Comparison of Ocular Biometry Parameters Between IOL Master And Immersion A-Scan in age Group of 35-85 Old Yrs Patients Presenting in EHS.

Vishnu kesh Tripathi[1], Ankit kumar Mishra[2], Dheeraj Kumar Diwedi[3]

[1]*Assistant Professor Optometry Scpm College of Nursing & Paramedical Science Lucknow Road, Haripur Gonda*

[2]*Associate Professor & HOD Optometry School of optometry sitapur eye hospital sitapur uttarpradesh*

[3]*Professor SCPM Group of Hospital and Education, Gonda*

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Abstract

This study compared axial length measurements obtained using IOL Master (optical biometry) and immersion A-scan ultrasonography in 90 patients undergoing cataract surgery, comprising 48 males and 42 females. Patients were stratified into four age groups: 35–50 years (n=19), 50–60 years (n=35), 60–70 years (n=34), and 70–85 years (n=12), and axial length was compared for both eyes within each group. The percentage difference between the two techniques was smallest in the youngest and oldest age groups (0.39–0.99%) and comparatively higher, though still clinically modest, in the middle-aged groups (2.97–3.37%). No age group showed a difference likely to affect intraocular lens power calculation meaningfully. The findings confirm close agreement between IOL Master and immersion A-scan across all age groups, supporting the use of either technique for accurate preoperative biometry in cataract surgery.

Keywords; Intraocular Lens (IOL) Master, Immersion A-Scan, Ocular Biometry. Left Eye (LE), Right Eye (RE), Patients (Pt).

INTRODUCTION

Nowadays, cataract surgery has evolved from a procedure for restoring the vision to a refractive surgery in which the accurate calculation of the IOL power becomes a fundamental for obtaining the desired postoperative vision. Thus, the accurate measurement of the axial length (AL) is an important part of the ophthalmic examination before cataract surgery. Clinically significant postoperative refractive errors can be caused by even small AL measurement errors [1], [2].

Based on optical partial coherence interferometry, the IOL Master delivers fast, non-contact and extremely reproducible measurements without corneal indentation. It can also measure the additional biometric parameters like anterior chamber depth and keratometry. It can be limited in eyes with dense cataract, corneal opacity or vitreous haemorrhage or in patients with poor fixation. Under these circumstances, ultrasound-based biometry is still valuable. Immersion A-scan ultrasonography is the technique that does not compress the cornea, unlike contact A-scan, and it is believed to be an accurate method of measuring AL [3], [4].

The variations between optical and immersion ultrasound measurements may affect the choice of IOL power and postoperative refractive results. Thus, it is clinically relevant to compare their agreement in age groups. The present study compares biometric parameters of the eyes measured by IOL Master and immersion A-scan in patients with ages ranging from 35 to 85 years presented at EHS, with focus on Axial length measurements in the preset age groups.

The study will seek to understand the level of agreement between the two techniques and evaluate their clinical interchangeability in the pre-operative assessment of most common cataract cases.

Ocular Biometry and Its Clinical Significance in Cataract Surgery

Surgery for cataract has changed from an exclusively restorative procedure to a refractive procedure in which the primary concern is not just removal of the opacified crystalline lens, but is to obtain a desired and predictable postoperative refractive result [5]. Ocular biometry is the measurement of the dimensions of the eye, primarily axial length (AL), anterior chamber depth (ACD) and corneal curvature, these three measurements being at the heart of the intraocular lens (IOL) power calculation [6]. These measurements, no matter how small the error, can lead to clinically significant refractive surprises following surgery because an error of just 1mm in the axial length measurement can be associated with a refractive error of approximately 2 to 3 dioptres, especially in very short and long eyes [7]. Patients are more and more demanding for near-spectacle independence following surgery, particularly in the era of premium, toric and multifocal IOLs, which is why biometric accuracy is essential for surgical success and patient satisfaction [8]. Residual refractive error is now recognised as being one of the most common sources of patients complaints and surgical revision after a generally successful cataract surgery, highlighting the need to pay particular attention to the choice of the biometry method that is both accurate and reproducible [9]. Until now, axial length has been clinically available only through ultrasound-based A-scan biometry, which for many decades has been the clinically valid procedure to measure axial length, and is still taught as the reference method in many training institutions [10]. New optical devices have been developed, and non-contact techniques, like the IOL Master, which relies on partial coherence interferometry, have been introduced into everyday practice, providing improved precision, higher reproducibility and far greater patient comfort than ultrasound techniques [11]. The use of immersion A-scan ultrasonography was, however, still prevalent despite the advantages of optical biometry, especially in eyes with dense cataracts, vitreous opacities, and media haze, where optical biometry might not succeed in obtaining an accurate measurement [12]. The two modalities are still in common use in clinical practice in diverse settings and their comparative accuracy, agreement and interchangeability have continued to be of great and ongoing relevance to practising ophthalmologists and biomedical researchers [13], [14].

