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Research Article

Ultrasonic

Comparison of IOL power & axial length estimated by optical biomicroscopy and ultrasonic biometry.

Chandra M.[1], Konda K.[2], Mounic S.[3], Sreevathsala T.[4*]

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[1] M. Ramesh Chandra, Associate Professor, Department of Ophthalmology, Santhiram Medical College and General Hospital, Kurnool, Andhra Pradesh, India.

[2] Kavya Konda, Assistant Professor, Department of Ophthalmology, Santhiram Medical College and General Hospital, Kurnool, Andhra Pradesh, India.

[3] S. Mounic, MBBS, Department of Ophthalmology, Santhiram Medical College and General Hospital, Kurnool, Andhra Pradesh, India.

[4*] T. Sreevathsala, Assistant Professor, Department of Ophthalmology,, Santhiram Medical College and General Hospital, Kurnool, Andhra Pradesh, India.

Aim: To compare IOL power & axial length estimated by optical biometry (OB) and ultrasonic biometry (UB). **Material & methods:** A prospective & comparative study was planned to compare axial length & IOL power calculated by Appa Scan AME - 01A (Appasamy Associates, India) (UB) & IOL master 500 (Carl Zeiss Meditec, Jena, Germany) (OB). Autokeratometry evaluated using IOL master 500 & SRK/T formula were taken for IOL power estimation. Spss software version 20.0 was used for analysis. **Results:** Overall agreement between UB & OB for axial length & IOL power was excellent (weighted kappa 0.807 & 0.825 respectively). **Conclusion:** Ultrasound biometry, a cost-effective method for IOL power & axial length calculation, still holds value as compared to optical biometry for routine cataract surgeries.

Keywords: Optical biometry, Ultrasonic biometry, IOL power

Corresponding Author	How to Cite this Article	To Browse
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Introduction

A cataract is one of the most common causes of visual impairment in the world. According to the World Health Organisation (WHO), cataract is the leading cause of blindness all over the world, responsible for 47.8% of blindness and accounting for 17.7 million blind people. In India, 80% of the blindness is due to cataract.

An increasing number of technologies have been introduced over time to assist in the biometric measurement of the eye, further enhancing refractive accuracy and precision as an achievable quality metric [1-5].

The refractive outcome after cataract surgery is dependent on several factors, including axial length, keratometry, anterior chamber depth, and lens formulas. Of these factors the preoperative measurement of axial length (AL) is considered to be a key determinant in calculating the IOL power to be implanted. Historically, applanation ultrasound (UB) biometry has been the most commonly used technique for AL measurement among biometrics. More recently, partial coherence laser interferometry (Optical biometry) has gained preference for calculating AL measurements for IOL implantation.

Partial coherence interferometry-based instruments, such as Zeiss IOL Master and Haag-Streit Lenstar, are most commonly used for IOL power calculation in developed countries. IOL Master is regarded as the gold standard in optical biometry. However, US biometry remains the preferred method for measuring AL and calculating IOL power, due to familiarity with the technique and cost in developing countries or when measurements by optical biometry are inadequate due to dense ocular media such as mature or hypermature cataract, severe posterior capsular opacity, or a posterior segment abnormality such as vitreous hemorrhage or poor fixation. It is generally believed that OB offers superior accuracy of the AL measurement and the IOL implant power calculation compared with (UB) [6-8].

Very few comparative studies found optical biometry to be comparable to that of high-precision immersion ultrasound, however in denser cataract the later had an advantage [9-10].

On contrary, a randomized controlled trial by Raymand S et al found no significant advantage of OB over UB [11].

This study was planned to find agreement of IOL power calculation between OB and UB for different axial lengths.

Material & methods

This prospective, consecutive, comparative & single centre study was conducted over 2 months (January & February 2019). Cataract surgery posted patients requiring IOL power calculation were included in the study after obtaining informed consent. Institutional ethics committee approval was obtained.

Patients having corneal opacities, pterygium, dense mature cataract & inability to fixate the target for IOL power calculation were excluded from the study.

For all the patients, autokeratometry evaluated using IOL master 500 (Carl Zeiss Meditec, Jena, Germany) was taken for IOL power estimation. It was followed by axial length estimation by IOL master 500. Ultrasound biometry was done using Appa Scan AME - 01A (Appasamy Associates, India) after instilling topical 0.5% paracaine eye drops and taking universal sterility precautions for each patient. Optical biometry based IOL power calculation was done with IOL master 500. SRK/T formula was used to calculate IOL power by both methods. Spss software version 20.0 was used for analysis.

Results

A total of 102 eyes of 102 participants were included in the study (47 males 46.1%; 55 females 53.9%). The mean age of the population was 60.9 ± 8.8 years [Range: 33 – 88 years]. The mean IOL power difference between the two methods was not significant (p-value =1, Table 2). The overall agreement between the two methods was excellent for axial length calculation (weighted kappa=0.807) as well as for IOL power calculation (weighted kappa= 0.825).

