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ORIGINAL RESEARCH

Incremental Predictive Value of Preoperative Macular Optical Coherence Tomography for Postoperative Visual Acuity After Phacoemulsification Cataract Surgery: A Retrospective Cohort Study

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Background: Occult macular pathology may limit visual recovery after cataract surgery but can remain undetected on routine clinical examination due to media opacity. Preoperative macular optical coherence tomography (OCT) improves detection of such abnormalities; however, its incremental prognostic value beyond routinely available clinical predictors remains uncertain. This study evaluated whether preoperative macular OCT provides additional predictive information for early (30–120 day) postoperative visual acuity after phacoemulsification cataract surgery.

Methods: This retrospective cohort study included consecutive eyes undergoing phacoemulsification for nuclear cataract at a tertiary eye hospital in Saudi Arabia between April 2023 and April 2025. Eligible eyes had documented preoperative and postoperative best-corrected visual acuity (BCVA) and a preoperative macular OCT scan of adequate quality. The primary outcome was postoperative BCVA measured within 30–120 days after surgery. Multivariable analysis of covariance was used to identify predictors of postoperative BCVA. Incremental predictive value of OCT variables was assessed by comparing a base clinical model with an OCT-augmented model using changes in the coefficient of determination (R^2), Akaike information criterion (AIC), and nested *F*-tests. Cluster-robust standard errors were applied to account for correlation between eyes from the same patient.

Results: A total of 177 eyes were included, of which 57 (32%) demonstrated macular pathology on preoperative OCT. Eyes with macular pathology had worse preoperative BCVA but similar postoperative BCVA compared with eyes without pathology. In multivariable analysis, poorer preoperative BCVA ($\beta = 0.224$; $P = 0.039$) and older age ($\beta = 0.090$ per 10-year increase; $P = 0.004$) were independently associated with worse postoperative BCVA, whereas macular pathology was not. Adding OCT variables increased the model R^2 from 0.296 to 0.325 ($\Delta R^2 = 0.029$; $P = 0.029$), indicating a statistically significant but modest improvement in predictive performance.

Conclusion: Preoperative BCVA and age were the primary predictors of early postoperative visual acuity after phacoemulsification cataract surgery. Although macular OCT detected abnormalities in nearly one-third of eyes and provided a statistically significant improvement in predictive performance, the magnitude of this gain was modest, suggesting limited additional value for short-term visual outcome prediction beyond standard clinical factors.

Keywords: cataract surgery, optical coherence tomography, visual acuity, macular pathology, prognostic modeling

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Background

Cataract remains the leading cause of reversible blindness worldwide and continues to represent a major public health burden despite advances in surgical techniques.[1] The global cataract surgical rate (CSR) varies markedly across regions, ranging from approximately 36 to 12,800 surgeries per million population per year.[2] In many low- and middle-income countries, the average cataract surgical coverage (CSC) remains around 50% or lower, reflecting ongoing barriers to access, surgical capacity, and postoperative outcome optimization.[2] Even in regions with high surgical volume, variability in postoperative visual outcomes persists, emphasizing the importance of accurate preoperative assessment and prognostication.[3]

Modern phacoemulsification generally produces excellent visual results; however, postoperative visual acuity is influenced by coexisting macular disease that may be clinically occult prior to surgery.[4,5] Media opacity from cataract can obscure subtle macular pathology during slit-lamp biomicroscopy and fundus examination, leading to undetected conditions that limit visual recovery.[4] Spectral-domain optical coherence tomography (SD-OCT) has therefore gained increasing attention as a preoperative tool for identifying macular abnormalities that are not apparent on clinical examination.[6]

Evidence from multiple international studies demonstrates that occult macular pathology is common among cataract surgery candidates. Reported prevalence varies widely by population and methodology, ranging from as low as 4.6% in Australian cohorts to over 40% in studies from Germany.[7,8] Large-scale studies from China and Spain have reported intermediate prevalence rates of approximately 19 to 25%.[9,10] Importantly, a subset of these findings is visually significant. For example, visually significant macular pathology has been reported in 12.4% of eyes in Germany, indicating potential impact on postoperative visual outcomes and patient expectations.[8]