Principles and Techniques of Axial Length Measurement

The measurement of axial length may be done via ultrasonic or optical measurements and is based on completely different physical principles. The ultrasound A-scan biometry measures the time taken for the ultrasound waves to reach from the cornea to the retinal pigment epithelium and back and estimates the axial length based on the known speed of sound in each of the ocular media [15], [16]. In clinical practice, two forms of ultrasound biometry are used, the contact or applanation method, which involves direct contact between the probe and the cornea and may cause some corneal indentation, resulting in a systematic underestimation of axial length, and the immersion type, in which a fluid-filled scleral shell is placed between the probe and the cornea, preventing direct contact and corneal indentation and providing generally more accurate and reproducible measurements [17], [18]. Immersion A-scan has long been considered more reliable than the other ultrasound-based methods and is frequently used as a standard for calibration and validation of newer techniques. The IOL Master, however, utilizes partial coherence interferometry, which is based on light rather than sound waves, to determine the distance from the corneal vertex to the retinal pigment epithelium (RPE) along the patient's fixation axis [19], [20], [21]. As a non-contact technique, it does not involve corneal indentation or trauma to the cornea, avoids topical anaesthesia and direct eye contact, reduces the risk of cross-infection of patients and can be performed quickly with a high level of cooperation, even in elderly or apprehensive patients [22]. It also allows the keratometry, anterior chamber depth, lens thickness and white-to-white corneal diameter to be measured simultaneously in a single and short acquisition, reducing preoperative workup [23]. But there are also certain drawbacks to optical biometry, especially that it is less effective in the eyes with dense cataract, extensive corneal scarring and vitreous haemorrhage, where immersion ultrasound is still essential as a rescue method. It is thus still of great and real clinical interest to continue comparing the performance and agreement of these two modalities [24].

OBJECTIVES OF THE STUDY

1. To compare ocular biometry parameters, particularly axial length, measured using the IOL Master and immersion A-scan in patients aged 35–85 years presenting in EHS.

2. To assess the agreement and correlation between IOL Master and immersion A-scan measurements across different age groups.
3. To evaluate age-related differences in biometric measurements between the two techniques across the defined age groups: 35–50, 50–60, 60–70, and 70–85 years.
4. To determine the clinical interchangeability and reliability of IOL Master and immersion A-scan measurements for preoperative cataract assessment and IOL power calculation.

RESEARCH METHODOLOGY

1. **Study Design:** This study aimed to be a prospective, quantitative, cross-sectional, observational study using an analytical approach to determine the degree of agreement between two independent methods for measuring ocular biometry.
2. **Study Setting and Duration**: The study was carried out in the Department of Ophthalmology of an eye hospital at Sitapur over a period of two months from 1st August, 2021 to 30th September, 2021.
3. **Study Population and Sample Size**: A total of 90 patients scheduled for cataract surgery were enrolled in the study using a simple random probability sampling technique. Of these, 48 (53.3%) were male and 42 (46.7%) were female. Patients were further stratified into four age subgroups for analysis: 35–50 years, 50–60 years, 60–70 years, and 70–85 years.
4. **Inclusion Criteria**: Patients aged between 35 and 85 years who were scheduled to undergo cataract surgery were included in the study.
5. **Exclusion Criteria**: Patients with a history of ocular trauma or previous intraocular surgery, active ocular infective or inflammatory pathology, nystagmus, poor fixation, which could not be satisfactorily positioned for accurate biometric measurement were excluded from the study.
6. **Materials and Methods**: Axial length (AL) and anterior chamber depth (ACD) were measured in all enrolled patients using two independent techniques: (i) optical biometry, performed using the IOL Master, a partial coherence interferometry–based non-contact biometer, and (ii) immersion A-scan ultrasonography, performed using a fluid-filled scleral shell interposed between the probe and the cornea to avoid corneal indentation. Measurements were obtained for both the right and left eyes of each patient, and the readings from the two methods were subsequently compared. All measurements were performed by trained ophthalmic personnel under standardised conditions in order to minimise inter-observer variability.
7. **Statistical Analysis**: Data were tabulated and analysed using descriptive statistics, including mean and standard deviation, for each age subgroup and for each eye. The mean difference and percentage difference between IOL Master and immersion A-scan readings were calculated for every subgroup. The Pearson correlation coefficient was computed to assess the strength of association between the two techniques, and the paired t-test was used to determine whether the mean difference between the two methods was statistically significant, with $p < 0.05$ considered significant.

