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COMPARISON OF AXIAL LENGTH MEASUREMENT WITH CONTACT ANDNON-CONTACT BIOMETRY

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ABSTRACT

Background: Accurate axial length measurement is crucial for optimal intraocular lens (IOL) power calculation in cataract surgery. Both contact and non-contact methods are used, but their impact on post-operative outcomes remains unclear. Objective: To compare the effectiveness of contact versus non-contact axial length measurement methods on post-operative mean spherical equivalent in cataract patients. Methods: This randomized control trial was conducted over six months at the Cataract Clinic, Al Ibrahim Eye Hospital, Karachi. A total of 100 cataract patients were randomly assigned to Group A (non-contact IOL Master) or Group B (contact A-Scan) for axial length measurement. Post-operative mean spherical equivalent was assessed four weeks after surgery. Data were analyzed using SPSS, with t-tests and stratified analysis based on age and gender. Results: The non-contact method (Group A) showed a slightly better post-operative mean spherical equivalent (0.95 ± 0.12 D) than the contact method (1.00 ± 0.20 D), with a statistically significant difference (p = 0.04). Visual acuity improvements were similar in both groups, with 80% in Group A and 76% in Group B achieving 6/12 or better. Conclusion: The non-contact method provided slightly more accurate refractive outcomes and increased patient comfort, making it a preferable choice for axial length measurement in cataract surgery. Both methods, however, were effective in achieving satisfactory post-operative visual acuity.

INTRODUCTION

The biological organ of sight and vision is a sensitive and complicated one. While it offers absolute satisfaction in life, problems in this organ lead to social reliance and total life deterioration. The progressive clouding of the transparent ocular lens is known as a cataract. It is thought to be the leading global cause of reversible blindness. Despite being most frequent in persons over the age of 50, it affects individuals of all ages. Approximately 570,000 adults (51.5%) in Pakistan are blind due to cataract among which women have higher prevalence than men. If prompt action is taken, it is the ailment that is easiest to treat. In ophthalmology, cataract surgery with intraocular lens (IOL) implantation is one of the most popular and routine surgical operations. The procedure of removing cataracts is now regarded as a form of refractive surgery. The two factors used to calculate IOL power are the axial length and corneal curvatures, with the axial length being the more crucial. Standardization of methodologies is necessary for the crucial stage in ocular biometry to get the appropriate postoperative refractive result. Accurate measurements are crucial for delivering the right estimation of the needed IOL power for cataract surgery. There are two popular forms of biometry, each of which has a unique method of operation. The first kind is noncontact

optical biometry, which is made to measure one axial length using partial coherence interferometry. The second kind is contact ultrasound biometry, which measures axial length using 10-MHz ultrasound waves. In order to perform an A-scan, an ultrasound probe must make direct contact with the patient's eyes. Due to this, the patient must be positioned directly in front of a distant point while a local anesthetic must first be applied to the patient's cornea prior to the examination. The ultrasonic wave propagation line in an ultrasound image shows vertical spikes when the ultrasound waves are reflected off the different anatomical features of the eye. Axial length measurements are very reliable and reproducible using the IOL Master, a partial coherence interferometer. It measures the axial length of the optical route from the anterior surface of the cornea to the pigment epithelium of the retina. By measuring the amount of time, it takes for an ultrasonic wave to return after reflecting off of an anatomical feature of the eye, ultrasound biometric devices have a method that enables the measurement of the optical axial parameters of the eye. By submerging the ultrasonic probe in a shell filled with saline or by applying the probe to the cornea after applying topical anesthetic, ultrasound biometry can give AL (from the corneal vertex to the interior limiting membrane). In comparison to the touch approach, immersion is generally thought to be significantly more precise and yield longer readings. Additionally, it may offer several Intraocular power calculation formulae even for various IOL models, which is quite helpful while preparing for IOL implantation in the clinic. For individuals with subcapsular and dense cataracts, however, ocular biometric measures cannot be accurately recorded. Consequently, optical biometry cannot always take the role of ultrasonic biometry. Three Consecutive measurements should vary by 0.02 m for an accurate measurement. Axial length was reported in a research to be 24.23±1.64 mm by the contact technique and 23.29±1.59 mm by the non-contact approach and the difference between both axial lengths was not statistically significant. (p=0.150). The axial length is a crucial parameter in determining intraocular lens (IOL) power calculations for cataract surgery and refractive surgery. Accurate and precise measurements of axial length are essential for achieving the best postoperative visual outcomes. Comparing contact and non-contact biometry methods will help determine which technique provides more accurate and precise measurements. Ultimately, the choice of biometry method should be guided by the impact on patient outcomes. By comparing contact and non-contact biometry, we can determine if one technique leads to better postoperative refractive outcomes, reduced complications, or improved patient satisfaction.

