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Comparison of Anterior Chamber Depth Measured by IOLMaster and A-Scan Ultrasonography

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ABSTRACT

Objective: To compare anterior chamber depth measurements by ultrasound A-scan and IOLMaster, and evaluate interdevice agreement and interchangeability.

Study Design: Cross-sectional study.

Place and Duration of Study: Study was conducted on subjects attending preoperative cataract surgery clinic at Armed Forces Institute of Ophthalmology, Rawalpindi Pakistan, from Nov 2018 and Jan 2019.

Methodology: Eighty subjects between 15 to 80 years of age were enrolled in the study. Biometric measurements of all subjects were carried out by a single investigator. The values obtained were compared using paired t-test, Pearson correlation and Bland-Altman analysis.

Results: Sixty-two men and eighteen women were examined. Mean age was 61.3 ± 11.8 years. Mean anterior chamber depth was 3.25 ± 0.42 mm with A-scan and 3.25 ± 0.47 mm with IOLMaster. Mean difference was 0.007 ± 0.32 mm which was not statistically significant (p=0.852). The values were significantly correlated (r=0.749, p<0.001) and had no significant proportional bias (p=0.138). There was good agreement between the two devices for anterior chamber depth measurement. Anterior chamber depth was found to be positively correlated with axial length, negatively correlated with age and not correlated with intraocular pressure.

Conclusion: Ultrasound A-scan and IOLMaster have good agreement in measuring anterior chamber depth. Any difference between them is not statistically significant and is unlikely to be clinically important.

Keywords: Anterior Chamber, Anterior Chamber, Interferometry, Reproducibility, Ultrasonography.

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INTRODUCTION

Anterior chamber depth is an established anterior segment parameter that represents the distance between corneal endothelium and anterior lens surface. It is influenced by various factors such as gender, age, refractive error and race.[1] With the recent advancements in cataract and refractive surgery and the higher expectations of patients with regards to postoperative results, accurate measurement of ocular dimensions has gained considerable importance. Precise biometry is essential in achieving the desired post-surgical refractive outcome and latest generation intraocular lens (IOL) power formulas increasingly depend on role of preoperative anterior chamber depth (ACD) measurement as considerable amount of refractive errors after IOL implantation may be attributed to inaccuracy in ACD measurement.[2-4] In addition, with shallow anterior chamber depth, there is anticipated increased risk of corneal endothelial injury during surgery which warrants the assessment of anterior chamber depth before planning cataract surgery.[5] Furthermore, anterior chamber depth has gained importance as a risk factor for primary angle closure glaucoma in certain racial groups and may be used as a screening parameter in the near future.[6,7]

Different methods are available for measuring the ACD, based on ultrasonic, optical and photographic techniques.[8] The most commonly used method is A-scan contact ultrasound which uses 10-MHz ultrasound waves to measure ocular dimensions and has long been considered as the gold standard for biometry. In comparison, newer non-contact devices include IOLMaster which uses partial coherence interferometry to provide ocular measurements. It is considered to be superior to ultrasound method on the basis of being a non-contact and operator independent device. However, due to its high cost, it is not available at most centres in Pakistan in contrast to A-scan ultrasound which is more widely available. The purpose of this study was to establish the normative values of anterior chamber depth for our population and to compare the two abovementioned modalities used for its measurement to determine whether both are comparable and interchangeable. As a secondary objective, it was determined whether axial length (AL) influences device interchangeability in measuring ACD and whether there is any correlation between IOP and ACD in our population.

METHODOLOGY

The cross-sectional study was conducted at AFIO Rawalpindi Pakistan, from November 2018 and January 2019 after approval by the ethical committee (Reg no. 199/ERC/AFIO). The sample size was calculated using WHO calculator with confidence interval 95%, absolute precision 15%, population Mean 3.02 and SD 0.46.[9] The sample size obtained was 37 but we included 80 subjects in this study. Consecutive sampling technique was used for the study.

The subjects were patients attending the preoperative clinic for cataract surgery assessment. Informed consent was taken from them prior to inclusion in the study and ophthalmic examination was performed, including

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uncorrected and corrected visual acuity assessment, slit lamp examination, fundoscopy and Goldmann applanation tonometry.

Inclusion Criteria: Healthy subjects with normal slitlamp and fundoscopic examinations, and steady central fixation was included in the study.

