ORIGINAL
ARTICLE

INTEROBSERVER REPRODUCIBILITY OF AXIAL OCULAR MEASUREMENTS WITH NON-CONTACT HAAG-STREIT BIOM

Submitted: 05 December, 2019
Accepted: 24 February, 2020

Muhammad Suhail Sarwar[1]
Sehrish Shahid[2]
Shaista Kanwal[3]
Muhammad Arslan Ashraf[4]
Fatima Riaz[5]
Fatima Abid[6]
Saiedo Abdi Osman[7]
Agha Saad Khan[8]

For Authors' affiliation & contribution see end of Article

Corresponding Author:

Sehrish Shahid
Trainee Investigative Oculist
College of Ophthalmology & Allied Vision Sciences, Lahore.
sehrish1350@gmail.com

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-Streit biometer.*

***METHOD:** This comparative reproducibility analytical study was conducted at Mayo hospital. This study included 66 healthy students (132 eyes) of College of Ophthalmology and Allied Vision Sciences. Data was collected through self-made Performa by 2 operators independently. Operator 1 was final year student of Investigative Ophthalmology while operator 2 was a graduate. 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:** 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:** It is concluded that non-contact biometer (HAAG-STREIT) has high inter-observer reproducibility with strong interclass coefficient of greater than 0.72.*

***KEYWORDS:** biometry, axial length, central corneal thickness, anterior chamber depth.*

INTRODUCTION

The full-term neonatal eye has a mean AL (axial length) of 16 to 18 millimeters and a mean ACD (anterior chamber depth) 1.5 to 2.9 millimeters. The mean grown-up values of AL are 22 to 25 millimeters and the mean refractive power -25.0±1.0 D. The mean AC (anterior chamber) in a grown emmetropic eye is 3 to 4 millimeters.[1]

Autonomous of cost and other influences, the very first expectancy from surgeon and patient is good visual outcomes after operation. In the last five eras modernizations such as phacoemulsification, ocular biometry and IOL power estimate formula have enhanced noticeably refractive outcome of the cataract surgery.[2] To encounter these prospects, consideration to precise biometry reading is critical. In recent cataract surgery and corneal refractive surgery, the biometric parameters, corneal curvature, CCT (central corneal thickness), ACD (anterior chamber depth), LT (lens thickness), ASL (anterior segment length), VL (vitreous length) and AL (axial length) are the most significant to achieve good refractive results. The normal corneal refractive power, ACD (anterior chamber depth) and AL of the eye are key factors of the essential refractive power, which can be calculated by a variety of formulae.[3] Optical biometry gives IOL power calculation which is main achievement to reach an emmetropic outcome after the surgery. Cataract surgery is feasibly the most commonly used surgical procedure. In surgery for pediatric cataract, the refraction is usually different from what have been prophesied or expected by the surgeon after operation. Several of the late refractive surprises result to myopic shift in refraction from axial eye growth; initial refractive surprises can be attributed to imprecision in intraocular lens power calculation.[4-8] Non-contact biometry devices use the principle of

partial coherent interferometry (PCI). It uses a 780-nm semiconductor diode laser and optical A-scans to determine the 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.[9] As mentioned earlier it also measures Central Corneal Thickness (CCT) which is important in scheming vision improvement surgeries e.g. laser in situ keratomileusis (LASIK), as well as in glaucoma diagnosis and other corneal diseases. In addition, they can provide measurements for K-reading and lens thickness.[9,10] 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.[9] Andrew KC 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 either practitioner.[11] Andrew Carkeet also found the AL and ACD measurements with non-contact showed better repeatability. The mean difference of AL and ACD between the reading 2 and 1 was -0.006 mm and 0.009 mm, respectively.[12] Cruysberg and co-worker evaluated the reproducibility with non-contact biometer of the Lenstar LS 900. Central corneal thickness, anterior chamber depth, lens thickness and axial length were attained to regulate the reproducibility of the Lenstar. The reproducibility of the Lenstar was better 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.[13] This study determined the repeatability of axial ocular measurements i.e. CCT (central corneal thickness), ACD (anterior chamber depth), LT (lens thickness) and AL (axial length) measured with non-contact biometer in patients visiting Mayo Hospital Lahore.

