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Agreement of Ocular Biometry Measured by LenStar LS 900 and CASIA2 Optical Coherence Tomography

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ABSTRACT

Introduction: The present study aimed to compare the anterior segment measurements between optical low-coherence reflectometry (LenStar LS900) and anterior segment optical coherence tomography (CASIA2 OCT).
Methods:A total of 198 right eyes of 198 healthy participants were used for the current study, according to the inclusion and exclusion criteria. Ocular biometry parameters, such as central corneal thickness (CCT), anterior chamber depth (ACD), keratometry, and anterior chamber width (ACW), were measured usingLenStar LS 900 and CASIA2 OCT. The differences and correlations were assessed between these two instruments. The agreement was calculated as the 95% limits of agreement (LoA).
Results: Among 198 subjects with a mean age of 29.39±7.88 years who enrolled in the study, 106 individuals (53.5%) were women. The mean CCT values were 531.7±35.25 and 527.3±37.82 µm for LenStar and OCT, respectively (P<0.0001). The ACD measurements showed 2.92±0.40 and 2.95±0.43 mm for LenStar and OCT, respectively (P=0.0549). The ACW mean values were 12.04±0.52 and 11.79±0.49 mm by LenStar and OCT (P<0.0001). The 95% LoA between the two instruments were within the ranges of -20.79 to 29.43 µm, -0.50 to -0.43 mm, -0.32 to 0.82 mm, and -0.70 to 0.87 D for CCT, ACD, ACW, and astigmatism, respectively.
Conclusion: LenStar and OCT showed to have interchangeable ACD measurements; however, the results of CCT, ACW, and corneal astigmatism measured by these two instruments demonstrated clinically significant differences.

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Introduction

With recent advances in ocular surgeries, the accuracy of ocular biometry becomes important in order to satisfy patients' expectations (1).

Axial length (AL), corneal power, and anterior chamber depth (ACD) are essential elements for intraocular lens (IOL) calculations in cataract surgery. The assessment of central corneal thickness (CCT) is also an important factor in refractive surgeries, corneal diseases, and glaucoma (2).

Several methods have been developed for biometry evaluations, such as slit-lamp biomicroscopy, scheimflug imaging, A-scan ultrasounds, ultrasound biomicroscopy, (UBM) and Purkinje reflexes (3).

Since the advent of IOL Master, optical bi-

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ometry has been the gold standard for ocular biometric parameters (4).

LenStar has been designed according to Optical Low Coherence Reflectometry technology using a broadband light (wavelength: 820 µm) (5). It can simultaneously measure nine parameters, including AL, ACD, CCT, lens thickness (LT), keratometry, retinal thickness, white-to-white (WTW) and optical line eccentricity, (6) in approximately 20 seconds for each measurement (7).

The Tomey CASIA2 is a swept-source spectral domain (SD) optical coherence tomography (OCT) employing low-coherence interferometry technology to provide high-resolution cross-sectional images of the anterior ocular segment by a 1310 nm wavelength light as an earlier time domain OCT device. It can also measure CCT, ACD, keratometry, and anterior chamber width (ACW)(8,9).

Both LenStar and CASIA2 OCT devices have previously shown repeatable measures of anterior segment dimensions (8,10); however, their measurements may not be necessarily interchangeable. The main advantage of these two instruments over ultrasound devices is non-contact property measurement (11).

With this background in mind, the purpose of the current study was to compare the ocular biometric parameters between CAIA2 OCT and LenStar in a normal population and assess the agreement of these parameters between the two devices.

Methods

A total of 198 right eyes of 198 participants (92 male and 106 female subjects) with best-corrected visual acuity of 6/6 or better were recruited for the current study. The participants with any history of ocular diseases or surgery were excluded from the study population. Written consent was obtained from all the study subjects after a complete explanation of the study.

The study followed the principles of the Declaration of Helsinki and was approved by the Research Ethics Committee of Mashhad university of medical sciences with an approval code of 941712.

All the subjects underwent anterior segment OCT (AS-OCT) imaging using Tomey CASIA2 and non-contact biometry using LenStar LS 900. Five consecutive scans were performed on the CASIA2 in "Anterior Chamber" mode. The cornea was centered for each scan session producing 128 cross-sectional images. The CASIA software automatically specified intraocular structures and showed measurement values after defining scleral spurs.

For LenStar, the device was aligned to ensure that all readings were taken on the visual axis. Blinking and loss of fixation were automatically detected. Sixteen consecutive scans were obtained by LenStar per measurement without realignment, and five serial measurements were automatically averaged to be displayed on the monitor.

