3 highlights the magnitude of refractive improvement, showing PHACO achieved a clinically meaningful +0.50D reduction in spherical error (p=0.01) versus minimal change in SICS (+0.17D, p=0.18).

Table 4: Post-Operative Complications

Complication	PHACO (n=24)	SICS (n=24)	p-value
Corneal Edema	2 (8.3%)	5 (20.8%)	0.25
PCO	1 (4.2%)	3 (12.5%)	0.30
IOL Decentration	0 (0%)	1 (4.2%)	0.31

Safety outcomes in Table 4 indicate numerically higher but statistically comparable complication rates in SICS, including corneal edema (20.8% vs 8.3%) and posterior capsular opacification (12.5% vs 4.2%), though no sight-threatening events occurred in either group.

DISCUSSION

The present study compared refractive outcomes between phacoemulsification (PHACO) and manual small incision cataract surgery (SICS) in 48 patients with senile cataracts. Our key findings demonstrate that PHACO provides superior refractive accuracy with significantly less postoperative astigmatism compared to SICS, supporting its status as the gold standard technique where resources permit.[9] The mean postoperative spherical equivalent in the PHACO group (-0.25 ± 0.50 D) was closer to emmetropia than in the SICS group (-0.65 ± 0.75 D), with this 0.40 D difference being both statistically (p=0.02) and clinically significant for visual quality.[10]

The astigmatic outcomes merit particular attention. PHACO induced just 0.50 D of astigmatism versus 1.25 D with SICS ($p<0.01$), consistent with biomechanical advantages of smaller incisions.[11] Our results align with Ruit et al.,[12] who reported 0.75 D less astigmatism with PHACO, though contrast with Gogate et al.[13] who found comparable outcomes in experienced hands. This discrepancy may reflect our standardized superior scleral tunnel approach in SICS versus temporal clear corneal PHACO incisions, known to minimize astigmatism.[14]

Several factors likely contributed to PHACO's superior refractive outcomes. First, the smaller incision size (2.8 mm vs 6.0 mm) reduces corneal flattening and wound healing variability.[15] Second, improved IOL positioning with foldable lenses versus rigid PMMA IOLs may enhance effective lens position accuracy.[7]

Our complication rates, though statistically comparable, showed a trend toward higher corneal edema (20.8% vs 8.3%) and PCO (12.5% vs 4.2%) with SICS. These findings reinforce PHACO's safety profile while acknowledging SICS remains valuable in resource-limited settings. Notably, no vision-threatening complications occurred in either group, supporting both techniques' overall safety when performed by trained surgeons.

Study limitations include the modest sample size (n=48) and single-center design, which may affect generalizability. Additionally, our 6-week follow-up captures early but not long-term refractive stability. Future studies could benefit from larger, multicenter designs with longer observation periods and corneal topography to better characterize astigmatic changes.

CONCLUSION

In conclusion, while both techniques effectively restore vision, PHACO demonstrates superior refractive precision with less induced astigmatism. These findings support its preferential use where infrastructure permits, though SICS remains an important alternative in resource-constrained environments. Surgical training programs should emphasize incision construction and wound architecture to optimize outcomes with both methods.

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