COMPARISON OF OPTICAL BIOMETRY DATA MEASURED WITH LENSTAR AND ANTERION

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SUMMARY

Objective: The aim of this study is to compare the results of preoperative biometric data measured with optical biometers of different generations in patients with cataract. Lenstar optical biometry is based on the principle of optical low-coherence reflectometry (OLCR), and Anterion on swept-source optical coherence tomography (SS-OCT).
Material and methods: A total of 200 eyes (103 patients) were included in a prospective study at the Faculty Hospital in Trenčín the period from June 2023 to January 2024. We compared the results of 6 parameters: axial length (AL), mean keratometry (K), lens thickness (LT), white-to-white diameter (WTW), astigmatism (AST), and intraocular lens (IOL) power. The results were statistically analyzed.
Results: The values of AL, AST, and IOL parameters between the Lenstar and Anterion biometers were consistent, with no statistically significant difference ($p = 0.593$; $p = 0.089$; $p = 0.069$). The values of K, LT, and WTW showed statistically significant differences ($p < 0.001$). A Bland-Altman plot analysis confirmed good concordance between the parameters within a 95% limit of agreement.
Conclusion: Biometric data measurement using SS-OCT Anterion is reliable, quick, and the results are comparable to those obtained with Lenstar. The AL, AST, and estimated IOL values were consistent between the biometers. Despite differences in the measurements of LT, WTW, and K parameters, the final IOL value was the same. In addition to biometric data, Anterion provides comprehensive tomographic examination of the cornea and OCT scanning of the anterior segment.
Key words: optical biometry, cataract, Lenstar, Anterion, biometry comparison

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INTRODUCTION

Cataract surgery is one of the most frequently performed operations in most countries worldwide [1,2]. The precision of preoperative biometry and the subsequent selection of an intraocular lens (IOL) are important elements in attaining the desired postoperative refractive result.

Until the arrival of optical biometry in 1999, ultrasound biometry (A-scan) was the standard in the measurement of axial length (AL), anterior chamber depth (ACD) and lens thickness (LT) when determining the value of the IOL [3]. The optical biometer Lenstar LS900 (Haag-Streit, Switzerland) is based on the principle of optic low coherence reflectometry (OLCR) [4]. The sources is an 820 nm superluminescent diode, which provides non-contact measurement. Lenstar uses reflexive keratometry based on 32 measuring points located on two concentric circles with a diameter of 1.65 mm and 2.3 mm. The axial length of the eye is calculated on the basis of a single refraction index for the entire eye. The final biometric values are composed of five separate automated measurements, and the results are influenced by the quality of the lacrimal film [4–6].

In recent years we have had the option of using the advanced technology of swept-source optical coherence tomography (SS-OCT) in optical biometry [9]. Anterion (Heidelberg Engineering, Germany) is an anterior segment OCT biometer working with a source with a wavelength of 1300 nm, which enables quick and precise measurement of biometric parameters, corneal topography and the structures of the anterior segment of the eye. It provides simulated keratometry from a 3 mm ring. Measurement of AL is also based on a single refraction index for the entire eye. It also provides complete tomographic

measurement of the cornea, including the anterior and posterior surface, which may be incorporated in some modern formulas. The results of biometry are based on a single measurement [7,8].

The objective of this study is to conduct a prospective comparison of measured biometric data obtained from the Lenstar and Anterion instruments, which work on a different principle of optical biometry. Few articles exist comparing the results of these biometers in patients with cataracts in regular clinical practice.