Exclusion Criteria: Subjects with history of ocular trauma or prior surgery, history of glaucoma, known anterior or posterior segment pathology and patients with pharmacologically dilated pupils (to ensure a physiologic condition of eye during examination).

The anterior chamber depth was measured with IOLMaster 700 (Carl Zeiss Meditec AG, Germany) followed by Ultrasound A-scan (PacScan 300, Sonomed, USA). For IOLMaster, the subjects were seated in front of the device and positioned using forehead and chin rest. They were instructed to keep both eyes open and fixate on the target. A-scan was performed using a contact probe after instillation of topical anaesthetic (0.5% proparacaine hydrochloride) eye drops. The subjects were instructed to fixate on a distant target with the opposite eye. Five readings were taken with each device and their average value was used in the data analysis. All AL measurements were taken with A-scan as IOLMaster could not obtain these measurements in patients with dense cataracts. Data collection proforma was filled for record keeping. All measurements/examinations were carried out by single person to exclude observer bias.

Statistical analysis was performed using Statistical Program for Social Sciences (SPSS) version 16.0. For analysis of difference between ultrasound and optical measurements, the paired two-tailed t-test was applied and for correlation analysis, Pearson correlation method was used. The agreement between the devices was evaluated using Bland-Altman analysis which determines the 95% limits of agreement (LoA) and plots the differences between the devices against their means.[10] It was used to show any relation between the differences and the size of measurements and to look for any systematic bias. A *p*-value less than or equal to 0.05 was considered significant.

RESULTS

In this study, 80 eyes of 80 subjects were examined. The mean age was 61.3 ± 11.8 years (range 15-80 years). There were 18 females (22.5%) and 62 males (77.5%). The mean anterior chamber depth was 3.25 ± 0.42 mm with ultrasound A-scan and 3.25 ± 0.47 mm with IOLMaster. The mean difference between the measurements recorded by the two devices was 0.0066 ± 0.32 mm with a 95% CI ranging from -0.06 to 0.08. The difference was not statistically significant (*p*=0.852) and the effect size was very small (Cohen d=0.02). As shown in Figure-1, the ACD values measured by A-scan and IOLMaster had significant positive correlation (r=0.749, *p*<0.001). Table-I shows comparison between measurements of A-scan and IOLMaster in different population subgroups.

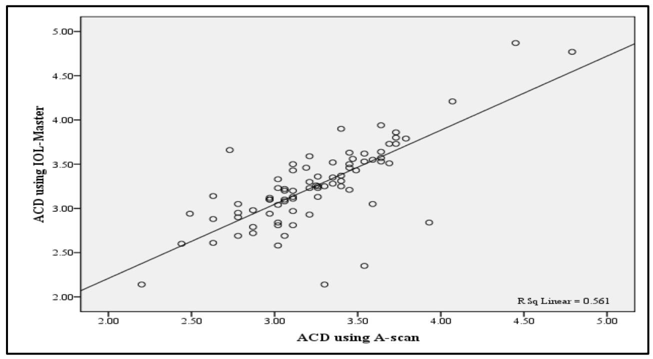

Figure-1: Correlation between ultrasound and optical measurements.

The mean axial length (AL) measured by A-scan was 23.34 ± 0.88 mm. It was significantly correlated with the ACD values measured by A-scan (r=0.439, *p*<0.001) and by IOLMaster (r=0.482, *p*<0.001). There was negative correlation between age of the subjects and the ACD measured by A-scan (r=-0.248, *p*=0.026) and IOLMaster (r=-0.230, *p*=0.04). The mean IOP of the examined subjects was 15.3 mmHg and it had no significant correlation with ACD measured by either device (r= -0.095, 0.097; *p*=0.43, 0.42, respectively).

The 95% limits of agreement (95% LoA) were defined for the assessment of inter-device agreement and interchangeability. For the measurement of ACD, the limits were -0.62-0.63. The Bland-Altman plot (Figure-2) was constructed with the horizontal axis representing the mean values for ACD and the vertical axis showing the difference between IOLMaster and A-scan measurements. The solid line depicts the mean difference between ACD measurements of the two devices and the dotted lines denote the 95% LoA. Simple linear regression was carried out to rule out any proportional bias and the result was not statistically significant (β=0.167, t(79)=1.497, *p*=0.138, R2=0.028).

