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Original Article

Inter-Observer Reproducibility of Axial Ocular Measurements with Non-contact HAAG-STRAIT Biometer

Muhammad Suhail Sarwar[1], Sehrish Shahid[2], Muhammad Arslan Ashraf[3], Shaista Kanwal[4]
[1-4]*Department of Ophthalmology, Mayo Hospital, Lahore*

ABSTRACT

Purpose: To check inter observer reproducibility of axial ocular measurements i.e. central corneal thickness (CCT), anterior chamber depth (ACD), aqueous depth (AD), lens thickness (LT), anterior segment lens (ASL), vitreous length (VL) and axial length (AL) with non-contact HAAG-STRAIT biometer.

Study Design: Comparative Reproducibility Analysis.

Place and Duration of Study: College of ophthalmology and allied vision sciences (COAVS), Mayo Hospital, Lahore.

Methods: This study included 66 healthy students (132 eyes). Data was collected through self-designed proforma by 2 operators independently. SPSS 21 was used for data analysis. Interclass correlation was applied for agreement between the two readings. Interclass coefficient (ICC) value greater than 0.7 was considered as excellent correlation.

Results: The mean CCT, AD, ACD, LT, ASL, VL, and AL were 526.47 ± 35.72 µm and 526.47 ± 36.06 µm (ICC = 0.92); 2.93 ± 0.29 mm and 2.93 ± 0.29 mm (ICC = 0.81); 3.45 ± 0.30 mm and 3.46 ± 0.30 mm (ICC = 0.79); 3.58 ± 0.28 mm and 3.56 ± 0.22 mm (ICC = 0.76); 7.03 ± 0.30 mm and 7.02 ± 0.27 mm (ICC = 0.80); 16.56 ± 0.85 mm and 16.62 ± 0.81 mm (ICC = 0.72); and 23.59 ± 0.85 mm and 23.64 ± 0.87 mm (ICC: 0.76) of observer 1 and 2, respectively.

Conclusion: Non-contact Biometer (HAAG-STRAIT) has high inter-observer reproducibility with strong interclass coefficient of greater than 0.72.

Key Words: Biometry, Axial Length, Central Corneal Thickness, Anterior Chamber Depth.

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INTRODUCTION

In last few decades, modernizations such as phacoemulsification, ocular biometry and intraocular lens (IOL) power estimate formulas have improved the refractive outcomes of cataract surgery.[1-3] To encounter these prospects, consideration to precise biometry reading is critical. In recent cataract surgery and corneal refractive surgery, the biometric parameters like corneal curvature, CCT (central corneal thickness), ACD (anterior chamber depth), LT (lens thickness) and AL (axial length), ASL, VL are the most significant to achieve good refractive results.[4,5] Like contact biometer, Optical biometry gives IOL power calculation which is the key to get an emmetropic outcome after the surgery.[6-10]

Correspondence: Muhammad Arslan Ashraf
Department of Ophthalmology, Mayo Hospital, Lahore
Email: rajkumararslan@yahoo.com

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Non-contact optical biometry devices use the principle of partial coherence interferometry (PCI). It uses a 780-nm semiconductor diode laser. Besides AL, it can also measure ACD and keratometry (K) based on 6 points of reference in a 2.3 mm zone. It has an accuracy of ± 0.02 mm for AL measurement; with excellent reproducibility compared with ultrasound devices.[11] It also measures CCT which is important in vision improvement surgeries e.g. laser in situ keratomileusis (LASIK), as well as in glaucoma diagnosis and other corneal diseases. In addition, it can also provide measurements for LT.[11-13]

This non-contact technique is associated with increased patient comfort and decreased risk for corneal complications when compared with immersion ultrasound biometry. It also allows for patient fixation during the measurement process, which increases the likelihood of the AL measurement being directly aligned to the fovea. However, obtaining measurements can be tough and less reliable in the human eyes with corneal opacities, dense posterior sub-capsular cataracts (PSC), macular disease, and poor fixation.[11,14]

This study was done to find out the repeatability of axial ocular measurements i.e. CCT (central corneal thickness), ACD (anterior chamber depth), LT (lens thickness), anterior segment lens (ASL), vitreous length (VL) and AL (axial length) measured with non-contact biometer in patients visiting Mayo Hospital Lahore.