Across studies, advanced age consistently emerges as a major risk factor for occult macular pathology, with additional associations reported for diabetes mellitus, hypertension, myopia, smoking, and cardiovascular disease.[11] These findings suggest that reliance on clinical examination alone may be insufficient, particularly in higher-risk populations. Regional data from the Middle East and South Asia further confirm that between 10 and 22% of cataract candidates harbor occult macular disease, with approximately 5 to 7% demonstrating pathology likely to be visually significant.[5,12]

Despite robust evidence supporting the diagnostic yield of preoperative OCT for detecting occult macular abnormalities, its incremental prognostic value for postoperative visual acuity remains less clearly defined. Importantly, the detection of structural macular abnormalities does not necessarily translate into meaningful differences in postoperative visual recovery when established clinical predictors are already considered. While several studies have reported reduced visual gains in eyes with macular pathology, demographic and clinical variables such as age and preoperative best-corrected visual acuity have consistently demonstrated stronger associations with postoperative outcomes.[5,12] In addition to its diagnostic role, preoperative OCT has increasingly been incorporated into predictive modeling frameworks aimed at estimating postoperative visual outcomes. Prior studies have demonstrated that combining OCT-derived structural parameters with clinical variables can improve prediction of postoperative visual acuity, although the magnitude of this improvement is often modest and context-dependent.[13,14] These findings suggest that OCT contributes incremental rather than dominant prognostic information when established clinical predictors are already considered.

Distinguishing between the diagnostic capability of OCT and its incremental prognostic contribution is clinically important, as preoperative OCT may influence patient counseling, intraocular lens selection, and surgical planning even when its additional predictive value for postoperative visual acuity is modest.[15] From a clinical perspective, OCT findings may inform risk stratification, guide intraocular lens selection, and help align patient expectations with anticipated visual outcomes.[15] However, given considerations related to cost-effectiveness and clinical workflow, the value of routine versus selective use of preoperative OCT remains an area of ongoing debate. Notably, no prior studies from Saudi Arabia have evaluated the incremental prognostic contribution of preoperative macular OCT in patients undergoing phacoemulsification for nuclear cataract, underscoring the relevance of the present investigation.

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Methods

Study Design and Ethical Approval

This retrospective cohort study included consecutive eyes that underwent phacoemulsification with intraocular lens implantation for nuclear cataract at a tertiary eye hospital in Saudi Arabia between April 1, 2023, and April 1, 2025. This study was conducted in accordance with the tenets of the Declaration of Helsinki and was approved by the Institutional Review Board of Imam Abdulrahman Bin Faisal University (IRB-2024-01-915). Given the retrospective nature of the study and the use of de-identified data, the requirement for informed consent was waived.

Study Population

Eligible eyes met all of the following criteria: (1) cataract surgery performed for nuclear cataract as the primary indication; (2) availability of preoperative and postoperative best-corrected visual acuity (BCVA); and (3) availability of a preoperative macular OCT scan with central subfield thickness (CST) measurement. Patients were aged 18 to 95 years at the time of surgery.

Eyes were excluded if any of the following were present: OCT signal strength <6/10; postoperative assessment outside the prespecified follow-up window of 30–120 days; combined intraocular procedures at the time of cataract surgery (eg, glaucoma surgery or pars plana vitrectomy); or incomplete clinical or imaging data. When both eyes of a patient met eligibility criteria, both were included in the analysis.

Data Collection

Demographic, systemic, ocular, and surgical data were extracted from electronic medical records. Collected variables included age, sex, eye laterality, cataract type, and cataract severity graded using the Lens Opacities Classification System III (LOCS III). Systemic comorbidities recorded were diabetes mellitus, hypertension, dyslipidemia, ischemic heart disease, and chronic kidney disease.

Visual Acuity Assessment

Preoperative and postoperative BCVA were measured using standard clinical protocols and recorded in Snellen notation, then converted to logarithm of the minimum angle of resolution (logMAR) units for analysis. Qualitative visual acuity measurements were converted using established conventions: counting fingers (1.9 logMAR), hand motion (2.3 logMAR), light perception (2.7 logMAR), and no light perception (4.0 logMAR). The postoperative BCVA was defined as the measurement obtained at the first clinic visit within the 30–120 day postoperative interval.