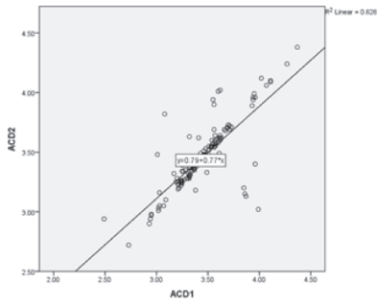
METHODOLOGY

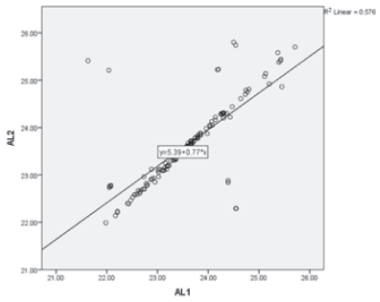
It was comparative analytical study, 132 was the sample size of individuals and they were the student of College of Ophthalmology and Allied Vision Sciences and the data was collected 6 months after the approval of synopsis. The sampling technique used in this study was non-probability convenient sampling. Cooperative patients of both genders more than 18 years of age were included but the patients having poor fixation, any opacity other than cataract or any other pathology were excluded. Equipment used was pen torch, slit lamp and non-contact Biometer (Haag Streit model: LS 900). Age, gender and laterality 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 are 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.

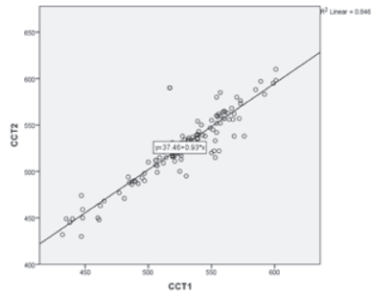
RESULT

Table 1 shows the mean axial ocular measurements, measured by observer 1 and 2. The mean CCT is 526.47±35.72 (SE: 3.11) and 526.47±36.06 (SE: 3.14) of observer 1 and 2, respectively. The mean difference of CCT is 0.00±14.355. Interclass correlation shows excellent correlation between two reading (0.921). The mean AD is 2.9350±0.291 (SE: 0.02529) and 2.934±0.293 (SE: 0.026) of observer 1 and 2, respectively. The mean difference of AD is 0.0010±0.179. Interclass correlation shows excellent correlation between two reading (0.813). The mean ACD is 3.452±0.296 (SE: 0.026) and 3.460±0.289 (SE: 0.025) of observer 1 and 2, respectively. The mean difference of ACD is -0.0080±0.189. Interclass correlation shows excellent correlation between two reading (0.792). The mean LT is 3.575±0.237 (SE: 0.021) and 3.561±0.222 (SE: 0.0193) of observer 1 and 2, respectively. The mean difference of LT is 0.0135±0.160.

Interclass correlation shows excellent correlation between two reading (0.757). The mean ASL is 7.027±0.298 (SE: 0.026) and 7.022±0.268 (SE: 0.023) of observer 1 and 2, respectively. The mean difference of ASL is 0.0055±0.182. Interclass correlation shows excellent correlation between two reading (0.795). The







mean VL is 16.558±0.854 (SE: 0.074) and 16.615±0.811 (SE: 0.071) of observer 1 and 2, respectively. The mean difference of VL is -0.057±0.624. Interclass correlation shows excellent correlation between two reading (0.719). The mean AL is 23.585±0.853 (SE: 0.074) and 23.637±0.869 (SE: 0.076) of observer 1 and 2, respectively. The mean difference of AL is -0.0519±0.598. Interclass correlation shows excellent correlation between two reading (0.759).