Table-I: Comparison of measurements of Anterior Chamber Depth with ultrasound A-scan and IOLMaster.

		ACD using A-Scan	ACD using IOL-Master	Difference	Correlation	
		Mean ± SD (mm)	Mean ± SD (mm)	*p*-value	r	*p*-value
Gender	Male	3.31 ± 0.43	3.30 ± 0.50	0.96	0.739	<0.001
	Female	3.05 ± 0.30	3.09 ± 0.28	0.45	0.737	<0.001
Eye length	Normal (22-24.5mm)	3.22 ± 0.40	3.21 ± 0.44	0.89	0.742	<0.001
	Long (>24.5mm)	3.64 ± 0.42	3.77 ± 0.50	0.14	0.916	0.004
	Short (<22mm)	3.10 ± 0.38	3.09 ± 0.40	0.98	-0.351	0.649

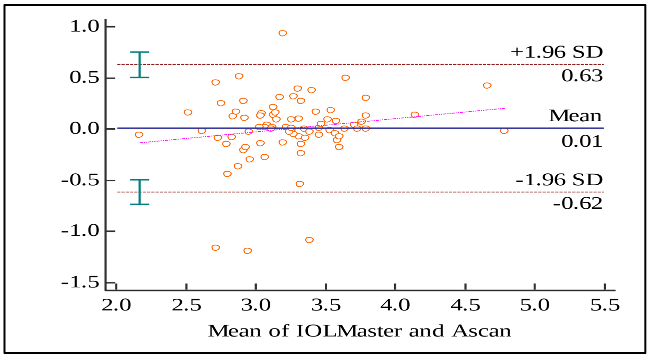

Figure-2: Bland-Altman plot comparing IOLMaster with A-scan for Anterior Chamber Depth assessment.

Solid line = mean difference. Dashed lines = upper & lower limits of 95% LoA. Dotted line = regression line.

DISCUSSION

With the growing demands for accurate ocular biometry measurements, assessment of anterior chamber depth has become progressively more important in ophthalmology practice. In this study, ultrasound and optical methods of ACD measurement were compared so that surgeons could know the ACD that the other device would yield without the need for having the device in their clinic.

Both devices have their advantages and disadvantages. A-scan is a contact method which can cause indentation of the cornea during measurement and the accuracy of measured values is influenced by various factors such as experience of the operator in handling its probe and different settings of the ultrasound velocity. On the other hand, IOLMaster is a non-contact device which can be used with minimal training and can obtain additional data in a single examination. However, in eyes with dense cataract, corneal opacity, vitreous haemorrhage, nystagmus, and high myopia, optical measurements are often unsuccessful and necessitate the need for conventional ultrasound assessment.[11] In such cases, ultrasound is the method of choice and will remain so for the foreseeable future.[12]

The results from this study demonstrated that ultrasound A-scan and IOLMaster have no statistically significant difference in anterior chamber depth measurements. There is strong correlation between the values measured by the two devices across different gender and axial length groups (Table-I) as well as age. The Bland-Altman plot was constructed to assess interdevice agreement. It shows that at shallower AC depths, the A-scan tended to give higher values than IOLMaster while at deeper AC depths, IOLMaster tended to give higher values than A-scan. Regression analysis showed that despite this trend, there is no statistically significant difference or systematic bias between the measurements of the A-scan and IOL Master, and there appears to be considerable agreement between the two devices in measuring the ACD.

The results of this study were in contrast to previous studies, which have showed conflicting results. According to Elbaz *et al*[13], ultrasound measurements of ACD were higher as compared to those of IOLMaster with a mean interdevice difference of -0.004mm. Dong *et al*[9] compared ACD measurements in eyes with normal, long and short axial lengths and found that the values of IOLMaster were higher than those of ultrasound in each group. They concluded that the two instruments have agreement in measuring ACD for long eyes but differ in the groups with normal and short eyes. Several studies showed an opposite result where the ACD measurements of IOL Master were found to be higher than the ultrasound group.[12,14-16] Lam *et al*[14] stated that the mean difference between optical and ultrasonic biometry was 0.15mm whereas Hashemi *et al*[15] found a mean difference of 0.09mm but stated that in spite of the difference in measurements, there was good agreement between ultrasound and IOLMaster. Similarly, Bai *et al* noted a high degree of agreement between the measurement values.[16]

