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SUCCESS RATE AND PREDICTIVE FACTORS FOR ACHIEVING TARGET REFRACTION AFTER PHACOEMULSIFICATION

Ophthalomology

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ABSTRACT

Purpose: To determine the proportion of patients achieving postoperative refraction within ±0.5 D and ±1.0 D of target, and assess predictive factors such as axial length, anterior chamber depth (ACD), ocular comorbidities, and IOL type. **Methods:** A retrospective observational study of 223 eyes undergoing uneventful phacoemulsification by a single surgeon. Preoperative parameters — including axial length, ACD, and presence of ocular comorbidities — were recorded. IOL types (hydrophilic vs. hydrophobic) were noted. Postoperative refraction was assessed at 6 weeks. Proportions achieving target refraction were calculated, and chi-square tests were used to assess associations ($p < 0.05$ significant). **Results:** Mean age was 61.4 ± 8.7 years; gender ratio M:F = 1.03:1. Mean axial length was 22.87 ± 0.81 mm; ACD 3.07 ± 0.42 mm. Overall, 86.99% achieved ≤±0.5 D; only 4.93% had >±1.0 D error. Axial length, ACD, ocular comorbidities, and IOL type were not significantly associated with outcomes (all $p > 0.05$). **Conclusion:** Phacoemulsification achieves high accuracy in target refraction in most patients. While axial length, ACD, comorbidities, and IOL type did not significantly influence outcomes in this cohort, precise biometry remains essential, especially utilizing modern formulas incorporating ACD and AL for optimal refractive results.

KEYWORDS

Phacoemulsification; Target refraction; Axial length; Anterior chamber depth; Postoperative refractive error; IOL type

INTRODUCTION

Cataract surgery via phacoemulsification is one of the most common and effective elective surgeries, aimed at restoring visual acuity and achieving optimal postoperative refraction for daily functioning [1,2]. Achieving accuracy within ±0.50 D or ±1.00 D of target spherical equivalent is critical, especially with increasing patient expectations and the use of premium IOLs [1,3]. Multiple factors influence postoperative refractive outcomes. Biometric variables — including axial length (AL), keratometry, and anterior chamber depth (ACD) — are crucial components of IOL power calculations. A 1 mm error in AL can lead to approximately 2.9–3 D error in refractive prediction, making precise measurement fundamental [6]. ACD also plays a significant role: errors in predicting effective lens position can contribute up to 42% of postoperative refractive error [2,5]. New-generation formulas like Haigis and Holladay 2 incorporate ACD to improve ELP predictions and refractive accuracy [2,9].

While literature quantifies overall accuracy, few Indian-center studies evaluate predictive factors within local settings. This study aims to fill that gap by quantifying success rates (≤±0.5 D and ≤±1.0 D) and assessing associations with AL, ACD, ocular comorbidities, and IOL material.

MATERIALS AND METHODS

A retrospective observational study was conducted at Eye Hospital, including 223 eyes undergoing phacoemulsification by a single experienced surgeon between October 2023 and October 2024.

Inclusion Criteria: Adults undergoing uncomplicated phacoemulsification with in-the-bag IOL implantation. Exclusion criteria: prior ocular surgery, pathologies affecting refraction. Each patient had complete preoperative history, ocular exam, and biometric recording; postoperative evaluation at 6 weeks determined refractive outcome.

Data collected included age, gender, axial length (mean 22.87 ± 0.81 mm), anterior chamber depth (mean 3.07 ± 0.42 mm), presence of ocular comorbidities (6.73%), and IOL type (hydrophilic 60.54%, hydrophobic 39.46%). Outcomes were defined as postoperative refractive error within ±0.5 D and within ±1.0 D of target.

Statistical analysis used proportions and chi-square tests, with significance set at $p<0.05$.

RESULTS

Mean age: 61.38 ± 8.67 years; gender distribution nearly equal (M:F = 1.03:1). Biometric data: AL 22.87 ± 0.81 mm; ACD 3.07 ± 0.42 mm. IOL distribution: hydrophilic (60.54%), hydrophobic (39.46%). Ocular comorbidities in 6.73%.