METHODS

It was a comparative reproducibility analysis and 132 was the sample size of healthy individuals who were students of college of ophthalmology and allied vision sciences (COAVS), Mayo hospital, Lahore. The mean age of males was 20.73 ± 2.337 and females was 21.17 ± 2.514 (Table 1). The sampling technique used in this study was non-probability convenient sampling. Patients with poor fixation, any opacity other than cataract or any other ocular pathology were excluded. Equipment used was pen torch, slit lamp and non-contact Biometer (Haag Streit model: LS 900). Log MAR visual acuity chart was used for visual acuity. Patients with visual acuity of 0.5 Log MAR or better were included. Age, gender and literality were independent variables while axial ocular parameters like CCT, ACD, AD, LT, ASL, VL and AL were dependent variables. Quantitative variables like age, CCT, AD, ACD, LT, ASL, VL and AL were presented as mean ± SD. SPSS 21 software was used for data analysis. Interclass correlation was applied for agreement between the two readings. Interclass coefficient (ICC) value greater than 0.7 was considered as excellent correlation.

RESULTS

Table 2 shows the mean axial ocular measurements, measured by observer 1 and 2. Interclass correlation showed excellent correlation between the two CCT readings (0.921), as well as between two readings of AD (0.813), ACD (0.792), LT (0.757), ASL (0.795), VL (0.719) and AL readings (0.759).

Table 1: *Descriptive statistics of Age distribution among gender.*

Descriptive Statistics

Gender		N	Minimum	Maximum	Mean		Std. Deviation
		Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Female	Age	74	18	28	20.73	.272	2.337
Male	Age	58	18	28	21.17	.330	2.514

Table 2: *Descriptive statistics of CCT, AD, ACD, LT, ASL, VL and AL measured by observer I and II.*

Descriptive Statistics

	Minimum	Maximum	Mean		Std. Deviation	Intra-class Correlation		Mean Diff.	Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic	Single Measures	Average Measures		
CCT1	432	601	526.4697	3.10887	35.71824	.921[a]	.959[c]	0	14.355
CCT2	430	610	526.4697	3.13861	36.05984				
AD1	2.23	3.84	2.935	0.02529	0.29052	.813[a]	.897[c]	0.001	0.17912
AD2	2.25	3.86	2.934	0.02552	0.29322				
ACD1	2.49	4.37	3.4522	0.02574	0.29574	.792[a]	.884[c]	-0.008	0.18911
ACD2	2.72	4.38	3.4602	0.02518	0.28932				
LT1	2.7	4.43	3.5752	0.02062	0.23693	.757[a]	.862[c]	0.0135	0.16016
LT2	3.06	4.43	3.5617	0.01935	0.22237				
ASL1	5.65	7.92	7.0273	0.02596	0.29826	.795[a]	.886[c]	0.0055	0.18216
ASL2	6.32	7.99	7.0219	0.02337	0.26847				
VL1	14.28	18.75	16.5575	0.07441	0.85495	.719[a]	.837[c]	-0.0574	0.62425
VL2	15.32	18.94	16.6148	0.0706	0.81115				
AL1	21.63	25.71	23.58482	0.07425	0.853064	.759[a]	.863[c]	-0.0519	0.59786
AL2	21.99	25.8	23.6367	0.07568	0.86948				

a. The estimator is the same, whether the interaction effect is present or not.
b. Type A intra-class correlation coefficients using an absolute agreement definition.
c. This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