Table 1: Descriptive Statistics

	Minimum	Maximum	Mean		Std. Deviation	Intraclass 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 intraclass correlation coefficients using an absolute agreement definition.

c. This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

DISCUSSION

Non-contact biometry was invented in 1999, from that time optical biometry is being widely used by the ophthalmologists to govern the biometry of the required eye and to calculate the intraocular lens power excluding 5 to 10 percent of those eyes having 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, the exactness of axial length measurements was tremendously high with ICC of 0.759.[14]

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 some cases like central corneal thickness in case of glaucoma or refractive surgery evaluation. In this study, like in some previous studies CCT, AD, ACD, ASL, VL and AL measurements have been performed by 2 observers. This study measured the mean CCT of observer 1 and 2 as 526.47±35.72 µm (SE: 3.11) and 526.47±36.06 µm (SE: 3.14), respectively. Interclass correlation (ICC) showed excellent correlation between two reading (0.921).

Ramazan Yagc 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).[14] Intraclass correlation coefficient was 99.3% for Lenstar and 99.2% for UP (ultrasound pachymetry). The measurements taken by the two different technicians seem to agree in a high level for both Lenstar (r = 0.993) and ultrasound pachymetry (r = 0.957).

The actual importance of this study is that: higher numbers of patients have been evaluated than the previous studies and the interobserver un-predictability was estimated for both OLCR (optical low-coherence reflectometry) and UP (ultrasound pachymetry).[15] The mean AD measured was 2.9350±0.291 mm (SE: 0.02529) and 2.934±0.293 mm (SE: 0.026) of observer 1 and 2, respectively. ICC showed excellent correlation between two reading (0.813). The mean ACD of observer 1 and 2 measured as 3.452±0.296 mm (SE: 0.026) and 3.460±0.289 mm of observer 1 and 2, respectively. ICC showed excellent correlation between two reading (0.792).

According to 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.[14]

JS Shammas[16] also found that, with ICC of 0.946 the accuracy of the ACD measurements was high. Mean LT is 3.575±0.237 mm (SE: 0.021) and 3.561±0.222 mm (SE: 0.0193) of observer 1 and 2, respectively. ICC shows excellent correlation between two reading (0.757). H. John Shammas found the accuracy of the measurement of LT was also high, with an ICC of 0.963. Even though the currently used IOL formulas is not taken in consideration for evaluating LT,[11–14] it is a definite constituent in the Holladay 2[15] and the Olsenformulas.[16] The mean ASL was 7.027±0.298 mm (SE: 0.026) and 7.022±0.268 mm (SE: 0.023) of observer 1 and 2, respectively. ICC showed excellent correlation between two reading (0.795). The mean VL was 16.558±0.854 mm (SE: 0.074) and 16.615±0.811 mm (SE: 0.071) of observer 1 and 2, respectively. ICC showed excellent correlation between two reading (0.719). The mean AL was 23.585±0.853 mm (SE: 0.074) and 23.637±0.869 mm (SE: 0.076) of observer 1 and 2, respectively. ICC shows excellent correlation between two reading (0.759).

Ramazan Yagc found that the non-contact 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.[14]

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

RECOMMENDATIONS & LIMITATION

It is recommended that the non-contact biometer is

highly reproducible. This study can be improved with the participation of more than 2 observers. The sample size was smaller, larger data may result in different result.

