CORRELATION BETWEEN PREOPERATIVE RETINOMETRY AND POSTOPERATIVE CATARACT VISION WITH PHACOEMULSIFICATION AND LENS IMPLANTATION IN JAKARTA HOSPITAL

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ABSTRACT

Background: Cataractsis, characterized by lens cloudiness and impaired vision. Predicting visual outcomes after phacoemulsification with intraocular lens (IOL) implantation is crucial, and preoperative retinometry may be a valuable predictive tool. This study aimed to analyze this relationship.

Methods: A cross-sectional analytical study was conducted using secondary data from 31 patients who underwent phacoemulsification with IOL at Jakarta Hospital (January 2020-June 2022). Patient characteristics (age, sex) were described. The correlation between preoperative retinometry measurements and postoperative visual acuity was analyzed using Spearman's rank correlation test.

Results: The cohort comprised 22 males and 9 females. Most male patients were aged 46–64, while most female patients were >65 years old. A statistically significant correlation was found between preoperative retinometry and postoperative visual acuity (p=0.005). The correlation strength was moderate (r=0.494), indicating that higher preoperative retinometry values predicted better postoperative visual acuity.

Conclusion: Preoperative retinometry is a significant predictor of visual acuity following cataract surgery. This finding supports its clinical use for prognosticating surgical outcomes, demonstrating a direct, positive relationship between preoperative measurement and postoperative result.

Keywords: Cataract, age, sex, retinometry, phacoemulsification, intraocular lens

INTRODUCTION

Cataract is a common ocular disorder characterized by lens opacity that obstructs light entry into the eye, leading to impaired vision. The condition may arise from disruptions in fluid and electrolyte balance, lens protein denaturation, or both. Approximately 90% of cases are age-related, while other causes include congenital abnormalities and trauma. In Indonesia, cataracts occur earlier than in subtropical regions, by about 15 years, likely due to increased ultraviolet (UV) exposure, particularly UV-B. The 2018 Infodatin survey reported a prevalence of 1.9% among individuals aged over 50 years. Surgical intervention remains the only effective treatment, with several techniques available, including Extracapsular Cataract Extraction (ECCE), Intracapsular Cataract Extraction (ICCE), Small Incision Cataract Surgery (SICS), and phacoemulsification. Among these, phacoemulsification is the preferred method because it uses a smaller incision, enables faster recovery, and minimizes complications.[1,2,3,19,20,21]

Ocular history is critical in determining the prognosis and outcome of surgery. Pre-existing conditions such as a history of trauma, inflammation, amblyopia, glaucoma, optic nerve disorders, or retinal diseases (e.g., diabetic retinopathy or macular degeneration) are known to be underlying pathologies that limit the final postoperative visual acuity, thereby influencing the predictive accuracy of preoperative tests like retinometry. Moreover the general health status of the patient is crucial. The presence of systemic diseases (e.g., uncontrolled diabetes mellitus or hypertension) and possible drug allergies must be investigated as they can significantly impact the final visual outcome and recovery post-surgery. Furthermore the morphology and density of the cataract itself, particularly the cloudiness of the central area (nuclear cataract), condirectly affects the accuracy of the retinometry in assessing retinal

function. Patient adherence to postoperative therapy and restrictions is an important external consideration that can influence the final outcome as well. Finally the decision for surgery is also often based on the patient's visual function related to their daily activities, which is a key patient-centric factor.[4,5,6]

Accurately predicting postoperative visual acuity is essential for counseling patients and planning surgery. Several preoperative predictive tools have been developed, including the Potential Acuity Meter (PAM) and retinometry, both based on grating acuity principles. These methods aim to estimate postoperative visual potential despite media opacities such as cataract. Snellen charts, on the other hand, are typically used postoperatively to evaluate actual visual function. Previous studies have assessed the reliability of predictive tools. For instance, Lasa et al. found that central lens opacity reduced the accuracy of PAM and interferometry, while Wildan et al. reported significantly lower preoperative retinometry results compared to postoperative measurements. However, most studies have focused on describing differences between pre- and postoperative values rather than determining the prognostic accuracy of preoperative retinometry in predicting postoperative vision after phacoemulsification.[2,4,5,6,7,24]

Previous studies have highlighted the limitations of potential visual acuity tests like retinometry. For instance, the results of the Interferometer Method (IFM) and Potential Acuity Meter (PAM) demonstrated higher inaccuracy when the central area of the lens was cloudier, such as in nuclear cataracts. Furthermore, one study found that the correlation between retinometer findings and postoperative visual acuity was not statistically significant when compared to other charts like the Bailey-Lovie type chart and the three points vernier acuity test.