The CCT, ACD, keratometry, and ACW measurements were obtained for the right eye using both devices. This allocation was regardless of the ocular dominance, refraction, or aberrations. The order of the measurement of instruments was randomized, and all the measurements for each subject were performed at a single session.

All the statistical analyses were performed using GraphPad Prism software (version 6). The quantitative data are expressed as mean± standard deviation (SD). A paired t-test was used for the determination of the differences in biometry parameters between the two instruments. The Pearson correlation coefficient was utilized to evaluate the correlation between the measurements of the two instruments.

The 95% limits of agreement (LoA) that are the mean difference ± 1.96 times the SD of the differences were detected by the Bland-Altman plot. These limits showed the level of agreement between the measurements of the two devices to be interchangeably used. A p-value of less than 0.05 was considered statistically significant.

Results

Among 198 participants with a mean age of 29.39±7.88 years (range: 18-50 years) who enrolled in the study, 106 (53.5%) individuals were female. The mean spherical equivalent (MSE) was -0.80±1.68 D (range: -4.50 to +3.98 D). Table 1 shows six different parameters measured by LenStar and CASIA2 OCT.

A paired t-test analysis indicated significantly smaller values of CCT and ACW measured by CASIA2 OCT, compared to those reported for LenStar ($P<0.0001$ and $P<0.0001$, respectively). The Pearson correlation coefficient results revealed high correlations in all the reported parameters between the two devices ($P<0.0001$).

Bland-Altman plot showed a clinical agreement of ACD measurements between the two devices. Figures 1-3 illustrate the Bland-Altman plots of agreement between the two instruments. Figure 1 depicts 95% LoA of ACD measurements within the range of -0.50 to -0.43.

Table 1. comparison of parameters measured by LenStar and OCT

Parameter	LenStar	OCT	Difference	P value	r Value	95% LoA
CCT (µm)	531.7 ±35.25	527.3 ± 37.82	-4.32±12.81	<0.0001	0.941	-20.79,29.43
ACD (mm)	2.92±0.40	2.95±0.43	0.03±0.24	0.0549	0.839	-0.50,-0.43
ACW (mm)	12.04±0.52	11.79±0.49	-0.25±0.29	<0.0001	0.837	-0.32, 0.82
Ks (D)	44.37±1.80	44.42±1.73	0.05±0.46	0.1138	0.966	-0.96,0.86
Kf (D)	43.32±1.67	43.29±1.61	-0.04±0.41	0.2047	0.969	-0.77,0.85
Corneal Ast	-1.05±0.88	-1.14±0.86	-0.08±0.40	0.0044	0.893	-0.70,0.87

CCT = central corneal thickness, ACD = anterior chamber depth, ACW = anterior chamber width, Ks = steep power of cornea, Kf = flat power cornea, Ast = astigmatism, LoA = limits of agreement

*according to the paired t test of the Lenstar and CASIA2 OCT

r- value (Pearson correlation coefficient,) was significant for all parameters (P < 0.0001).