RESULT AND DISCUSSION

This section presents the findings on gender distribution and axial length agreement between IOL Master and immersion A-scan biometry across four age groups of patients undergoing cataract surgery. A total of 90 patients were evaluated, comprising 48 males and 42 females. Axial length measurements for both the right and left eyes were compared between the two techniques within each age subgroup (35–50, 50–60, 60–70, and 70–85 years), and the percentage differences observed are interpreted graph-wise below, followed by an overall discussion of the results.

Gender

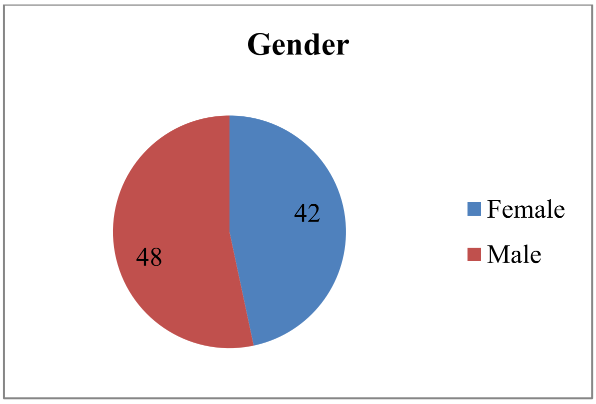

Figure 1: Gender

Of the 90 patients enrolled in the study, 48 (53.3%) were male and 42 (46.7%) were female, indicating a fairly balanced gender distribution with a slight male predominance. This pattern is consistent with typical age-related cataract case series and suggests that gender is unlikely to have introduced any meaningful bias into the biometric comparisons undertaken in this study.

Age group – 35-50 year

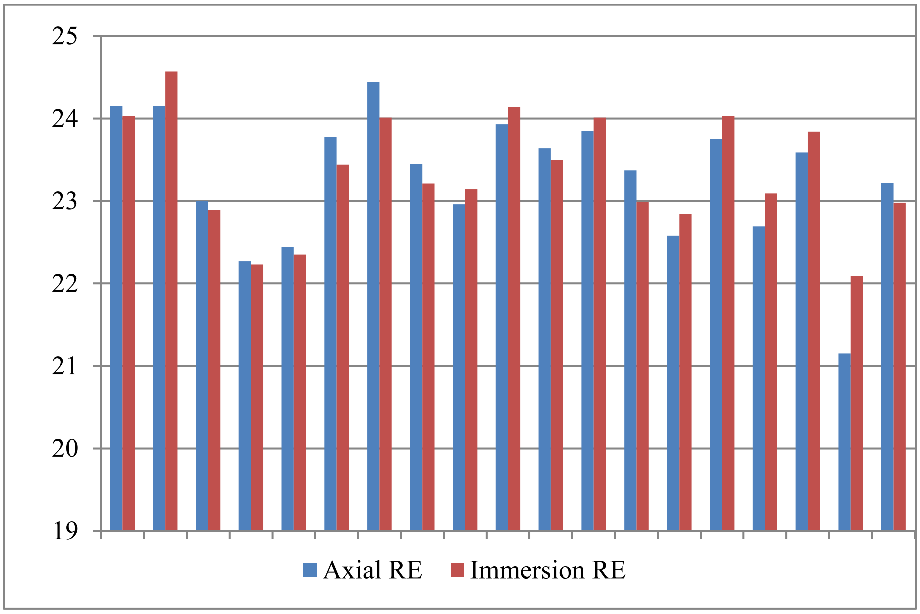

Figure 2: The axial length difference between IOL Master and immersion A-scan for the right eye of age group 35-50

In the 35–50-year age group (n = 19), the axial length difference between IOL Master and immersion A-scan for the right eye was 0.99%. This very small difference indicates excellent agreement between the two techniques in younger patients, likely reflecting clearer ocular media and more stable fixation, both of which favour accurate optical and ultrasound measurement alike.