Despite the existing literature comparing preoperative retinometry and postoperative retinometry results, studies that genuinely investigate the significant relationship (accuracy) between preoperative retinometry measurements and final postoperative visual acuity following phacoemulsification and IOL implantation are still scarce.

To address this gap, the present study aims to analyze the relationship between preoperative retinometry results and postoperative visual acuity in cataract patients undergoing phacoemulsification with intraocular lens implantation. This research is expected to provide evidence on the predictive value of retinometry, thereby enhancing preoperative assessment accuracy and contributing to improved surgical outcomes.

METHODS

This study employed an analytical quantitative approach with a cross-sectional design using secondary data. The purpose was to evaluate the relationship between preoperative retinometry results and postoperative visual acuity, measured using the Snellen chart, in patients undergoing cataract surgery. Ethical approval for this study was obtained from the local institutional review board of Jakarta Hospital before data collection commenced.

The research was conducted at Jakarta Hospital, Setiabudi District, South Jakarta, Indonesia, during October 2022. The study population included all medical records of patients diagnosed with cataracts who underwent phacoemulsification between January 2020 and June 2022 by an ophthalmologist and had preoperative retinometry measurements performed by trained personnel. Sampling was carried out using a consecutive sampling technique, where every patient meeting the inclusion criteria was included in the study.[8] The sample size of this study consisted of 31 respondents, which was determined using the sample size formula for correlational analytic studies.[10] The calculation is based on the standard normal deviate for α (α = 1.64 for 5% significance) and β (β = 1.28 for 10% power), with an estimated correlation coefficient (r) of 0.5.

With α = 5% (Z_α = 1.64), β = 10% (Z_β = 1.28), and an assumed correlation (r) of 0.5.

The variables in this study were defined as follows: (1) preoperative retinometry, measured using the HEINE LAMBDA 100 Retinometer. The results were recorded as numerical values with three decimal places ranging from 0 to 1.0;(2) postoperative visual acuity, measured using a Snellen Chart at a distance of 6 meters, at least 14 days after surgery. The results were converted from fractional notation to decimal values ranging from 0 to 1.000 after correction to minimize refractive errors.

The inclusion criteria were: (1) eyes diagnosed with cataract; (2) availability of preoperative retinometry measurements performed by trained personnel no later than two months before surgery; (3) patients who underwent phacoemulsification between 2020 and 2022 by an ophthalmologist at Jakarta Hospital; and (4) availability of postoperative visual acuity measurements performed by trained personnel. Exclusion criteria were: (1) patients with postoperative complications and (2) patients with anterior segment abnormalities. Postoperative visual acuity data were collected at least 14 days after surgery, when inflammation had subsided, and glasses could be prescribed, ensuring a stable condition. Most data were collected around 30 days postoperatively, which is considered the ideal period for visual recovery.

To minimize the influence of confounding variables, this study employed a restriction method through strict exclusion criteria. Factors such as different surgical techniques were controlled by selecting only patients operated on by a single surgeon using the phacoemulsification technique with the same type of IOL (AR40e). Additionally, post-operative measurements were taken after refractive correction to ensure that the visual acuity recorded reflected the retinal potential rather than residual refractive errors.

Data analysis was performed using IBM SPSS Statistics software version 26 (IBM Corp., Armonk, NY, USA). Bivariate analysis was carried out using the nonparametric Spearman correlation test. A 95% confidence interval and α = 0.05 were applied. In addition to p-values, correlation coefficients (r) were reported to indicate effect size and the strength of association.[8,10]

ETHICAL APPROVAL

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Syarif Hidayatullah State Islamic University Jakarta (Approval No. 3674022P111132022091300003, dated October 10, 2022). All research procedures adhered to the Declaration of Helsinki and ICH-GCP ethical standards.

RESULTS

General Description

Data collection was carried out in October 2022 through the medical records of cataract patients who underwent phacoemulsification surgery at Jakarta Hospital between January 2020 and June 2022. A total of 31 subjects met the inclusion criteria: patients diagnosed with cataract who underwent phacoemulsification with AR40e intraocular lens implantation performed by a single ophthalmologist at the same institution.