Authors' Affiliation & Contribution

[1]Prof. Muhammad Suhail Sarwar
Professor of Diagnostic Ophthalmology, COAVS
drsuhail@yahoo.com
Analysis, Results, Discussion

[2]Sehrish Shahid
Trainee Investigative oculist, COAVS
sehrish1350@gmail.com,
Data collection, write up, Methodology

[3]ShaistaKanwal
Investigative Oculist, COAVS
shaistausman13@gmail.com
Data collection, Results

[4]Muhammad Arslan Ashraf
COAVS
rajkumararslan@yahoo.com
Study design, proof reading of manuscript

[5]Fatima Riaz
COAVS
fatimaryaz@gmail.com
Data Collection, proof reading

[6]Fatima Abid
COAVS
fatimaabid308@gmail.com
Data Collection, Literature search

[7]Saiedo Abdi Osman
COAVS
Manaalcdey19@gmail.com
Data collection

[8]Agha Saad Khan
COAVS
aghasaad66@gmail.com
Data collection, methodology

REFERENCES

1. Bhardwaj V, Rajeshbhai GP. Axial length, anterior chamber depth-a study in different age groups and refractive errors. J Clin Diagn Res.2013;7(10):2211-2.
2. Eleftheriadis H. IOLMaster biometry: refractive results of 100 consecutive cases. Br J Ophthalmol. 2003;87(8):960-3.
3. Goyal R, North RV, Morgan JE. Comparison of laser interferometry and ultrasound A-scan in the measurement of axial length. Acta Ophthalmol Scand. 2003;81(4):331-5.
4. Cao X, Hou X, Bao YJJoo. The ocular biometry of adult cataract patients on lifeline express hospital eye-train in rural China. J Ophthalmol. 2015;1(1):171564.
5. Aydin R, Erdur SK, Cabuk KS, Karahan E, Kaynak SJE, lens c. Comparision of optical low coherence reflectometry versus ultrasonic biometry in high hypermetropia. CLAO. 2018;44(1):S115-S7.
6. Çınar Y, Cingü AK, Şahin M, Şahin A, Yüksel H, Türkcü FM, et al. Comparison of optical versus ultrasonic biometry in keratoconic eyes. J Ophthalmol. 2013;1(1):481238.
7. Erb-Eigner K, Hirnschall N, Hackl C, Schmidt C, Asbach P, Findl OJIo, et al. Predicting lens diameter: ocular biometry with high-resolution MRI. IOVS. 2015;56(11):6847-54.
8. Trivedi RH, Wilson MEJO. Axial length measurements by contact and immersion techniques in pediatric eyes with cataract. Ophthalmology. 2011;118(3):498-502.
9. Guimarães de Souza R, Montes de Oca I, Esquenazi I, Al-Mohtaseb Z, Weikert MP. Updates in Biometry. Int Ophthalmol Clin. 2017 Summer;57(3):115-124. doi: 10.1097/IIO.0000000000000175.
10. Huang J, Lu W, Savini G, Chen H, Wang C, Yu X, et al. Comparison between a new optical biometry device and an anterior segment optical coherence tomographer for measuring central corneal thickness and anterior chamber depth. J Ophthalmol. 2016;1(1):6347236.
11. 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.
12. Carkeet A, Saw S-M, Gazzard G, Tang W, Tan DT. Repeatability of IOLMaster biometry in children. Optom Vis Sci. 2004;81(11):829-34.
13. Cruysberg LP, Doors M, Verbakel F, Berendschot TT, De Brabander J, Nuijts RM. Evaluation of the Lenstar LS 900 non-contact biometer. Br J Ophthalmol. 2010;94(1):106-10.
14. Yağcı R, Güler E, Kulak AE, Erdoğan BD, Balcı M, Hepşen İF. Repeatability and reproducibility of a new optical biometer in normal and keratoconic eyes. J Cataract Refract Surg. 2015;41(1):171-7.
15. Koktekir BE, Gedik S, Bakbak B. Comparison of central corneal thickness measurements with optical low-coherence reflectometry and ultrasound pachymetry and reproducibility of both devices. Cornea. 2012;31(11):1278-81.
16. Shammas HJ, Hoffer KJ. Repeatability and reproducibility of biometry and keratometry measurements using a noncontact optical low-coherence reflectometer and keratometer. Am J Ophthalmol. 2012;153(1):55-61.