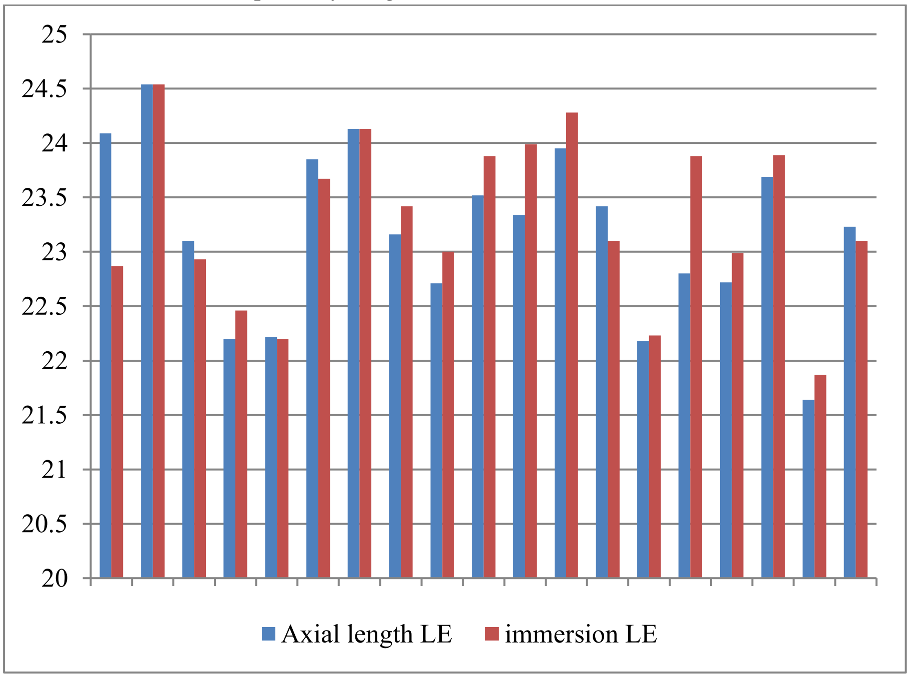

Figure 3: The axial length difference between IOL Master and immersion A-scan for the left eye of age group 35-50

For the left eye in the same 35–50-year age group (n = 19), the difference between IOL Master and immersion A-scan was 0.729%, marginally lower than the right eye value. This close inter-ocular consistency further supports the reliability of both instruments in relatively younger cataract patients with fewer age-related media changes.