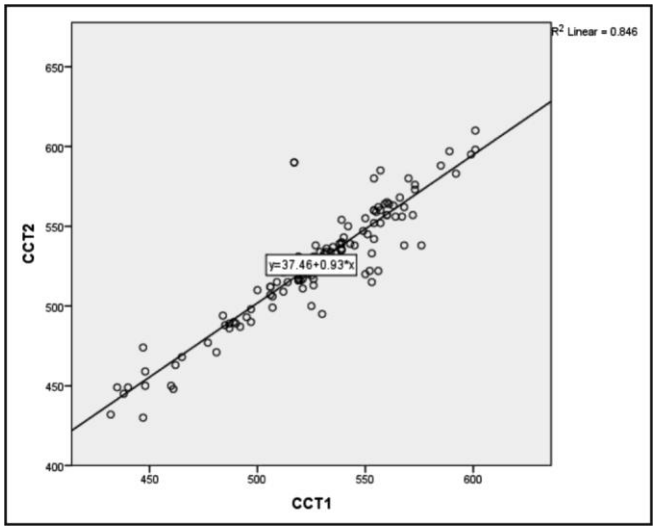

Figure 1: scatter chart showing regression value (0.846), strong relationship between both measurements of CCT.

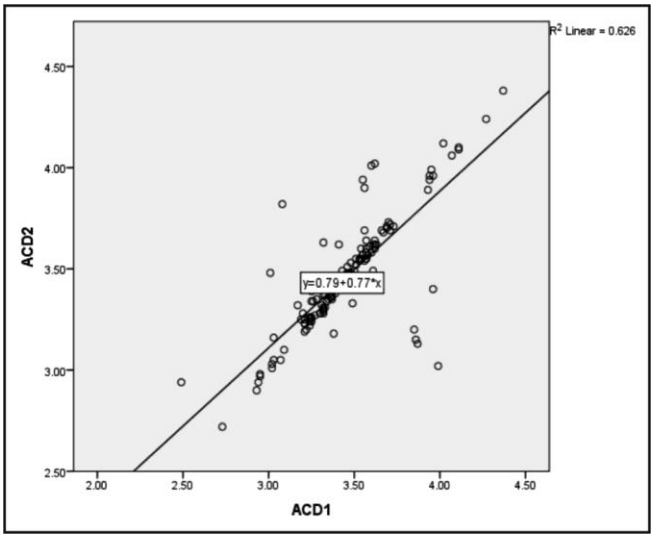

Figure 2: scatter chart showing regression value (0.676), moderate relationship between both measurements of ACD.

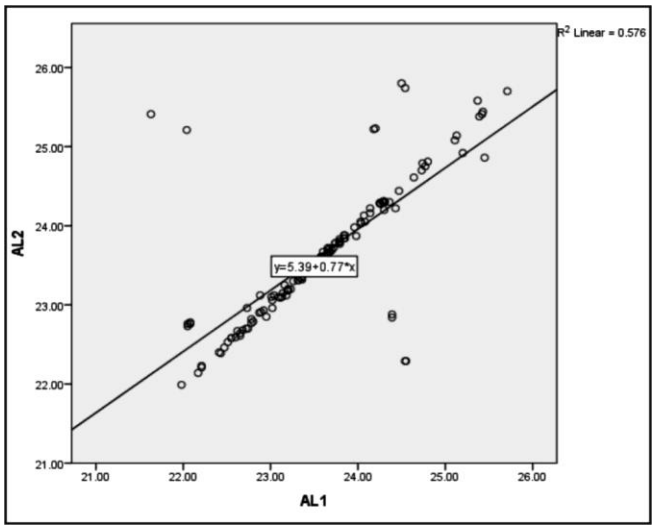

Figure 3: Scatter chart showing regression value (0.576), moderate relationship between both measurements of AL.

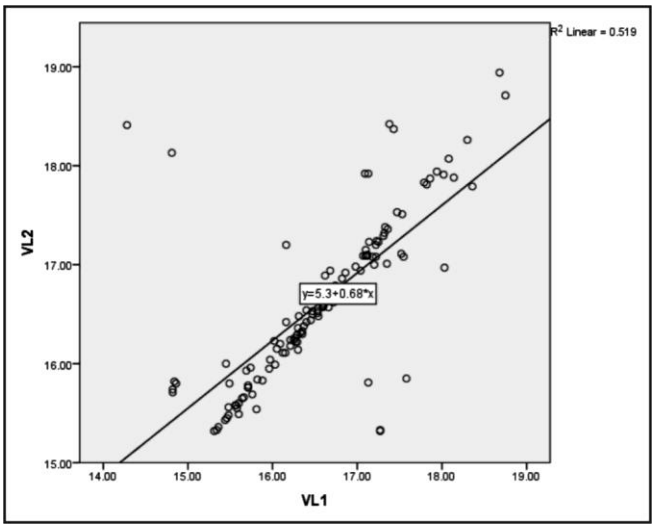

Figure 5: Scatter chart showing regression value (0.519), moderate relationship between both measurements of VL.