Optical Coherence Tomography Acquisition and Definitions

All eyes underwent preoperative macular OCT imaging using a spectral-domain OCT system as part of routine clinical evaluation. OCT signal strength was recorded on a 0–10 scale, and scans with signal strength <6 were excluded to ensure adequate image quality.

Central subfield thickness (CST) was extracted from OCT reports. The presence of any macular pathology was determined based on OCT interpretation and included epiretinal membrane, macular edema, age-related macular degeneration, or other structural macular abnormalities.

Postoperative cystoid macular edema (CME) was defined objectively by OCT as the presence of intraretinal cystic spaces accompanied by either a CST ≥300 µm or an increase in CST of ≥30 µm compared with the individual eye's baseline measurement.

Study Outcomes

The primary outcome was postoperative BCVA (logMAR) measured at the first follow-up visit within 30–120 days after surgery. The secondary outcome was the presence or absence of postoperative CME as defined by OCT criteria.

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Statistical Analysis

All statistical analyses were performed using R software (version 4.5.0; R Foundation for Statistical Computing, Vienna, Austria). Baseline characteristics were summarized according to the presence or absence of macular pathology on preoperative OCT. Continuous variables were reported as means with standard deviations or medians with interquartile ranges, as appropriate, and compared using the Wilcoxon rank-sum test. Categorical variables were summarized as counts and percentages and compared using Pearson's chi-square test or Fisher's exact test, as appropriate. To evaluate predictors of postoperative best-corrected visual acuity (BCVA), an analysis of covariance (ANCOVA) model was constructed with postoperative BCVA (logMAR) as the dependent variable. The base clinical model included preoperative BCVA, age, diabetes mellitus, hypertension, and cataract grade (LOCS III).

An OCT-augmented model additionally included the presence of any macular pathology and OCT signal strength. Because cataract severity may independently influence visual acuity, cataract grade (LOCS III) was included as a covariate in all multivariable models to minimize confounding related to lens opacity. Central subfield thickness (CST) was analyzed descriptively and examined in exploratory analyses but was not included as a primary predictor in the multivariable model because the primary objective was to evaluate the incremental prognostic contribution of OCT detection of macular pathology rather than structural thickness subgroups. In addition, macular pathology was modeled as a binary variable to reflect the pragmatic clinical question of whether the presence of any OCT-detected abnormality provides incremental predictive value beyond standard clinical factors. Although this approach may reduce lesion-specific granularity, it was chosen to enhance model interpretability and align with real-world clinical decision-making, where the presence of any macular abnormality often guides management and counseling.[16] Exploratory analyses of structural parameters were performed to assess consistency of findings, but these were not included in the primary model to avoid overfitting and maintain parsimony given the study sample size.

Incremental prognostic value was assessed by comparing the base clinical model and the OCT-augmented model using changes in the coefficient of determination (R^2), differences in Akaike information criterion (AIC), and nested *F*-tests. Secondary analyses for postoperative cystoid macular edema were performed using logistic regression with the same covariates. To account for correlation between eyes from the same patient, cluster-robust standard errors were applied to all regression models. Adjustment for multiple comparisons was performed using the false discovery rate method. Statistical significance was defined as a two-sided P value <0.05.

Results

Study Population

A total of 177 eyes from patients undergoing phacoemulsification for nuclear cataract met the inclusion criteria. Of these, 57 eyes (32%) demonstrated at least one macular abnormality on preoperative OCT, while 120 eyes (68%) had no detectable macular pathology.

Baseline Characteristics

Baseline demographic, ocular, and systemic characteristics stratified by preoperative OCT findings are summarized in Table 1. The mean age was similar between eyes without macular pathology (65 ± 8 years) and those with macular pathology (66 ± 9 years; $P = 0.80$). Sex distribution, laterality, cataract grade (LOCS III), and cataract type did not differ significantly between groups. The prevalence of systemic comorbidities, including diabetes mellitus (43% vs 47%; $P = 0.60$) and hypertension (35% vs 44%; $P = 0.30$), was comparable. No statistically significant differences were observed for dyslipidemia, ischemic heart disease, or chronic kidney disease.