Age group – 50-60 year

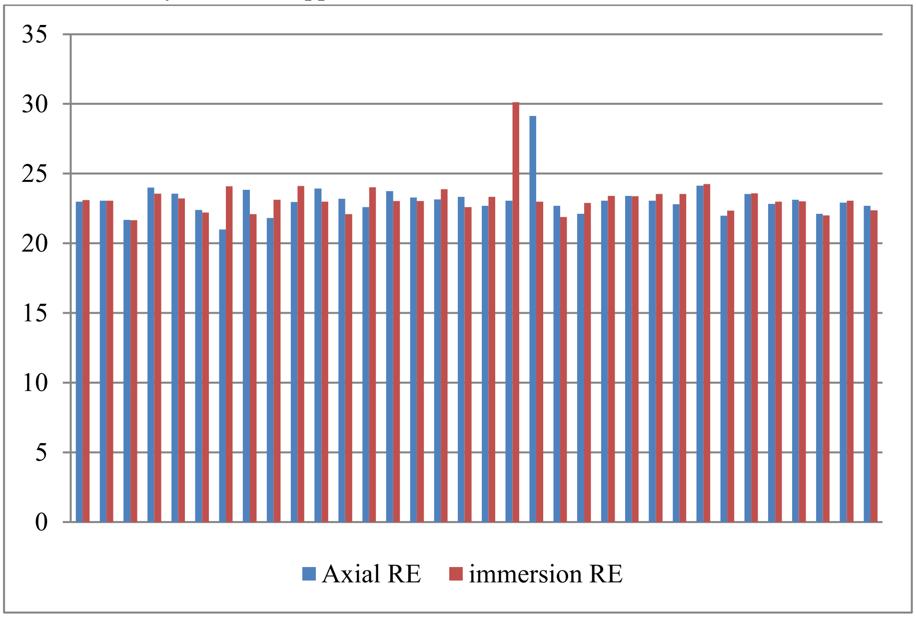

Figure 4: The axial length difference between IOL Master and immersion A-scan for the right eye of age group 50-60

In the 50–60-year group (n = 35), the right-eye difference rose to 3.37%, the highest value recorded across all subgroups. This increase may reflect greater biological variability in axial length, early lenticular changes, or a small number of atypical eyes within this specific age band affecting measurement concordance.

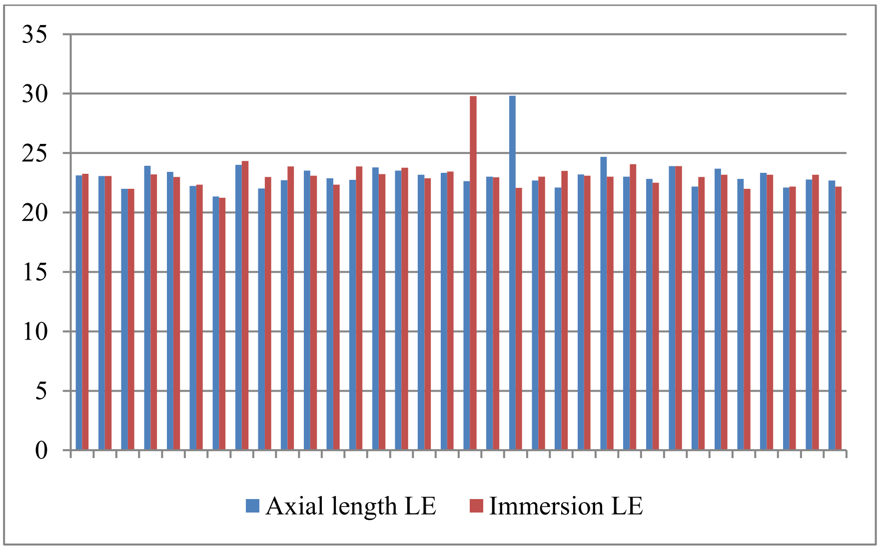

Figure 5: The axial length difference between IOL Master and immersion A-scan for the left eye of age group 50-60

The left eye in the 50–60 year group (n = 35) showed a difference of 2.98%, slightly lower than the right eye but still elevated relative to the youngest and oldest groups. This supports the impression that the 50–60 year subgroup shows comparatively greater, though still clinically modest, divergence between techniques.