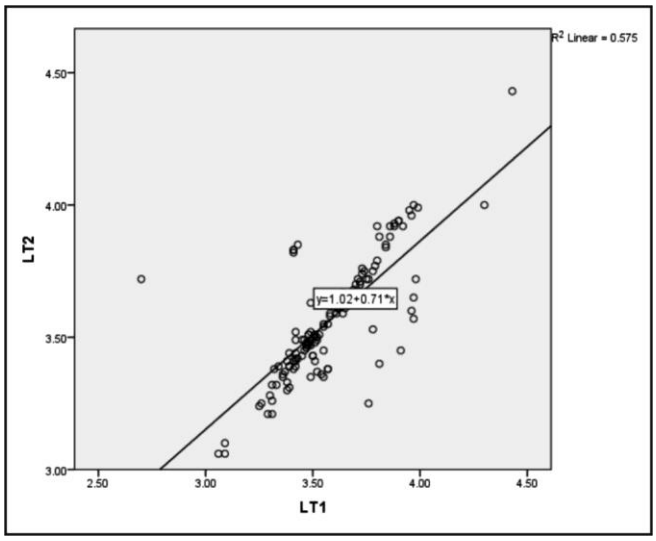

Figure 4: Scatter chart showing regression value (0.575), moderate relationship between both measurements of LT.

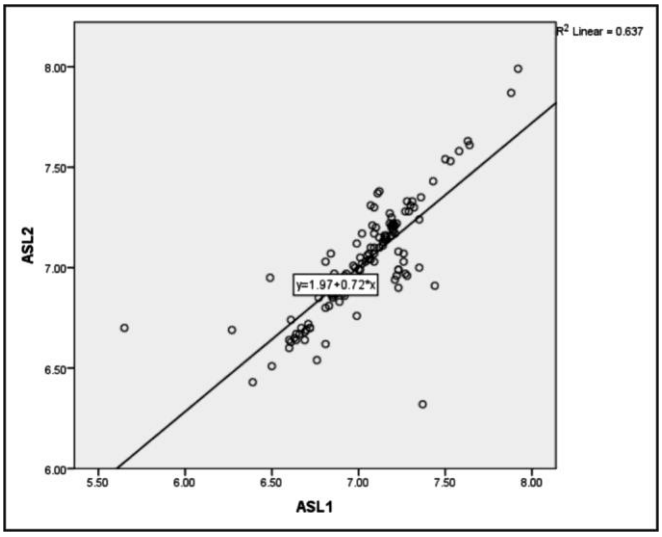

Figure 6: Scatter chart showing regression value (0.637), moderate relationship between both measurements of ASL.

DISCUSSION

Optical biometry is being widely used by ophthalmologists to measure axial ocular measurement of eyes and to calculate the intraocular lens power excluding 5 to 10 percent of those eyes with dense cataract or poor fixation. With the help of biometer we can measure the CCT, AD, LT, AL and IOL power of eye. The accuracy of all parameters that can be measured by optical biometer is imperative for exact intraocular lens power calculation. In this study, like in some previous studies CCT, AD, ACD, ASL, VL and AL measurements have been performed by 2 observers.