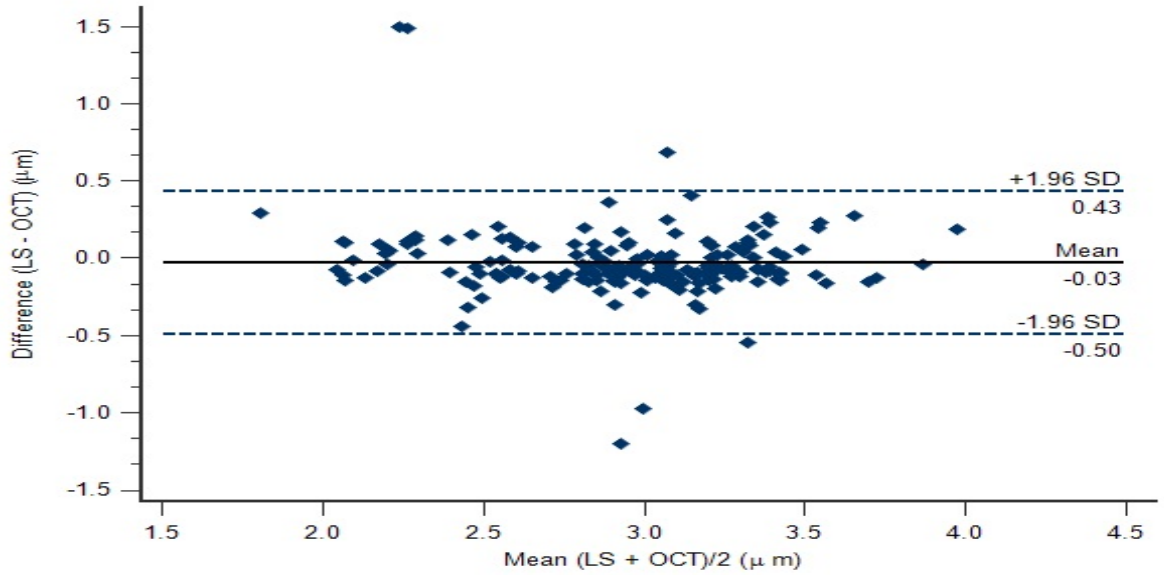

Figure 1. Bland-Altman plot of anterior chamber depth (ACD) compared between LenStar and CASIA2 OCT

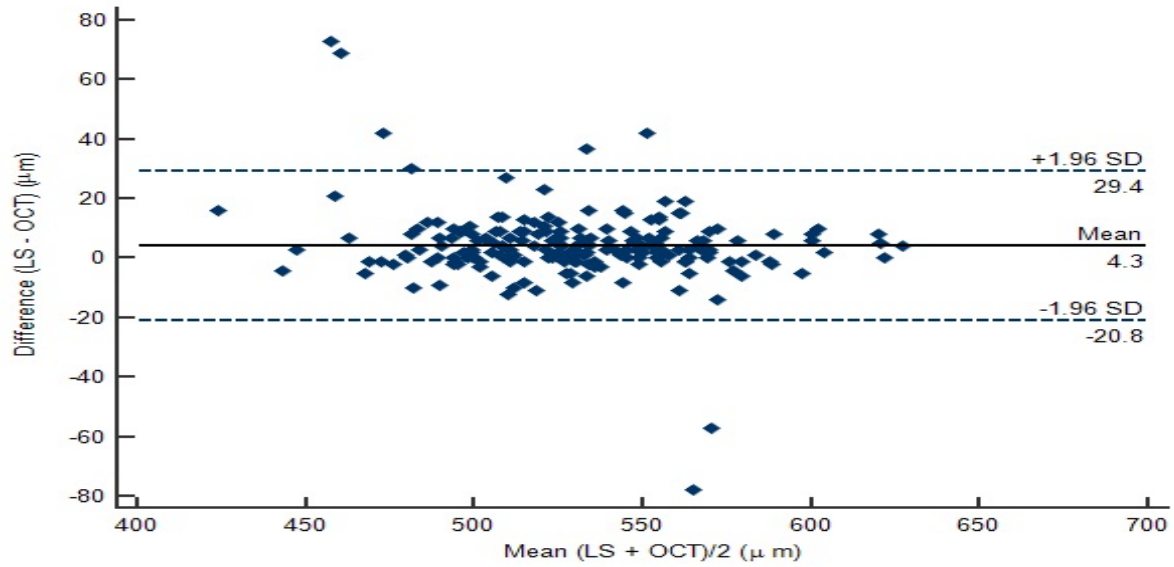

Figure 2. Bland-Altman plot of central corneal thickness (CCT) compared between LenStar and CASIA2 OCT

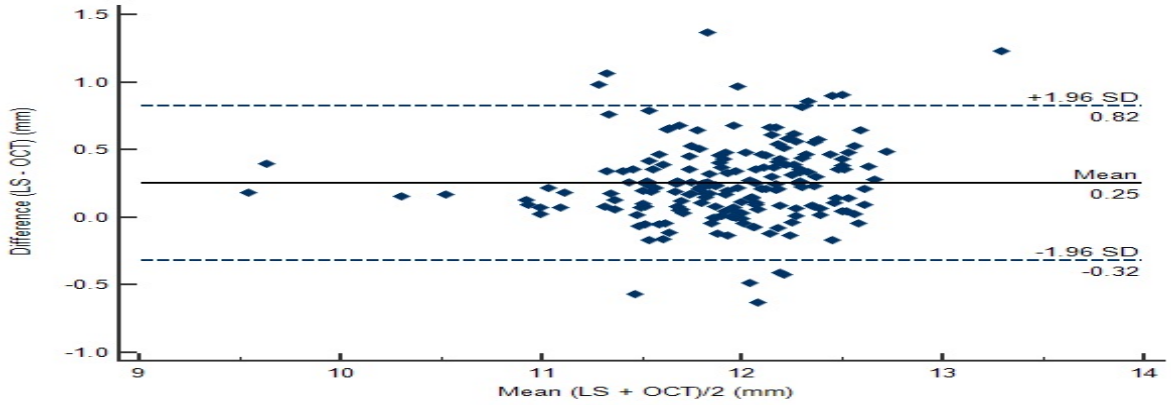

Figure 3. Bland-Altman plot of anterior chamber width (ACW) compared between LenStar and CASIA2 OCT