Characteristics of Study Subjects

Table 1. Distribution of Study Subjects Characteristics

Characteristics	Category	Frequency (n=31)	Percentage (%)
Sex	Male	22	71.0
	Female	9	29.0
Age Group	Adult (26–45 years)	4	12.9
	Elderly (46–64 years)	12	38.7
	Geriatric (>65 years)	15	48.4

Among the 31 subjects, the majority were male, with 22 participants (71%), while female patients accounted for 9 participants (29%). The age distribution indicated that the largest group was the geriatric category (≥65 years), comprising 15 subjects (48.4%). The smallest age group was adults aged 26–45 years, with 4 subjects (12.9%). Further analysis by sex showed that most male patients were in the geriatric category (11 out of 22; 50%), whereas most female patients were in the oldest age category (geriatric), with 7 out of 9 (77.8%).

Normality Test and Data Distribution

Prior to correlation analysis, the Shapiro-Wilk test was applied because the sample size was fewer than 50 subjects. Results indicated that both preoperative retinometry scores and postoperative visual acuity values were not normally distributed (p = 0.008 and p < 0.001, respectively). Histogram inspection showed a moderate negative skewness. Several attempts to normalize the data using square root transformation [SQRT(k − x), k = 1] were unsuccessful; therefore, a nonparametric test was selected for the correlation analysis.[10]

Correlation Between Retinometry and Postoperative Visual Acuity

Table 2. Preoperative Retinometry and Postoperative Visual Acuity Results

Variables	Median	Range (Min – Max)
Preoperative Retinometry	1.0	0.6 (0.4 – 1.0)
Postoperative Visual Acuity	0.7	0.9 (0.1 – 1.0)

The central tendency analysis showed that the median preoperative retinometry score was 1.0 (range: 0.4–1.0), while the median postoperative visual acuity score measured using the Snellen chart was 0.7 (range: 0.1–1.0). These findings suggest that, on average, patients demonstrated a visual improvement following phacoemulsification surgery.[10]

To assess the relationship between preoperative retinometry and postoperative visual acuity, the Spearman rank correlation test was employed due to the non-normal data distribution. The analysis revealed a statistically

significant positive correlation (r = 0.494, p = 0.005, n = 31), indicating that higher retinometry scores prior to surgery were moderately associated with better visual outcomes after surgery. The correlation coefficient (r) of 0.494 suggests a moderate strength of association rather than a weak or very strong relationship. This implies that while preoperative retinometry is an important predictor of postoperative visual acuity, it is not the sole determinant, and other factors such as surgical technique, lens status, or postoperative complications may influence the final visual result.[10]

The significance level (p < 0.05) further confirms that the observed correlation is unlikely to be due to chance. Clinically, this finding highlights that patients with higher retinometry scores (closer to 1.0) are more likely to achieve better visual acuity after phacoemulsification surgery. However, the moderate correlation also emphasizes the necessity of managing patient expectations, as some variability remains unaccounted for by retinometry alone.[10]

DISCUSSION

Characteristics of Study Subjects

The higher proportion of male patients undergoing phacoemulsification compared to females in this study reflects the influence of sociocultural and functional factors on surgical decisions. While cataract prevalence generally rises with age for both sexes, the demand for visual restoration appears greater in males, possibly due to occupational and lifestyle requirements. Previous literature indicates that indications for cataract surgery often depend on subjective visual needs rather than standardized visual acuity thresholds, which may explain this discrepancy.[11,22]

Interestingly, most female patients were in the geriatric category (>65 years), while a large proportion of male patients belonged to the younger geriatric group (46–64 years). The predominance of older women aligns with evidence linking post-menopausal estrogen withdrawal to increased cataract risk. Estrogen has demonstrated antioxidative and anti-aging properties within ocular tissues, offering protection against oxidative stress a key factor in lens opacification. The abrupt decline in estrogen following menopause accelerates oxidative damage in lens fibers. However, demographic trends, particularly women's longer life expectancy, amplify their representation in the oldest age groups, further increasing their cumulative cataract risk.[12,13,22]