Visual Acuity and OCT Parameters

Preoperative and postoperative visual acuity outcomes and OCT-derived parameters are presented in Table 2. Eyes with macular pathology had significantly worse preoperative BCVA compared with eyes without pathology (mean logMAR 0.71 ± 0.55 vs 0.48 ± 0.36; $P = 0.007$). Postoperative BCVA was numerically worse in the macular pathology group but did not differ significantly between groups (0.35 ± 0.42 vs 0.21 ± 0.20 logMAR; $P = 0.10$). Both groups experienced

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Table 1 Baseline Demographic, Ocular, and Systemic Characteristics of Eyes Undergoing Phacoemulsification for Nuclear Cataract, Stratified by the Presence of Macular Pathology on Preoperative OCT

Characteristic	No Macular Pathology (n = 120)	Any Macular Pathology (n = 57)	*P* value
Age, years			0.80
Mean ± SD	65 ± 8	66 ± 9	
Median (IQR)	66 (61–70)	66 (60–72)	
Sex			0.50
Female	69 (58%)	30 (53%)	
Male	51 (42%)	27 (47%)	
Eye			0.60
Right (OD)	57 (48%)	25 (44%)	
Left (OS)	63 (52%)	32 (56%)	
Cataract type			0.20
Nuclear	120 (100%)	57 (100%)	
Cataract grade (LOCS III)			0.50
Grade 1	56 (47%)	31 (54%)	
Grade 2	50 (42%)	18 (32%)	
Grade 3	13 (11%)	7 (12%)	
Grade 4	1 (1%)	1 (2%)	
Systemic comorbidities			
Diabetes mellitus	52 (43%)	27 (47%)	0.60
Hypertension	42 (35%)	25 (44%)	0.30
Dyslipidemia	8 (7%)	1 (2%)	0.30
Ischemic heart disease	4 (3%)	3 (5%)	0.70
Chronic kidney disease	0 (0%)	2 (4%)	0.10

Notes: Data are presented as n (%) unless otherwise indicated. *P* values were calculated using the Wilcoxon rank-sum test for continuous variables and Pearson's chi-square or Fisher's exact test for categorical variables, as appropriate.
Abbreviations: IQR, interquartile range; LOCS III, Lens Opacities Classification System III; OCT, optical coherence tomography.

Table 2 Preoperative and Postoperative Visual Acuity and Macular OCT Parameters by Preoperative Macular Pathology Status

Variable	No Macular Pathology (n = 120)	Any Macular Pathology (n = 57)	*P* value
Preoperative BCVA (logMAR)			**0.007**
Mean ± SD	0.48 ± 0.36	0.71 ± 0.55	
Median (IQR)	0.40 (0.20–0.70)	0.50 (0.30–0.90)	

(*Continued*)

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Table 2 (Continued).

Variable	No Macular Pathology (n = 120)	Any Macular Pathology (n = 57)	*P* value
Postoperative BCVA (logMAR)			0.10
Mean ± SD	0.21 ± 0.20	0.35 ± 0.42	
Median (IQR)	0.20 (0.10–0.30)	0.20 (0.10–0.50)	
Change in BCVA (ΔlogMAR from baseline)			0.30
Mean ± SD	−0.27 ± 0.32	−0.36 ± 0.52	
Median (IQR)	−0.20 (−0.40 to −0.10)	−0.30 (−0.50 to −0.10)	
Preoperative CST (μm)			0.068
Mean ± SD	256 ± 28	278 ± 62	
Median (IQR)	256 (240–275)	260 (248–281)	
Postoperative CST (μm)			**0.025**
Mean ± SD	506 ± 78	579 ± 130	
Median (IQR)	502 (475–539)	542 (483–640)	
Change in CST (μm)			0.10
Mean ± SD	259 ± 63	290 ± 71	
Postoperative CME			0.70
Absent	81 (68%)	37 (65%)	
Present	39 (33%)	20 (35%)	
OCT signal strength (0–10)			0.60
Median (IQR)	8 (7–9)	9 (8–10)	
Days to postoperative visit			0.40
Mean ± SD	59 ± 25	54 ± 21	

Notes: BCVA values are reported in logMAR units; negative change indicates visual improvement. Postoperative cystoid macular edema (CME) was defined as CST ≥300 μm or an increase in CST ≥30 μm from baseline. Missing CST data were due to unavailable postoperative OCT scans. Bold values indicate statistical significance (P < 0.05).