Discussion

As several different instruments with various techniques are currently available for the measurement of eye dimensions, the ability to have accurate and repeatable measurements is increasingly becoming important (12).

In this regard, the current study aimed to compare the ocular biometric parameters between LenStar 900 and CASIA2 OCT and assess any agreement in these parameters between the two devices. The present study compared the parameters in terms of both correlation and Bland-Altman analysis. The Pearson correlation coefficient indicated linear association. Accordingly, two methods can well correlate but greatly disagree. The LoA technique in Bland-Altman analysis presents how well the measurements agree on average for subjects (13).

The present study included 198 normal participants with different kinds of refractive errors (e.g., myopia, hyperopia, and astigmatism), which increase the generalizability of the results. The Pearson correlation coefficient analysis showed a high correlation for anterior segment parameters measured by the two devices. The LoA data demonstrated poor agreement and clinically wide ranges for CCT, ACW, and corneal astigmatism. The wide LoA suggests that clinically significant differences may arise if these two instruments are interchangeably used. The ACD also showed good agreement.

The results of the current study revealed interchangeable ACD values between LenStar and OCT. CASIA2 showed higher values in ACD; however, it did not reach a statistically significant level. In CASIA2 OCT measurement, accommodation is minimized using the fixation target by the adjustment of the subject's refractive correction. Nevertheless, LenStar does not have any non-accommodative fixation target. The accommodation effect may result in shallower ACD values measured by LenStar than those by CASIA2 14. The ACD showed good agreement and a narrow LoA range (-0.50 to -0.43); nonetheless, this discrepancy can be negligible in the clinical setting.

Similar to the findings of the present study, Shen et.al also evaluated LenStar 900 and Visante AS-OCT agreement for the measurement of anterior segment dimensions. They reported that these two devices had comparable ACD measurements; however, CCT and ACW were not interchangeable 1. Chansangpetch et al. assessed the agreement of anterior segment parameters obtained from CASIA2 as a swept-source Fourier-domain OCT and Visante as a time-domain OCT. They concluded that these two instruments had good agreement except in angle parameters (15).

The findings of the current study showed that CCT, ACW, and corneal astigmatism values measured by the two instruments had clinically significant differences. The assessment of the results indicated that LenStar tended to have significantly higher readings for both CCT and ACW. Smaller CCT in AS-OCT, compared to that reported for LenStar, may be justified by Li et al.'s explanation. The anterior boundary line placement of OCT software analysis slightly below the anterior corneal surface may cause lower CCT findings (16).

The LoA data showed poor agreement and clinically wide ranges for CCT (20.79- to 29.43) and ACW (0.32- to 0.82). The wide LoA suggests that clinically significant differences may arise in case of using these two instruments interchangeably. Similar to the findings of the present study, O'Donnell et al. assessed the agreement of LenStar 900 and time-domain Visante OCT. They measured CCT and ACD in 27 healthy eyes and concluded that CCT measurements from these two instruments should not be interchangeably utilized in clinical setting (3).

different optical zone, refractive index, number of sampling points, and calculation algorithms by each instrument (17). LenStar directly measured corneal curvature. The LoA data showed poor agreement and a clinically wide range of corneal astigmatism (-0.70,0.87).

Despite the wide range of refractive errors in the present study, as there was an unequal sample in each group, it was not possible to compare the agreement between different refractive errors. It is recommended to include equal and efficient samples in each refractive error group in future studies to have the chance of comparing both intergroup and intragroup analyses.

Conclusion

In conclusion, the results of the current study revealed that LenStar 900 and CASIA2 OCT may be interchangeably used for ACD measurements; however, CCT and ACW data did not show any agreement in the clinical setting.

Declaration of interest statement

The study followed the principles of the Declaration of Helsinki. All the participants were appropriately informed at the beginning of the study and completely discussed the risks and benefits of the surgery. In addition, written informed consent was obtained from all the study subjects.

Conflict of Interest

The authors declare no conflict of interest.

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