Andrew KC et al. showed a study to assess the repeatability and accuracy of non-contact device. The AL and ACD were measured by two practitioners independently by using non-contact biometer followed by ultrasound. There was good repeatability of AL and ACD. There was no difference on AL and ACD between the two practitioners.[15] Andrew Carkeet et al. also found the AL and ACD measurements with non-contact showed better repeatability. The mean difference of AL and ACD between the readings 2 and 1 was -0.006 mm and 0.009 mm, respectively.[16] L P J Cruysberg and co-workers evaluated the reproducibility with non-contact biometer of the

Lenstar LS 900. CCT, ACD, LT and AL were attained to regulate the reproducibility of the Lenstar. The reproducibility of the Lenstar was more than 0.9%; for CCT, ACD, LT, K values and AL measurements. Even though all correlations were highly significant (p, 0.001). The reproducibility of the Lenstar was excellent.[17]

In another study, the exactness of axial length measurements was tremendously high with ICC of 0.759.[18] Some of the measurements can be little different when taken by different instruments and technicians, but some of these measurements should be firmly checked in cases like central corneal thickness and cases of glaucoma or refractive surgery evaluation.

This study measured the mean CCT of observer 1 and 2 as 526.47 ± 35.72 µm and 526.47 ± 36.06 µm, respectively. Interclass correlation (ICC) showed excellent correlation between the two reading (ICC: 0.921). Ramazan Yagc et al, also reported that the assortment of agreement for reproducibility was great for the measurements of central corneal thickness (1.610 and 3.077 for normal eyes and for the eyes with keratoconus, respectively).[18] Bengu E. found correlation coefficient to be 99.3% for Lenstar and 99.2% for UP (ultrasound pachymetry). The measurements taken by the two different technicians seemed to agree in a high level for both Lenstar (r = 0.993) and ultrasound pachymetry (r = 0.957). The actual importance of this study was that sample size was large and the interobserver unpredictability was estimated for both OLCR (optical low-coherence reflectometry) and UP (ultrasound pachymetry).[19]

In our study, mean AD was 2.9350 ± 0.291 mm and 2.934 ± 0.293 mm of observer 1 and 2, respectively. ICC showed excellent correlation between two reading (ICC: 0.813). The mean ACD of observer 1 and 2 was 3.452 ± 0.296 mm and 3.460 ± 0.289 mm of observer 1 and 2, respectively. ICC showed excellent correlation between two reading (ICC: 0.792). According to a former study of Lenstar device, the accuracy of measurement of anterior chamber depth was high and the assortment of agreement was 0.025 millimeter and 0.069 millimeter in normal (emmetropic) eye and the eye with keratoconus, respectively. According to the assessment of Haigis formula, which uses the preoperative measurement of anterior chamber depth in the calculation of intraocular lens power, a difference of 0.06 millimeter in ACD affects the ultimate refraction by only 0.05 D.[18] J. S Shammas et al. also found that, with ICC of 0.946 the accuracy of the ACD measurements was high.[20]

In our study, ICC showed excellent correlation between two LT readings (ICC: 0.757). H. John Shammas found high accuracy of the measurement of LT, with an ICC of 0.963. Ramazan Yagc et al, found that the non-contact biometer attained brilliant reproducibility for the measurements of axial length (assortment of agreement 0.038 and 0.041 for normal eyes and eyes having keratoconus, respectively). In a usual eye, a difference of 0.04 millimeter affects the final refraction by almost 0.10 D.[18]

Limitation of this study are small sample size and it was a single center study. More data for our population is needed for further evaluation. This study can be improved with the participation of more than two observers. Moreover, comparison of reproducibility and repeatability of non-contact with contact biometer can also be done.

CONCLUSION

It is concluded that non-contact biometer (HaigStrait) has high reproducibility. The interclass coefficient value for CCT, AD, ACD, LT, ASL, VL and AL is greater than 0.7.

Ethical Approval

The study was approved by the Institutional review board/ Ethical review board.
(Ref No. COAVS/276/2021)

Conflict of Interest

Authors declared no conflict of interest.

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Authors' Designation and Contribution

Muhammad Suhail Sarwar; MS: *Concepts, Design, Manuscript preparation, Manuscript review.*

Sehrish Shahid; Consultant Ophthalmologist: *Literature search, Data acquisition, Data analysis, Manuscript preparation, review.*

Muhammad Arslan Ashraf; Consultant Ophthalmologist: *Literature search, Data acquisition, Data analysis, Statistical analysis, Manuscript review..*

Shaista Kanwal; Consultant Ophthalmologist: *Data acquisition, Manuscript preparation, Manuscript review.*