Abbreviations: BCVA, best-corrected visual acuity; CST, central subfield thickness; CME, cystoid macular edema; OCT, optical coherence tomography; IQR, interquartile range.

substantial visual improvement following surgery. The mean change in BCVA was −0.36 ± 0.52 logMAR in eyes with macular pathology and −0.27 ± 0.32 logMAR in eyes without pathology, with no statistically significant difference ($P = 0.30$).

Preoperative central subfield thickness (CST) tended to be greater in eyes with macular pathology, although this did not reach statistical significance (278 ± 62 μm vs 256 ± 28 μm; $P = 0.068$). Postoperative CST was significantly higher in eyes with macular pathology (579 ± 130 μm vs 506 ± 78 μm; $P = 0.025$). The magnitude of CST change from baseline did not differ significantly between groups ($P = 0.10$). Postoperative cystoid macular edema occurred in 35% of eyes with macular pathology and 33% of eyes without pathology ($P = 0.70$). OCT signal strength and the timing of postoperative follow-up were similar between groups.

Multivariable Predictors of Postoperative Visual Acuity

Results of the multivariable ANCOVA model are shown in Table 3. Worse postoperative BCVA was independently associated with poorer preoperative BCVA (β = 0.224; 95% CI, 0.011 to 0.437; $P = 0.039$) and older age (per 10-year increase: β = 0.090; 95% CI, 0.030 to 0.151; $P = 0.004$). After adjustment for multiple testing, age remained statistically significant (q = 0.025). The presence of any macular pathology on preoperative OCT was not independently associated with postoperative BCVA (β = 0.096; 95% CI, −0.026 to 0.218; $P = 0.12$). Diabetes mellitus, hypertension, cataract grade, and OCT signal strength were also not significant predictors of postoperative visual acuity.

Incremental Prognostic Value of Preoperative OCT

The incremental predictive performance of adding preoperative OCT variables to the base clinical model is summarized in Table 4. The base model, incorporating age, preoperative best-corrected visual acuity (BCVA), diabetes mellitus, hypertension, and cataract grade, explained 29.6% of the variance in postoperative BCVA ($R^2 = 0.296$). Upon inclusion of OCT-derived variables—specifically the presence of any macular pathology and OCT signal strength—the model's explanatory power increased to $R^2 = 0.325$, yielding a ΔR^2 of 0.029.

This improvement in model performance was statistically significant, as demonstrated by the nested *F*-test (P = 0.029), and was further supported by enhanced model fit reflected by a reduction in the Akaike information criterion (ΔAIC = −3.44). These findings indicate that preoperative OCT parameters provide meaningful incremental prognostic value beyond standard clinical predictors for postoperative visual acuity outcomes.

Table 3 Multivariable Analysis of Predictors of Postoperative BCVA (logMAR) Using ANCOVA with Cluster-Robust Standard Errors

Predictor	β Coefficient	95% CI	*P* value	*q* value[†]
Preoperative BCVA (logMAR)	0.224	0.011 to 0.437	0.039	0.14
Age (per 10-year increase)	0.090	0.030 to 0.151	**0.004**	**0.025**
Diabetes mellitus	0.026	−0.086 to 0.139	0.60	0.70
Hypertension	−0.033	−0.162 to 0.095	0.60	0.70
Cataract grade (LOCS III)	−0.014	−0.078 to 0.051	0.70	0.70
Any macular pathology on OCT				
No	Reference	–	–	–
Yes	0.096	−0.026 to 0.218	0.12	0.20
OCT signal strength	−0.031	−0.072 to 0.010	0.14	0.20

Notes: β coefficients represent change in postoperative logMAR BCVA per unit increase in predictor. [†]False discovery rate–adjusted *q* values. Bold values indicate statistical significance (P < 0.05).
Abbreviations: BCVA, best-corrected visual acuity; CI, confidence interval; LOCS III, Lens Opacities Classification System III; OCT, optical coherence tomography.