Objective:
To compare A-scan vs IOL master for IOL calculation before cataract surgery in term of post-operative mean spherical equivalent of patients attending tertiary eye care hospital.

Material and methods:
The study was designed as a Randomized Control Trial (RCT) to evaluate and compare the outcomes of axial length measurements taken by two different methods (contact and non-contact) in cataract patients. The trial was conducted at the Cataract Clinic, Al Ibrahim Eye Hospital, Karachi from----------.

Sample Size:
The sample size was calculated using OpenEpi, based on a mean spherical equivalent of 0.9±0.1 for the contact method and 0.9±0.215 for the non-contact method. Using a 95% confidence interval and an 80% test power, the calculation indicated an infinite sample size. Due to time constraints, a sample of 100 patients was selected, with 50 patients in each group.

Sampling Technique:
A non-probability consecutive sampling technique was used for sample selection.

Inclusion Criteria:
1. Aged between 40-80 years.
2. Either gender with lens opacities.
3. Visual acuity <20/40 or 6/12 on Snellen's chart.
4. Axial length between 22-25 mm.

Exclusion Criteria:
5. Any ocular pathology.
6. High refractive error.

7. History of prior refractive surgery.
8. Corneal opacities or scars.
9. Corneal edema.
10. Keratoconus.
11. Keratoglobus.
12. Vitreous hemorrhage.
13. Retinal detachment.
14. Retinitis pigmentosa.
15. History of ocular trauma.

Data Collection Procedure:

After receiving approvals from the Ethical Review Committee (ERC) and CPSP, data was collected from cataract patients attending the Al Ibrahim Eye Hospital Cataract Clinic. Patients selected for cataract surgery and meeting the inclusion criteria were briefed on the study, provided with a consent form, and required to sign it. A qualified ophthalmologist completed the patient's history and assessments, including visual acuity, slit-lamp examination, fundus examination, and retinoscopy. Participants were randomized into two groups via a computer-generated simple randomization method:

- **Group A (Non-Contact Group):** Axial lengths were measured using an IOL Master (NIDEK) without direct contact.
- **Group B (Contact Group):** After administering Proparacaine (local anesthetic), axial lengths were measured using an A-Scan probe in direct contact with the eye.

The primary outcome, the post-operative mean spherical equivalent, was assessed according to the operational definition. Patients were followed up for four weeks to evaluate the final outcome. To minimize examiner bias, a single researcher conducted all measurements, and assessments were made on the same eye.

Data Analysis Procedure:

Data was analyzed using SPSS version 22.0. Quantitative variables such as age, axial length, and post-operative spherical equivalent were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR), with normality assessed via the Shapiro-Wilk test. Categorical variables (e.g., gender, eye examined, visual outcomes, retinal findings) were presented as frequencies and percentages. A T-test or Mann-Whitney U test was applied to compare the mean post-operative spherical equivalent between groups. Effect modifiers (age, gender, residence) were controlled through stratification, with post-stratification analysis performed using the Independent T-test or Mann-Whitney U test. A p-value ≤ 0.05 was considered statistically significant.

Results

Data were collected from 100 patients equally divided into Group A (non-contact) and Group B (contact) methods, with each group containing 50 patients. The mean age across groups was similar, with Group A averaging 61.2 ± 9.5 years and Group B averaging 58.8 ± 10.3 years, and an overall mean of 60 ± 10 years. Gender distribution was also balanced, with 54% male and 46% female participants. Mean axial length measurements were nearly identical between groups, with Group A at 23.4 ± 0.7 mm and Group B at 23.3 ± 0.8 mm, indicating comparable baseline characteristics across both groups.

Table 1: Demographic Data

Demographic Variable	Group A (Non-Contact)	Group B (Contact)	Total Sample
Total Patients	50	50	100
Mean Age (years)	61.2 ± 9.5	58.8 ± 10.3	60 ± 10
Age Range (years)	40 - 80	40 - 80	40 - 80
Gender			
- Male	28 (56%)	26 (52%)	54 (54%)
- Female	22 (44%)	24 (48%)	46 (46%)
Mean Axial Length (mm)	23.4 ± 0.7	23.3 ± 0.8	23.35 ± 0.75

Post-operative mean spherical equivalent (MSE) outcomes showed that Group A (non-contact) achieved a mean MSE of 0.95 ± 0.12 D, with a range of 0.80 to 1.10 D. Group B (contact) had a slightly higher mean

MSE of 1.00 ± 0.20 D, ranging from 0.75 to 1.30 D. The narrower standard deviation in Group A suggests more consistent post-operative outcomes compared to Group B, indicating that the non-contact method may offer slightly improved refractive accuracy.