MATERIAL AND METHOD

A total of 200 eyes (103 patients) were included in the prospective study at the Department of Ophthalmology of the Faculty Hospital in Trenčín in the period from June 2023 to January 2024. The average age of the patients at the time of measurement was 72.0 ±8.5 years. These were patients with cataracts on whom preoperative biometry was performed using the Lenstar and Anterion instruments. Patients who had suffered ocular trauma, with refractory glaucoma, keratopathy, who had undergone pars plana vitrectomy or with active intraocular inflammation were excluded from the study. A complete ophthalmological examination was conducted on all the patients, including refraction, best corrected visual acuity, endothelial microscopy, measurement of intraocular pressure and examination of the anterior segment in mydriasis. Measurement on the Lenstar and Anterion instruments was conducted by 2 doctors, in mydriasis, immediately after one another on the same day. The examination was conducted first on the Lenstar instrument and subsequently on Anterion. The instruments were configured in the standard automatic mode. The Anterion instrument was used in the "Cataract app" mode. For these patients we statistically evaluated 6 biometric parameters: AL, LT, mean keratometry (K), white to white diameter (WTW), astigmatism (AST) and estimated IOL power, which was selected for the patient on the basis of biometry. For conformity of data we used the Barrett formula in our evaluation in the case of both instruments, and as a reference we chose the lens Alcon SN60WF AcrySof IQ. The results were statistically processed and expressed as the mean ± standard deviation (SD) with a 95% confidence interval (CI). Statistical significance was set at $p < 0.05$. The mean was calculated with the aid of descriptive statistics. A paired t-test was used for comparison of the measured parameters (K, AL, LT, WTW, AST, IOL) between Lenstar and Anterion. We used Bland-Altman graphs for assessing the accordance between the parameters. The 95% limit of agreement (LoA) was expressed as a mean of ±1.96 SD of difference, which indicated the interval at which 95% agreement between measurements is situated.

RESULTS

The study incorporated 200 eyes (103 patients). Table 1 contains the mean values of the parameters measured on the Lenstar and Anterion biometers, the difference between the parameters, their statistical significance and the 95% limit of agreement. The success rate of measurement of all 6 observed parameters of biometry was 95% on the Lenstar instrument (190 eyes) and 97.5% on Anterion (195 eyes).

Figure 1 demonstrates the agreement between the parameters expressed by the Bland-Altman graphs. The values of the parameters AL, AST, IOL were identical between the biometers, without any statistically significant difference. The mean measured values of AL on the Lenstar and Anterion instruments were identical (23.04 ±0.98; 23.04 ±0.98 mm), with a difference of 0.00 ±0.00 mm ($p = 0.593$). The values of AL manifested the greatest agreement of all the parameters, and the-

Table 1. Mean values of measured parameters on Lenstar and Anterion biometers, differences between parameters, their statistical significance and 95% limit of agreement

Value	Lenstar	Anterion	Mean difference	P-value of mean difference	95% LoA
K (D)	43.8 ±1.8	43.6 ±1.8	0.14 ±0.50 CI = 1.00	< 0.001	-0.9–1.1
AL (mm)	23.04 ±0.98	23.04 ±0.98	0.00 ±0.00 CI = 0.08	0.593	-0.08–0.07
AST (D)	0.96 ±0.97	0.93 ±0.99	0.04 ±0.30 CI = 0.57	0.089	-0.54–0.61
LT (mm)	4.64 ±0.38	4.74 ±0.38	-0.10 ±0.10 CI = 0.20	< 0.001	-0.30–0.10
WTW (mm)	12.05 ±0.43	11.67 ±0.44	0.38 ±0.20 CI = 0.42	< 0.001	-0.04–0.80
IOL power (D)	22.3 ±2.9	22.4 ±2.9	-0.07 ± 0.30 CI = 0.54	0.069	-0.6–0.5

AL – axial length, AST – astigmatism, CI – confidence interval, D – dioptre, LT – lens thickness, IOL – intraocular lens, K – keratometry, LoA – limit of agreement, WTW – white to white diameter, SD – standard deviation

refore the narrowest LoA (-0.08 – 0.07 mm). Very similar (p = 0.069) were the results of the dioptric power of the chosen IOL (22.3 ±2.9 D; 22.4 ±2.9 D), with a difference of only -0.07 ±0.30 D and a narrow LoA (-0.6–0.5 D). The mean value of corneal astigmatism (0.96 ±0.97; 0.93 ±0.99 D) manifested a minimal difference of 0.04 ±0.30 D (p = 0.089) with LoA (-0.54–0.61 D).