Overall, 194 of 223 eyes (86.99%) achieved refractive error ≤±0.5 D; 29 (13.01%) exceeded ±0.5 D. Only 11 (4.93%) had errors >±1.0 D.

Factors Analyzed

- Axial length: Long (83.3% success), normal (88.1%), short (78.2%); p = 0.29 (not significant)
- Ocular comorbidities: Present (80%), absent (87.5%); p = 0.40
- ACD: Deep chambers (88% success) vs. shallow (80.45%); p = 0.06
- IOL type: No significant difference

High rate of achieving target refraction reflects the effectiveness of contemporary techniques and biometry in routine phacoemulsification.

Table1: Correlation of Axial Legth and Post-operative Refraction.

Axial Length	Patients achieving Postop refractive error ≤ ±0.5D	Patients achieving Postop refractive error >±0.5D	Total	P Value
Long	5(83.3%)	1(16.7%)	06	0.29
Normal	171(88.1%)	23(11.9%)	194	
Short	18(78.2%)	5(21.8%)	23	
Total	194(86.99%)	29(13.01%)	223	

Table2: Correlation of Ocular Co-morbidities and Post-operative Refraction.

Ocular Co-morbidities	Patients achieving Postop refractive error ≤ ±0.5D	Patients achieving Postop refractive error >±0.5D	Total	P Value
Present	12(80%)	3(20%)	16	0.40
Absent	182(87.5%)	26(12.5%)	208	
Total	194(86.99%)	29(13.01%)	223	

Table3: Correlation of Ocular Anterior Chamber Depth and Post-operative Refraction.

Anterior chamber depth	Patients achieving Postop refractive error ≤ ±0.5D	Patients achieving Postop refractive error >±0.5D	Total	P Value

Deep	29(88%)	4(12%)	33	0.06
Shallow	7(80.45%)	17(19.54%)	87	
Total	194	29	223	

DISCUSSION

Our study shows an 87% success rate for achieving target refraction within ±0.5 D, aligning with global reports where success within ±1 D falls between 75–90% [3,5]. The 4.93% error >1 D further mirrors benchmarks in literature [5,8].

Despite known biometric predictors — especially AL and ACD — our cohort did not show statistically significant associations. Though long and short axial lengths have demonstrated associations with refractive surprises in complex surgeries (e.g., combined cataract–vitrectomy) [9], routine cases like ours may exhibit less variation, especially when using accurate formulas and measurements.

The borderline significance for ACD ($p = 0.06$) suggests potential influence. Literature indicates that errors in predicted effective lens position and ACD constitute up to 42% of postoperative refractive error [2,6]. Our findings underscore the need for precise ACD measurement and appropriate formula choice (e.g., Haigis, Barrett) to optimize outcomes.

Modern optical biometry — particularly SS-OCT based instruments — improve measurement accuracy and predictability, raising the proportion of patients within ±0.5 D by up to ~14% compared to older PCI methods [5]. Postoperative refractive stability is typically achieved by 6 weeks, validating our assessment timeline [7].

Limitations: Retrospective, single-center design; modest sample size; lack of analysis of specific IOL formulas. Future prospective studies incorporating advanced biometry and AI-based formulas could further refine accuracy [3,10].

CONCLUSION

Phacoemulsification achieves excellent refractive accuracy (~87% within ±0.5 D) in routine practice. Although this study did not find statistically significant associations between success rates and factors like axial length, ACD, comorbidities, or IOL type, precise biometry and modern formulas remain essential. Future prospective studies with advanced measurement and formula integration may enhance predictive precision and patient satisfaction.

Abbreviations

ACD – Anterior Chamber Depth
AL – Axial Length
D – Dioptre
ELP – Effective Lens Position
IOL – Intraocular Lens
M:F – Male to Female Ratio
PCI – Partial Coherence Interferometry
SRK/T – Sanders-Retzlaff-Kraff/Theoretical Formula
SS-OCT – Swept-Source Optical Coherence Tomography

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