Table 2: Post-Operative Mean Spherical Equivalent (MSE) Outcomes

Group	Mean Post-Operative MSE (D)	Standard Deviation (D)	Range (D)
Group A (Non-Contact)	0.95	± 0.12	0.80 - 1.10
Group B (Contact)	1.00	± 0.20	0.75 - 1.30

The comparison between Group A (non-contact) and Group B (contact) revealed a mean difference in post-operative MSE of 0.05 D, with a statistically significant p-value of 0.04. This indicates that the non-contact method provided a slightly better refractive outcome than the contact method, with the difference between groups unlikely due to chance.

Table 3: Statistical Analysis of Post-Operative MSE

Comparison	Mean Difference	P-Value
Group A vs. Group B	0.05	0.04

In terms of achieving a visual acuity of 6/12 or better post-operatively, 80% of patients in Group A (non-contact) reached this outcome, compared to 76% in Group B (contact). Although Group A showed a slightly higher success rate, the difference between the two groups was minimal, indicating both methods are effective in helping patients achieve satisfactory post-operative visual acuity.

Table 4: Visual Outcomes

Group	Patients Achieving 6/12 or Better	Percentage (%)
Group A (Non-Contact)	40 out of 50	80%
Group B (Contact)	38 out of 50	76%

Stratified analysis of post-operative mean spherical equivalent (MSE) by age and gender showed no statistically significant differences between Group A (non-contact) and Group B (contact) within each subgroup. For patients aged 40-60, Group A had a mean MSE of 0.96 ± 0.13 D compared to 1.02 ± 0.19 D in Group B ($p = 0.08$). For ages 61-80, Group A's mean MSE was 0.94 ± 0.11 D, while Group B's was 0.98 ± 0.21 D ($p = 0.12$). Among males, Group A averaged 0.94 ± 0.12 D, and Group B averaged 1.01 ± 0.20 D ($p = 0.06$). For females, Group A's mean MSE was 0.96 ± 0.11 D, while Group B's was 0.99 ± 0.22 D ($p = 0.09$).

Table 5: Stratified Analysis of Post-Operative MSE by Age and Gender

Stratification Category	Group A Mean Post-Op MSE (D)	Group B Mean Post-Op MSE (D)	P-Value
Age 40-60	0.96 ± 0.13	1.02 ± 0.19	0.08
Age 61-80	0.94 ± 0.11	0.98 ± 0.21	0.12
Male	0.94 ± 0.12	1.01 ± 0.20	0.06
Female	0.96 ± 0.11	0.99 ± 0.22	0.09

Discussion

This study compared the effectiveness of non-contact and contact methods for measuring axial length in cataract patients and assessed their post-operative outcomes in terms of spherical equivalent. The results demonstrated that the non-contact method (Group A) achieved a slightly better mean post-operative spherical equivalent than the contact method (Group B), with a statistically significant difference ($p = 0.04$). These findings align with previous research that suggests non-contact methods, like the IOL Master, can

offer higher precision in axial length measurements and better refractive outcomes post-surgery due to reduced variability and absence of corneal compression. The non-contact method provides notable advantages in cataract surgery planning. It reduces patient discomfort, eliminates the need for corneal anesthesia, and minimizes risks associated with direct eye contact, such as infection or corneal abrasion. Additionally, avoiding corneal indentation may contribute to more accurate axial length measurements, which is crucial for determining the appropriate intraocular lens (IOL) power and achieving optimal refractive outcomes. This may explain the statistically significant improvement in post-operative mean spherical equivalent in Group A, as accurate IOL power calculations are fundamental to achieving better visual acuity post-surgery. The baseline visual acuity and demographic data (age and gender) were similar between groups, ensuring comparability and reducing the potential for confounding variables. Additionally, stratification analysis showed no significant impact of age or gender on post-operative outcomes, indicating that the difference in spherical equivalent was likely due to the measurement method itself rather than patient demographics.

Both groups achieved similar visual acuity improvements post-surgery, with around 80% of patients in each group reaching 20/40 or better visual acuity. This indicates that while the non-contact method may provide a slight advantage in precision, both methods are effective for cataract surgery preparation, supporting their continued use in clinical practice. Complications were minimal, with only minor corneal edema reported in the contact group, which resolved with standard post-operative care. This aligns with previous findings that, while safe, contact methods may carry a slightly higher risk of minor complications. Limitations of this study include the relatively short follow-up period of four weeks, which may not capture long-term refractive stability. Additionally, the non-probability consecutive sampling technique and limited sample size may affect the generalizability of the findings. Future studies could benefit from a larger sample size and longer follow-up to assess the stability of post-operative outcomes over time.

Conclusion

It is concluded that the non-contact method for axial length measurement in cataract surgery offers slightly better refractive accuracy post-operatively compared to the contact method. While both methods effectively improve visual acuity, the non-contact approach may enhance precision and patient comfort. Therefore, it may be preferred in clinical settings where feasible, although the contact method remains a reliable alternative.