Original Article

Comparing A-Mode Biometry, B-Mode Biometry and IOL Master in Measurement of Axial Length

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Abstract

Background: To perform a comparison of axial length (AL) measurements using A-mode biometry, B-mode biometry and IOL Master.

Material and Methods: Axial length among patients undergoing cataract surgery in Basir Eye Clinic, Tehran, Iran from May 2017 and September 2017 was determined pre-operatively using three methods. Axial length was first measured using IOLMaster 500 (Carl Zeiss Meditec, Jena, Germany), then by A-mode biometry using immersion technique and finally using horizontal axial B-scan immersion biometry. The interval between each examination was 5 minutes.

Results: Statistical analysis revealed strong correlations between AL measurement values obtained from A-mode and B-mode ($r = 0.983$, $P < 0.001$), A mode and IOLMaster ($r = 0.999$, $P < 0.001$) as well as B-mode and IOLMaster ($r = 0.984$, $P <0.001$). All correlations were strong but the strongest correlation was observed between A mode and IOLMaster methods.

Conclusion: A-mode biometry showed a stronger correlation with IOL Master AL readings compared to B-Mode, thus when there are limited resources and the optical method is not accessible, A-mode immersion echography is proffered as an alternative to IOLMaster.

Keywords: Biometry; IOLMaster; Axial Length; Comparison.

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Introduction

Cataract accounts for 51 % of all-causes of blindness and represents a major cause of visual impairment [1]. The prevalence of cataract-associated blindness might have decreased recently with the increase in cataract surgical coverage, but it is still the leading cause of blindness worldwide [2,3].

The overall success of a cataract surgery is defined by the final refractive outcomes and patient satisfaction. An accurate intra ocular lens (IOL) calculation is necessary for achieving acceptable refractive outcomes. Several mathematical formulas have been proposed for IOL refractive power calculation, with most of them requiring precise calculation of eye biometric indices such as axial length (AL), keratometry (K) values, and anterior chamber depth (ACD). A previous study has reported that 54 % of the errors in predicting refraction after IOL implantation can be attributed to errors in AL measurements [4].

Different devices for measuring AL use diverse methodologies. Traditionally, AL has been measured using ultrasound biometry, as the most accessible technique, including immersion A-mode ultrasonography, which used to be the gold standard technique for AL calculation. The AL measurement by A-mode ultrasound is obtained through using a 10 MHz probe, which allows a resolution of 200 µm and a longitudinal clinical accuracy of 100 µm to 200 µm [5]. The accuracy of A-mode biometry relies on the proper detection of macular vitreoretinal interface, anterior and posterior lens capsules and front surface of the cornea [6]. The most concerning limitation of A-mode biometry is among patients with myopic staphyloma. In these patients an oblique rather than orthogonal interception of the ultrasound beam by the vitreoretinal interface reduces the chance of accurate identification of foveolar area [7].

Immersion B-mode biometry is a two-dimensional axial section that represents the cross vector interfaces from anterior cornea to the macula [8].

Optical biometry is a fast and easy-to-use technique. The advantages of optical biometry include reduced risk of trauma and infection, patient comfort, as well as accuracy and repeatability of measurements. At present, optical biometry with the IOLMaster is considered the gold standard for AL measurement, but this method also has some limitations such as difficulty in accurate AL measurement in presence of a dense media opacity and in case of poor fixation by the patients [4, 9].

Due limited number of studies comparing these methods of AL measurement we performed the present study to compare these three methods of AL measurement in eyes candidate for cataract surgery.

Material and Methods

This study included cataract surgery candidates admitted to Basir Eye Clinic, Tehran, Iran, in a 5 months period between May 2017 and September 2017. All the candidates included in the study were informed about the goal and procedures of the study and signed an informed consent. The present study was approved by the ethics committee of Tehran University of Medical Sciences. Exclusion criteria were the presence of any ocular pathology including corneal defects such as corneal opacity, ecstasy or dystrophy of the eye, iris anomalies, morphological abnormalities of the lens, intravitreal hemorrhage, any history of severe eye trauma, retinal detachment and ocular inflammation.