The values of K, LT, WTW recorded statistically significant differences, but a relatively narrow 95% LoA. A statistically significant difference (p < 0.001) of mean K, specifically by a -0.14 ±0.50 D lower mean value was measured on Anterion (43.8 ±1.8 D; 43.6 ±1.8 D) with LoA (-0.9–1.1 D). A statistically significant difference (p < 0.001) was confirmed in the values of WTW (12.05 ±0.43; 11.67 ±0.44 mm), specifically the values measured on Lenstar were on average 0.38 ±0.20 mm higher with LoA (-0.04–0.80 mm). A significant difference (p < 0.001) was also confirmed in the values of measured LT (4.64 ±0.38; 4.74 ±0.38 mm), in which the measurement on Anterion were 0.10 ±0.10 mm thicker.

DISCUSSION

In our observation we compared the results of the optic biometers of a different generation (Lenstar vs. Anterion) in patients with cataract. We compared 6 biometric parameters: K, AL, LT, WTW, AST and estimated IOL. We did not evaluate anterior chamber depth because the calculation differs between the instruments. Lenstar measures ACD from the corneal epithelium to the lens epithelium, and Anterion from the corneal endothelium to the lens epithelium [9]. We performed both measurement in mydriasis following the application of tropicamide. Several studies confirm that pupil dilation has an influence on ACD. It was determined that in 3rd generation formulas (SRK/T) mydriasis does not have an influence on the dioptric power of the IOL measured on Lenstar, but in 4th generation formulas (Barrett), higher ACD values may influence the choice of IOL [10,11]. The influence of pupil dilation on biometric data obtained with the Anterion instrument is not known.