Age-related cataract formation is explained by continuous biochemical and structural changes in the lens, including increased light scattering, lens hardening, and reduced elasticity. These changes begin early in adulthood and progress steadily after the fourth decade of life. Literature consistently supports that cataract prevalence and severity correlate strongly with age, which justifies the predominance of geriatric individuals in the study population.[14]

Correlation Between Retinometry and Postoperative Visual Acuity

The positive correlation between preoperative retinometry and postoperative visual acuity observed in this study demonstrates that retinometry remains a clinically relevant predictive tool. Higher retinometry values typically indicate better postoperative outcomes, which can help surgeons provide realistic visual expectations to patients prior to cataract surgery. However, the correlation strength classified as moderate suggests that retinometry should not be considered an absolute predictor. Factors such as cataract density, macular pathology, or other ocular comorbidities can reduce predictive accuracy.

Comparison with previous studies reveals a generally consistent trend. Mimouni reported a positive predictive value of 85.7% for retinometry in forecasting postoperative visual acuity, while Colombo-Barboza et al. observed a predictive value exceeding 86%. These findings reinforce retinometry's utility as a practical and cost-effective method. However, Quan's study demonstrated that the correlation between retinometry and postoperative vision was not statistically significant when compared to hyperacuity-based tests, emphasizing the limitations of retinometry as a standalone predictor.[15,16,17]

This variation across studies indicates that while retinometry is useful, it cannot replace a comprehensive preoperative evaluation. Advanced tools such as optical coherence tomography of the macula or potential acuity meters may provide complementary predictive value, particularly in cases where cataract density or other media opacities hinder retinometry measurements.[18,23]

Scientific and Clinical Implications

The findings highlight the practicality of retinometry in routine cataract surgery planning, especially in resource-limited settings where sophisticated imaging may not be available. The novelty of this work lies in its analysis within a uniform surgical context phacoemulsification with AR40e IOL implantation providing a standardized baseline for assessing retinometry reliability. This supports its continued role in patient counseling and surgical decision-making, while underscoring the need for additional predictive strategies to improve accuracy and address limitations such as variability caused by ocular comorbidities and cataract density.

CONCLUSION

This study demonstrates a significant positive correlation between preoperative retinometry measurements and postoperative visual acuity following phacoemulsification with intraocular lens implantation. The findings confirm that retinometry serves as a valuable predictive tool for estimating visual outcomes after cataract surgery, enabling clinicians to set realistic expectations for patients and improve surgical planning. Additionally, the demographic analysis revealed that cataract surgery was more frequently performed in males within the elderly age group, while females were predominantly represented in the older age group, reflecting both biological and demographic influences on cataract prevalence and surgical decisions. These results contribute to strengthening the evidence for incorporating retinometry into preoperative evaluations as part of a comprehensive approach to optimizing patient outcomes.

IMPLICATION

The observed association between retinometry and postoperative visual acuity underscores its utility as an accessible and cost-effective screening tool, particularly in clinical settings with limited resources or where advanced imaging is not readily available. From a practical standpoint, this study supports the routine integration of retinometry into preoperative assessments for cataract patients to enhance counseling accuracy and patient satisfaction. Future research should aim to refine predictive algorithms by combining retinometry with other diagnostic modalities, such as macular OCT or potential acuity testing, to further improve accuracy and applicability in diverse patient populations.

STRENGTHS AND LIMITATION

A notable strength of this study lies in its standardized surgical approach phacoemulsification with AR40e IOL implantation ensuring uniformity in postoperative outcomes. Additionally, the use of validated measurement tools, including retinometry and Snellen visual acuity charts, enhances the reliability of findings. However, the study is limited by its relatively small sample size and single-center design, which may restrict the generalizability of results to other populations or healthcare settings. Potential confounders such as cataract density, macular health, and unrecognized comorbidities were not fully controlled, which could influence the strength of the observed correlation. Larger, multicenter studies incorporating additional predictive variables are warranted to validate and extend these findings.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to this study. All funding sources had no involvement in the design, execution, analysis, or reporting of the research. The authors retained full access to all study data and independently performed the analysis and interpretation.

DECLARATION OF USING AI

The authors declare that artificial intelligence (AI) tools were utilized exclusively for language enhancement purposes, including grammar correction, paraphrasing, and improving clarity of expression. No AI tools were used to generate original scientific content, perform data analysis, or interpret research findings. The authors assume full responsibility for the accuracy, interpretations, and conclusions presented in this manuscript.

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