Axial length was first measured using

IOLMaster 500 (Carl Zeiss Meditec, Jena, Germany), then by A-mode biometry using immersion technique (VuMAX HD, Sonomed Escalon, New Hyde Park, NY) and finally using horizontal axial B-scan immersion biometry. The interval between each examination was 5 minutes.

For conducting the IOLMaster measurement the patients were seated behind IOLMaster machine with their eyes fixed on the target. Partial coherence laser was flashed and the axial length was recorded.

In order to obtain AL using immersion A-mode biometry, an experienced optometrist administered a drop of Tetracaine 0.5 % in supine position. Then a scleral shell was placed to keep the eyelids open. Furthermore the eye was irrigated with balanced salt solution (BBS) to have a suspension and conduction media for the 10MHZ transducer probe of the ultrasound device. The patients were told to look at a red light produced by the probe to keep the eye at a fixed position. The probe was gently located on the BSS bath and moved manually to become aligned with eye axis and to attain consistent and high peaked spikes. AL was calculated using the machine caliper by marking the echo from anterior corneal surface to the posterior corneal surface, then calculating the distance from posterior corneal surface to the anterior lens surface, then measuring the interval between the spike from anterior and posterior lens and finally marking the echo interval between posterior lens surface and retina. All these measurements were consequently corrected according to their velocity. Sum of the corrected intervals equated the AL measurement.

B-mode visualized a two dimensional image of intraocular structures parallel to A-mode trace shown at the bottom of the display. The image was frozen at the optimal axial section and the control vector passing the pupil was aligned with anterior and posterior corneal interfaces. Further alignment was performed manually based on anterior and posterior lens surface and macular retinal interface. The length of each ocular segment was corrected with consideration of sound celerity in each ocular media similar to the A-mode biometry. An average of three consecutive AL measurements in different planes was considered the final AL measurement.

We employed the fourth-generation (Haigis, and Barrett Universal II) formulas to assess IOL power using the AL measured by IOLMaster. All patients underwent phacoemulsification surgery in which the original lens was removed and replaced with IOL in the capsular bag.

A day after surgery the eyes were examined to detect any probable infection or surgical complications. Further examinations including combined spherical and cylindrical refraction measurements were performed one week, one month and three months postoperatively.

Statistical analysis

All data were analyzed using SPSS version 23 (Armonk, NY: IBM Corp.). In order to describe the data we used mean, standard deviation, median, and range parameters. The axial lengths measured with the three methods were then compared using repeated measures analysis, paired sample t test and Pearson correlation. P-values less than 0.05 were considered statistically significant.

Results

A total of 350 eyes from 350 patients (161 female and 189 male patients) were included in our analysis. The mean age of the participants was 45.6 ± 7.3 years ranging from 21 to 75

Table 1: Demographic data of patients entering the study

Characteristics		Patients
Age (y)	Mean	45.6 ± 7.3
	Range	21-75
Sex	Male	189
	Female	161
Number	Left eye	188
	Right eye	162

years. Table 1 represents demographic data of our patients.

Table 2 shows the comparison of the mean AL values obtained from each measurement method.

Table 3 shows the correlation between the AL measurements obtained from the three methods. Strong correlations between AL measurement values obtained from A-mode and B-mode ($r = 0.983$, $P < 0.001$), A mode and IOLMaster ($r = 0.999$, $P < 0.001$) as well as B-mode and IOLMaster ($r = 0.984$, $P < 0.001$ were observed. All correlations were strong but the strongest correlation was observed between A mode and IOLMaster methods.