Age group 60-70 year

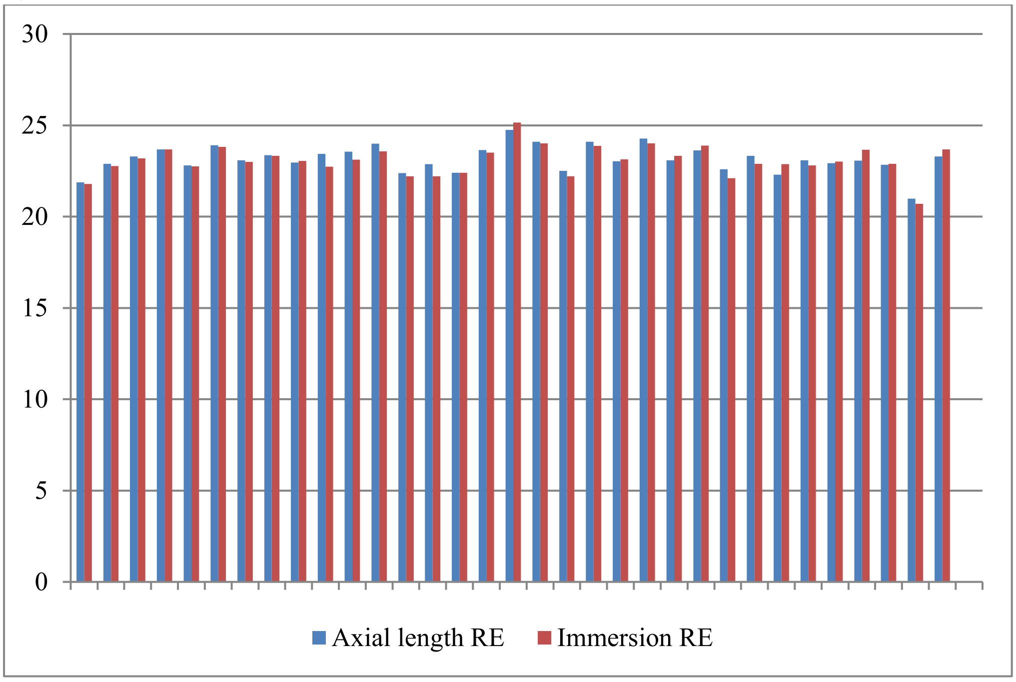

Figure 6: The axial length difference between IOL Master and immersion A-scan for the right eye of age group 60-70

In the 60–70-year age group (n = 34), the right-eye difference between IOL Master and immersion A-scan was 2.97%, comparable to the 50–60-year subgroup. This suggests that moderate divergence between the two techniques persists into the seventh decade, possibly related to increasing cataract density affecting measurement conditions.

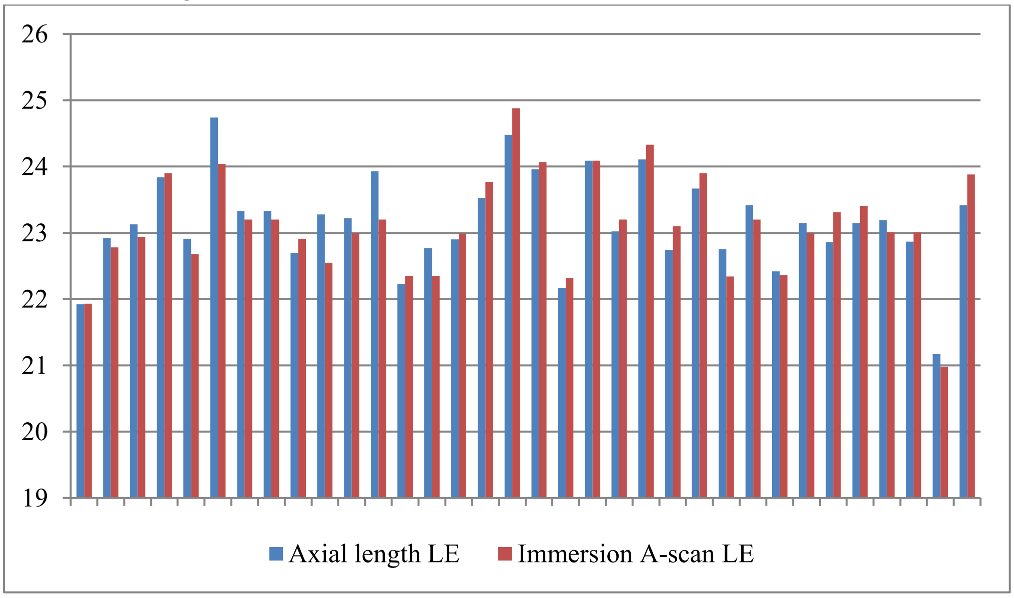

Figure 7: The axial length difference between IOL Master and immersion A-scan for the left eye of age group 60-70

The left eye in the 60–70 year group (n = 34) recorded a difference of 3.03%, closely matching the right eye value for the same subgroup. The consistency between both eyes reinforces that this age group, as a whole, shows a modest but symmetrical divergence between the two biometry methods.