Table 1: Age distribution of participants

Age group	No. of Cases	Percentage
31 – 40	01	0.98%
41 – 50	13	12.7%
51 – 60	38	37.3%
61 – 70	38	37.3%
71 – 80	09	8.82%
>80	03	2.9%
Total	102	100%

Table 2: Comparison of IOL Power between UB and OB methods:

	Ultrasound Biometry	Oprical Biometry	p-value
Mean IOL power	21.5 ± 3.1	21.5 ± 3.3	1.0

Independent Student's t-test. (p-value <0.05 significant)

Table 3: Agreement between UB & OB for different axial lengths

Axial length	Agreement (kappa) between A-scan biometry & IOL master	Std Error
<20 mm	-	-
20–21mm	0.00	0.00
21–22mm	0.390	0.125
22–23mm	0.430	0.072
23–24mm	0.695	0.061
24–25mm	0.172	0.170
25–26mm	0.00	0.00
>26mm	0.00	0.00

(0.00 values came because of only 2 values in that category)

Table 4: Overall agreement for axial length measurement between UB & OB

Weighted Kappaa	0.807
Standard error	0.046
95% CI	0.717 to 0.896

Table 5: Overall agreement for IOL power calculation between UB & OB

Weighted Kappaa	0.825
Standard error	0.031
95% CI	0.764 to 0.886

Discussion

Preoperative biometry performed using A-scan ultrasonography uses the echo delay time to measure intraocular distances. It has a longitudinal resolution of 200 μm and an accuracy of 100–120 μm in measuring axial lengths. Studies have shown that an error of 100 μm in axial length measurement could lead to 0.28 D of postoperative refractive error. Further, the ultrasound technique requires contact with the eye for measuring the axial length and the applanation method suffers from the disadvantage of corneal indentation during measurement. Recently, optical coherence tomography has found its clinical application in preoperative biometry. This technique aims to improve the precision in axial length measurements using the principle of partial coherence laser interferometry (PCLI).

A dual-beam of infrared light (780 nm) of short coherence length (160 μm) with different optical lengths is emitted by a laser diode source. The eye to be measured and the photodetector is situated at each leg of the interferometer. Both partial beams are reflected at the corneal surface and the retina (RPE). Interference occurs if the path difference between the beams is smaller than the coherence length. The interference signal received by the photodetector is measured depending on the position of the interferometer mirror, which could be measured precisely. This measurement gives the optical length between the corneal surface and the retina. The optical distance is used to derive geometric intraocular distances by incorporating the group refractive indices of the respective ocular media (cornea, lens, aqueous and vitreous humour). This technique of optical biometry is reported to have a high resolution (12 μm) and precision (0.3–10 μm) in measuring intraocular distances as compared to conventional ultrasound [12].

It is generally agreed that accurate biometry is the most important factor in achieving a successful refractive outcome after lens implantation and currently UB is the most widely used technique for biometry. It is generally accepted that the IOL Master offers superior reproducibility of AL measurement in comparison with ultrasound biometry. It is also apparent that the most significant limitation of OB is poor laser penetration in eyes with dense media opacities such as posterior subcapsular cataract [9-11].

Haigis et al [9] reported that the IOL Master and ultrasound have statistically significant differences in their AL measurements and IOL power (using LADAS formula) for normal, long and short eyes. The difference between the two devices in the normal and long eye groups was clinically negligible.

Immersion UB was found as good as OB is other studies [9,10] which is in-sync with the findings of our study underlines the importance of immersion UB in routine clinical practice.

The most widely used UB is much cost-effective as compared to the IOL master. Our study shows excellent agreement between OB & UB for IOL power calculation which is similar to a randomized trial by Raymand et al [11].

No significant statistical difference between ocular biometry of immersion ultrasound, partial coherence interferometry observed by Montés-Micó R et al

[13], is similar to our study where we found no difference between OB & UB for axial length measurement as well as for IOL power calculation.

Limitations of this study being a small sample size, lack of comparison for small (< 20 mm) as well as large axial length (> 26mm) eyes & dense cataract cases.

Conclusion

There is excellent agreement between ultrasound biometry & optical biometry (IOL master) for the calculation of axial length & IOL power calculation.

What does the study add to the existing knowledge?

Ultrasound biometry, a cost-effective technique, still holds importance in the era of optical biometry for routine cataract surgeries.

Author's contribution

Dr. M. Ramesh Chandra: Concept

Dr. Kavya Konda: Study design

Dr. S. Mounica: Manuscript preparation

Dr. T. Sreevathsala: Manuscript preparation

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