The contradictory results were attributed to several factors: difference in measurement techniques (i.e. ultrasound and optical), potentially different states of accommodation during each measurement, and effect of operator experience on the performance.[17] Despite these differences, contact ultrasound and IOL Master have been shown to have adequate repeatability of ACD and AL measurements for clinical use.[14,16]

In the past few years, many studies have suggested that the measurement of anterior chamber depth may have a potential role in screening of primary angle closure glaucoma patients. Devereux *et al* conducted a study on an East Asian population and concluded that axial anterior chamber depth may be used as a screening tool for early detection of occludable angles in a primary prevention program.[6] Kaygisiz *et al* studied patients with pseudoexfoliation and found that they had deeper ACD than normal subjects.[18] Elgin *et al* found similar results in a group of patients with juvenile open-angle glaucoma.[19] In our study, IOP of the subjects was compared to their anterior chamber depths to find any association but no significant correlation was noted between the two. This suggests that it may not be beneficial to use ACD as a screening tool in our population. This result was comparable to the studies done by Adewara *et al* and Wang *et al* who likewise found no significant association between ACD and IOP.[20,21].

LIMITATIONS OF STUDY

First, the sample size for long and short eyes was not large enough to draw conclusive results about those subgroups. A larger scale study is recommended to evaluate interdevice agreement across different axial length groups. Second, ACD was checked with undilated pupils to allow the subjects to fixate easily on the target and to obtain the measurement in a physiologic condition. However, the potential influence of a subject's accommodation state on the measurements cannot be excluded without cycloplegia.[4,22,23] Furthermore, the pupils of patients are dilated before surgery which may alter the peroperative anterior chamber depth. Therefore, future studies should aim to measure ACD in both undilated and dilated conditions.

CONCLUSION

This study showed that there is good agreement between ultrasound A-scan and IOLMaster for measuring anterior chamber depth. Any differences between their measurements of ACD were statistically insignificant and are unlikely to be clinically important. Therefore, ultrasound can be reliably used for planning of cataract and refractive surgeries in the absence of more advanced devices.

Confict of Interest: None.

Authors' Contribution

SA: Data collection, article writing, AA: Reviewed the article, AY: Concept and design, reviewed the article, AA: Data collection, analysis, FK: Abstract writing.