Age group 70-85 year

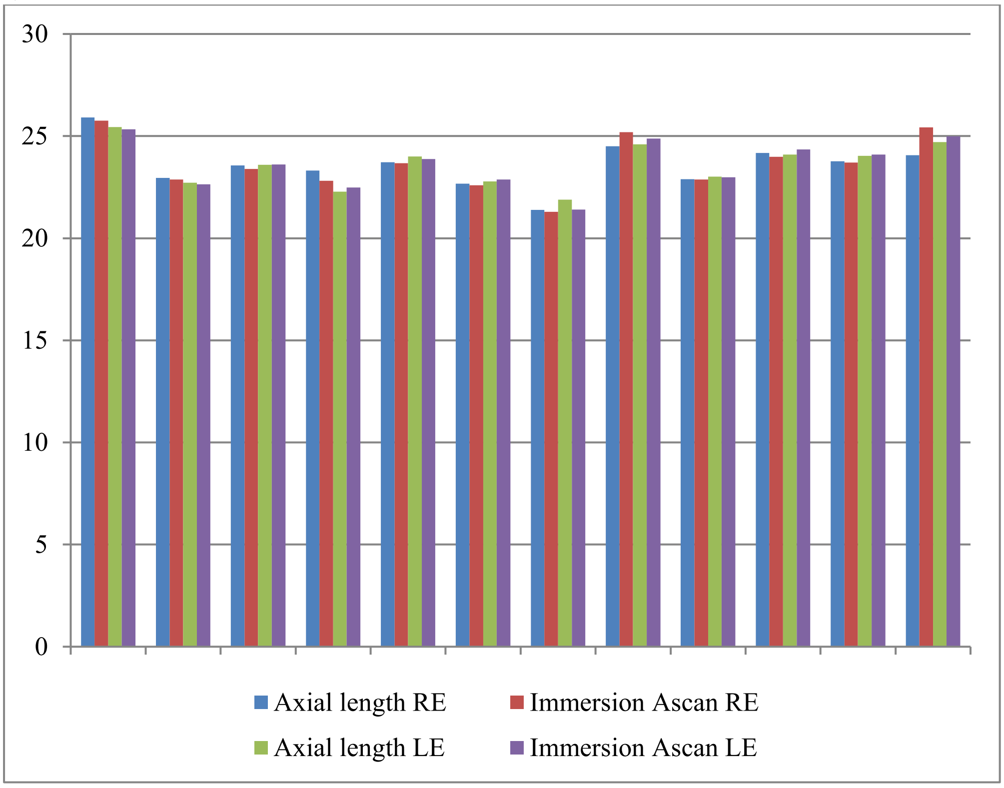

Figure 8: The axial length difference between IOL Master and immersion A-scan for the right and left eye of age group 70-85

In the oldest age group, 70–85 years (n = 12), the differences fell sharply to 0.41% (right eye) and 0.39% (left eye), the lowest values recorded in the study. This indicates very close agreement between IOL Master and immersion A-scan in elderly patients, despite this group having the smallest sample size.

Discussion

The overall pattern shows that percentage differences between IOL Master and immersion A-scan were smallest in the youngest (35–50 years: 0.73–0.99%) and oldest (70–85 years: 0.39–0.41%) age groups, while the middle-aged groups (50–70 years) showed comparatively higher, though still modest, differences of 2.97–3.37%. All values remained well within the clinically acceptable range for axial length agreement, and no age group showed a difference likely to translate into a clinically meaningful IOL power error. This pattern suggests that patient age itself does not produce a progressive or linear divergence between the two techniques; rather, the moderate rise seen in the 50–70 year range may reflect greater heterogeneity in lens density or ocular media within these subgroups, affecting both measurement modalities to a small extent. Overall, the consistently low percentage differences across all subgroups affirm that the two techniques measure axial length with a high degree of concordance throughout adult life.

CONCLUSION

This study compared axial length measurements obtained by IOL Master and immersion A-scan across four age groups in patients undergoing cataract surgery. In the 35–50 year group (n = 19), the difference was minimal (RE: 0.99%, LE: 0.729%). The 50–60 year group (n = 35) showed a comparatively larger, though still modest, difference (RE: 3.37%, LE: 2.98%), similar to the 60–70 year group (n = 34; RE: 2.97%, LE: 3.03%). The 70–85 year group (n = 12) again showed very close agreement (RE: 0.41%, LE: 0.39%). Across all age groups, differences remained small and clinically acceptable, with no evidence of a systematic or progressive bias between the two techniques. These findings confirm that both IOL Master and immersion A-scan ultrasonography provide accurate and dependable axial length measurements for preoperative biometry, and either instrument can be confidently used in routine cataract surgical planning across the full adult age spectrum.

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