Table 4 Incremental Predictive Performance of Adding Preoperative OCT Variables to a Base Clinical Model for Postoperative Visual Acuity

Outcome	Base Model R^2	OCT-Augmented R^2	ΔR^2	Base AIC	OCT AIC	ΔAIC	Nested *F*-test *P*
Postoperative BCVA (logMAR)	0.296	0.325	0.029	22.26	18.82	−3.44	**0.029**

Notes: Base model included age, preoperative BCVA, diabetes mellitus, hypertension, and cataract grade. The OCT-augmented model additionally included any macular pathology and OCT signal strength. Bold values indicate statistical significance (P < 0.05).
Abbreviations: AIC, Akaike information criterion; BCVA, best-corrected visual acuity; OCT, optical coherence tomography.

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Discussion

In this retrospective cohort study of patients undergoing phacoemulsification for nuclear cataract, we examined whether preoperative macular OCT provides incremental prognostic value for early postoperative visual acuity beyond standard clinical predictors. Our findings indicate that preoperative best-corrected visual acuity and age were the primary independent predictors of postoperative visual outcomes. Although the inclusion of OCT variables resulted in a statistically significant improvement in model performance, the magnitude of this improvement was modest and unlikely to meaningfully alter individualized short-term prognostication.

The strong association between preoperative visual acuity and postoperative outcomes observed in this study is consistent with prior literature. Baseline visual acuity has been shown to be a significant predictor of postoperative visual acuity in patients with age-related cataracts, reflecting its ability to integrate the effects of cataract severity and coexisting macular status.[17] Similarly, patients with poorer preoperative vision are more likely to experience meaningful gains after surgery, reinforcing the prognostic importance of baseline VA.[18] Advancing age has also been repeatedly shown to negatively influence visual outcomes, with older patients at higher risk of suboptimal postoperative acuity.[19]

Although macular pathology was common in our cohort, affecting nearly one-third of eyes, its presence was not independently associated with postoperative visual acuity after adjustment for baseline factors. This observation aligns with prior studies demonstrating that many OCT-detected macular abnormalities, particularly early epiretinal membrane or non-foveal lesions, do not substantially impair short-term postoperative vision. In a large retrospective cohort of eyes with primary epiretinal membrane, phacoemulsification cataract surgery resulted in a mean visual acuity improvement of 0.27 logMAR (approximately three Snellen lines), with a substantial proportion of eyes experiencing meaningful gain despite preexisting macular disease, although overall gains were lower than in eyes without ERM.[20]

Although central subfield thickness differed between groups postoperatively, these anatomic differences did not translate into significant functional disparities. Subclinical increases in macular thickness after cataract surgery are well documented and frequently observed even in uncomplicated cases. In one prospective study using OCT, a statistically significant subclinical increase in macular thickness was recorded at multiple postoperative time points without any detrimental effect on final visual outcomes at 12 weeks following surgery, suggesting that mild thickening often does not affect visual acuity.[21] Another study similarly reported subclinical macular thickening after phacoemulsification that did not compromise visual outcomes in any patient, reinforcing that many postoperative changes in CST reflect physiologic healing rather than clinically significant cystoid macular edema.[22] In clinical practice, increases in CST that remain below 300 micrometers or show less than a 30-micrometer rise from baseline are generally considered subclinical and attributable to postoperative inflammation rather than true edema requiring intervention.[23] Consistent with prior evidence, the presence of postoperative CME in our cohort was not associated with worse early visual outcomes, likely reflecting effective anti-inflammatory management in the perioperative period.[24]