REFERENCES

1. Fernández-Vigo JI, Fernández-Vigo JÁ, Macarro-Merino A, Fernández-Pérez C, Martínez-de-la-Casa JM, García-Feijoó J. Determinants of anterior chamber depth in a large Caucasian population and agreement between intra-ocular lens Master and Pentacam measurements of this variable. Acta Ophthalmol 2016; 94(2): e150-5. doi: 10.1111/aos.12824.
2. Ning X, Yang Y, Yan H, Zhang J. Anterior chamber depth - a predictor of refractive outcomes after age-related cataract surgery. BMC Ophthalmol 2019; 19(1): 134.
3. Jeong J, Song H, Lee JK, Chuck RS, Kwon JW. The effect of ocular biometric factors on the accuracy of various IOL power calculation formulas. BMC Ophthalmol 2017; 17(1): 62. doi: 10.1186/s12886-017-0454-y.
4. Avdagic E, Lazzaro DR. Evaluation of the Effect of Cycloplegia on Anterior Chamber Depth in Cataract Patients Using Optical Low-Coherence Reflectometry. Eye Contact Lens 2018; 44 Suppl 1: S59-S61. doi: 10.1097/ICL.0000000000000322.
5. Nanu RV, Ungureanu E, Istrate SL, Vrapciu A, Cozubas R, Carstocea L et al. Investigation of importance of the structural parameters of the eyeball and of the technical parameters of cataract surgery on corneal endothelial changes. Rom J Ophthalmol 2018; 62(3): 203-211.
6. Devereux JG, Foster PJ, Baasanhu J, Uranchimeg D, Lee PS, Erdenbeleig T, et al. Anterior chamber depth measurement as a screening tool for primary angle-closure glaucoma in an East Asian population. Arch Ophthalmol 2000; 118(2): 257-63.
7. Li X, Wang W, Huang W, Chen S, Wang J, Wang Z et al. Difference of uveal parameters between the acute primary angle closure eyes and the fellow eyes. Eye (Lond) 2018; 32(7): 1174-1182. doi:10.1038/s41433-018-0056-9.
8. Barrett BT, McGraw PV. Clinical assessment of anterior chamber depth. Ophthalmic Physiol Opt 1998; Suppl 2: S32-9.
9. Dong J, Zhang Y, Zhang H, Jia Z, Zhang S, Wang X. Comparison of axial length, anterior chamber depth and intraocular lens power between IOLMaster and ultrasound in normal, long and short eyes. PLoS One 2018; 13(3): e0194273. doi: 10.1371/journal.pone.0194273.
10. Bland JM, Altman DG. Measuring agreement in method comparison studies. Stat Methods Med Res 1999; 8: 135–60.
11. Shen P, Zheng Y, Ding X, Liu B, Congdon N, Morgan I, et al. Biometric measurements in highly myopic eyes. J Cataract Refract Surg 2013; 39(2): 180-7. doi: 10.1016/j.jcrs.2012.08.064.
12. Németh J, Fekete O, Pesztenlehrer N. Optical and ultrasound measurement of axial length and anterior chamber depth for intraocular lens power calculation. J Cataract Refract Surg 2003; 29(1): 85-8.
13. Elbaz U, Barkana Y, Gerber Y, Avni I, Zadok D. Comparison of different techniques of anterior chamber depth and kerato-metric measurements. Am J Ophthalmol 2007; 143(1): 48-53.
14. Lam AK, Chan R, Pang PC. The repeatability and accuracy of axial length and anterior chamber depth measurements from the IOLMaster. Ophthalmic Physiol Opt 2001; 21(6): 477-83.
15. Hashemi H, Yazdani K, Mehravaran S, Fotouhi A. Anterior chamber depth measurement with a-scan ultrasonography, Orbscan II, and IOLMaster. Optom Vis Sci 2005; 82(10): 900-4.
16. Bai QH, Wang JL, Wang QQ, Yan QC, Zhang JS. The measurement of anterior chamber depth and axial length with the IOLMaster compared with contact ultrasonic axial scan. Int J Ophthalmol 2008; 1(2): 151–4.
17. Findl O, Kriechbaum K, Sacu S, Kiss B, Polak K, Nepp J, et al. Influence of operator experience on the performance of ultrasound biometry compared to optical biometry before cataract surgery. J Cataract Refract Surg 2003; 29(10): 1950-5.
18. Kaygisiz M, Elgin U, Tekin K, Sen E, Yilmazbas P. Comparison of anterior segment parameters in patients with pseudo-exfoliation glaucoma, patients with pseudoexfoliation syndrome, and normal subjects. Arq Bras Oftalmol 2018; 81(2): 110-115. doi: 10.5935/0004-2749.20180025.
19. Elgin U, Şen E, Uzel M, Yılmazbaş P. Comparison of Refractive Status and Anterior Segment Parameters of Juvenile Open-Angle Glaucoma and Normal Subjects. Turk J Ophthalmol 2018; 48(6): 295-298. doi: 10.4274/tjo.68915.
20. Adewara BA, Adegbehingbe BO, Onakpoya OH, Ihemedu CG. Relationship between intraocular pressure, anterior chamber depth and lens thickness in primary open-angle glaucoma patients. Int Ophthalmol 2018; 38(2): 541-547. doi: 10.1007/s10792-017-0488-4.
21. Wang S, Zhuang W, Ma J, Xu M, Piao S, Hao J, et al. Association of Genes implicated in primary angle-closure Glaucoma and the ocular biometric parameters of anterior chamber depth and axial length in a northern Chinese population. BMC Ophthalmol 2018; 18(1): 271. doi: 10.1186/s12886-018-0934-8.
22. Momeni-Moghaddam H, Maddah N, Wolffsohn JS, Etezad-Razavi M, Zarei Ghanavati S, Akhavan Rezayat A, et al. The Effect of Cycloplegia on the Ocular Biometric and Anterior Segment Parameters: A Cross-Sectional Study. Ophthalmol Ther 2019; 8(3): 387-395. doi: 10.1007/s40123-019-0187-5.
23. Özyol P, Özyol E, Baldemir E. Changes in Ocular Parameters and Intraocular Lens Powers in Aging Cycloplegic Eyes. Am J Ophthalmol 2017; 173: 76-83. doi: 10.1016/j.ajo.2016.09.032.

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