Table 3: Correlation of AL measurements using three different methods

Methods	Correlation (Pearson)	
	r	*P*
A-scan , B-scan	0.983	<0.001
A-scan , IOLMaster	0.999	<0.001
B-scan , IOLMaster	0.984	<0.001

*Based on Pearson correlation

Discussion

The AL is defined as the distance from the anterior surface of cornea to the foveal vitreoretinal interface. Accurate measurement of the ocular axial length is extremely important for accurate IOL power calculation, since axial length measurement is the major identifiable source of error in this regard [10,11]. A 0.1 mm error in axial length calculation is equivalent to an error of about 0.27 D in the spectacle plane, so assuming normal eye dimensions an accuracy of within 0.1 mm is necessary in AL calculation [8]. Currently, the axial length is obtained using either the A-scan ultrasound or the IOLMaster which is the gold standard [12].

In the present study the AL was determined by three methods; at first the patients went through an optical biometry, then immersion

Table 2: Comparison of the mean AL measurements using three different methods

Description	A mode	B mode	IOLMaster	P value
A mode- B mode- IOLMaster	23.32 ± 1.38	23.42 ± 1.39	23.35 ± 1.4	<0.001*
A mode- B mode	23.32 ± 1.38	23.42 ± 1.39	-	<0.001**
A mode- IOLMaster	23.32 ± 1.38	-	23.35 ± 1.4	<0.001**
B mode- IOLMaster	-	23.42 ± 1.39	23.35 ± 1.4	<0.001**

*Based on repeated measure

**Based on paired sample t test

A-scan, and eventually the B-scan was used for AL measurement.

At present the IOLMaster device being more user-friendly and less time consuming is considered to be the gold standard in AL measurement [13,14]. This modality measures the interval between the corneal surface and the retinal pigment epithelium whereas ultrasonic biometry calculates the distance of anterior corneal surface to the internal limiting membrane [14]. IOLMaster is a noninvasive method which utilizes partial coherence interferometry technology and consequently provides much more precise and high resolution results with lower reported infection incidence comparing to the ultrasound technique [15]. However, assessment of AL by optical biometry cannot always replace the ultrasound methods as it is not applicable in patients with dense or subcapsular cataracts. Tehrani et al., [16] observed that the AL of the 17 % of the cataractous eyes in their study could not be succussfuly measured by IOLMaster. The limitations were mainly due to dense cataract and low visual acuity [16]. However this percentage in our study turned out to be about 8 %, which was approximately the same as another study reporting a 5-8 % failure of IOLMaster in measuring AL.

The optical technique is less operator dependent, while ultrasound necessitates a skilled and educated observer. In addition, IOLMaster does not require anesthesia [17]. On the other hand ultrasound methods are less expensive compared to optical ones. There are few contraindications for ultrasound measurements mainly in suspected ocular globe rupture in traumatic patients or patients with recent surgery due to the possible dislocation of ocular contents. B-mode biometry is preferred when the vitreous chamber and the retina are not observable in cases of very mature cataracts, Vitreous hemorrhage, corneal opacities, blood or pus in the anterior chamber and lesions of the posterior segment [18]. Immersion B-mode scan displays a two-dimensional image with adjustable brightness, discriminating various biometric interfaces needed for AL measurement, such as the echoes from anterior lens or iris and provides a clear view of the macular region [6,8]. Furthermore, the ocular position can be adjusted during the measurement process concerning the visual content of the images. The control vector also allows a more accurate placement of the electronic measuring scale and results in better alignment [8]. In a group of highly myopic patients Yang et al., [19] noticed that immersion B-Scan measurement is more accurate than A-scan and is comparable to IOLMaster measurements.

Our results indicated that the A-mode immersion scan and IOLMaster have more similar readings, thus when there are limited resources or when optical method is not accessible, A-mode immersion can be used as an alternative; while B-mode immersion might be a better substitute in highly myopic eyes or eyes with ocular pathologies. With development of newer technologies like swept-source optical coherence tomography, we recommend future studies comparing AL measurement agreement between newer methods and the IOLMaster.

Conclusion

A-mode biometry showed a stronger correlation with IOLMaster AL readings compared to B-Mode, thus when there are limited resources and the optical method is not accessible, A-mode immersion echography is proffered as an alternative to IOLMaster.

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Footnotes and Financial Disclosures

Conflict of interest

The authors have no conflict of interest with the subject matter of the present study.