Preoperative macular OCT remains clinically valuable in cataract surgery evaluation because it improves detection of occult macular disease that may not be visible on routine clinical examination. Systematic reviews suggest that previously unrecognized macular abnormalities may be identified in approximately one in seven eyes that appear normal on funduscopic assessment, highlighting the potential impact of OCT on diagnostic accuracy and surgical planning.[25] In clinical practice, identifying such abnormalities before surgery may influence patient counseling, intraocular lens selection, and postoperative expectation management.[13] Although the present study found that OCT variables provided only modest incremental predictive value for early postoperative visual acuity when baseline clinical factors were already included in the model, this finding should not be interpreted as diminishing the diagnostic or clinical importance of OCT screening. Rather, our results suggest that while OCT substantially improves detection of macular pathology, the additional gain in statistical prediction of short-term visual acuity beyond established predictors such as age and preoperative BCVA may be limited. Future prospective studies incorporating lesion-specific OCT features and longer follow-up periods may further clarify the role of preoperative OCT in individualized visual outcome prediction.

This study provides novel regional data from Saudi Arabia, where cataract surgery volume is high and outcomes are increasingly scrutinized. Prior regional studies have identified age and ocular comorbidity as key predictors of post-operative vision but have not incorporated OCT-based prognostic modeling.[26,27] By quantifying the incremental contribution of OCT variables, our findings extend existing evidence and offer a framework for evidence-based use of

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preoperative imaging in regional practice. However, these findings should be interpreted within the context of a single-center retrospective design, and external validation in larger, prospective, and more diverse populations is warranted. Given regional considerations related to resource utilization, the modest incremental predictive value observed suggests that OCT use may be best guided by clinical context rather than applied routinely.

From a clinical perspective, the significance of visual acuity improvement depends on baseline vision, as even a gain of one or two Snellen lines may represent meaningful functional benefit in patients with poorer preoperative acuity. Postoperative macular changes are well described and may be more relevant in eyes with pre-existing pathology, and without preoperative OCT, such changes may be under-recognized. Preoperative OCT also plays an important role in patient counseling and expectation management by detecting occult macular abnormalities not evident on routine examination, thereby reducing the risk of unexpected visual outcomes. These considerations highlight that the clinical value of OCT extends beyond its incremental predictive contribution within statistical models.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, its retrospective, single-center design may limit generalizability to other populations and practice settings, and residual confounding from unmeasured variables cannot be excluded. In addition, the sample size, although comparable to several prior OCT screening studies, may limit statistical power for detecting small effect sizes or lesion-specific prognostic differences. Second, the analysis focused on early postoperative outcomes within a 30–120-day follow-up window and therefore does not capture longer-term visual recovery or the potential progressive impact of preexisting macular pathology, which may become more clinically apparent over time. Third, macular status was modeled as a binary variable, grouping heterogeneous lesions with potentially different prognostic implications, which may have attenuated lesion-specific effects. Fourth, OCT parameters were limited to central subfield thickness and signal strength, without inclusion of more granular structural features such as ellipsoid zone integrity or vitreomacular interface metrics. The study did not include subgroup analyses based on cataract severity or stratified macular thickness, which may have provided additional insight into potential effect modification and residual confounding. Finally, surgical and perioperative factors such as intraocular lens type and postoperative medication adherence were not systematically analyzed and could have influenced visual outcomes.

Conclusion

Preoperative BCVA and age were the primary predictors of early postoperative visual acuity after phacoemulsification cataract surgery. Although macular OCT detected abnormalities in nearly one-third of eyes and provided a statistically significant improvement in predictive performance, the magnitude of this gain was modest, suggesting limited additional value for short-term visual outcome prediction beyond standard clinical factors. Importantly, the observed improvement in model performance ($\Delta R^2 = 0.029$), while statistically significant, is unlikely to meaningfully alter routine patient counseling or clinical decision-making in most cases. These findings support a selective rather than routine approach to preoperative OCT use, particularly in settings where resource utilization and workflow efficiency are important considerations, and where OCT may be most beneficial in specific clinical scenarios such as unexplained visual symptoms or preoperative planning for premium intraocular lens implantation.

Disclosure

The authors declare that they have no conflicts of interest in this work.

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