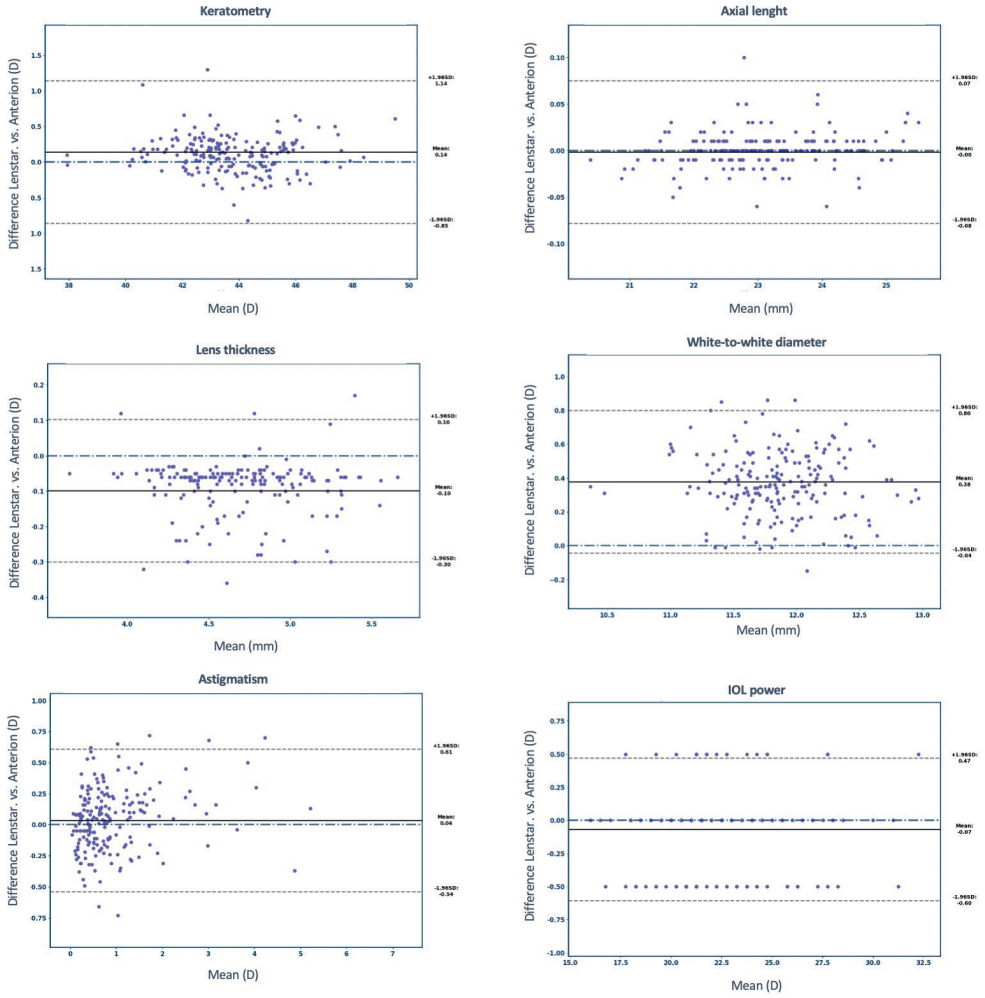

Figure 1. Bland-Altman plots showing the agreement between the Lenstar and Anterion biometry parameters. The solid lines represent the mean differences, while the dotted lines indicate the lower and upper 95% limits of agreement

Due to the higher wavelength, it is assumed that SS-OCT biometers are more successful in measuring AL in the case of opaque optic media and mature cataracts [12]. In our case the success rate of measurement was similar, and the average values of AL on the Lenstar and Anterion instruments were identical. A Bland-Altman analysis confirmed the highest accordance in AL between all parameters. The values of corneal astigmatism and resulting IOL were also identical.

We recorded a statistically significant difference in the measurements of WTW between Lenstar and Anterion. Lenstar measures the diameter of WTW on the basis of color photography and Anterior by a 16 mm horizontal high-resolution scan. Lenstar markedly overvalued WTW in comparison with Anterion by 0.38 ±0.20 mm. The diameter of WTW is important in the selection of an anterior chamber IOL, and there was a difference in measurements of LT, specifically Lenstar measured a lower value of LT by an average of 0.1 mm. We believe that Lenstar is less exact in recording the posterior boundary of the lens, probably when it is used in calculation of the IOL with the aid of the Holladay formula [13,14]. We observed that it detects the peak of the signal from opacities inside the lens instead of the posterior lens capsule [15].

Lenstar uses reflex keratometry with a diameter of 1.65–2.3 mm, whereas Anterion uses simulated keratometry with a diameter of a map of 3 mm created on a different SS-OCT principle. Because the cornea is aspherical, we may expect that the greater diameter of measurement provides a lower optical density of the cornea. This is in accordance with our results, in which mean K measured on Lenstar was 0.14 D stronger. Anterion also takes into account the posterior surface of the cornea in its calculations [15]. Despite the statistical significance, we consider these differences clinically acceptable.

Our results are in accordance with similar studies, which compared the results of Anterion biometry with other optical biometers, in which the greatest agreement was also confirmed in the values of AL and differences in WTW and LT values, which nevertheless in the same formula calculated identical optical density of the IOL [16,17].

Through a practical comparison in practice we observed that the Anterion biometer has several advantages over Lenstar: higher resolution, shorter length of measurement and higher success rate of measurement in the case of dense cataracts. We also confirmed that Anterion is a better choice for patients with head tremor or nystagmus, since one measurement lasting approx. 5–10 seconds is sufficient, whereas in the case of Lenstar an average is taken of the results of 4–5 measurements, which take approximately 1 minute. Anterion provides a comprehensive evaluation of the cornea, and the output is a number of maps: anterior and posterior axial curvature, tangential curvature and elevation maps, map of overall corneal thickness, anterior and overall wavefront of cornea and pachymetric map. The result is also an OCT scan with visualization of structures of the anterior segment and the lens in high resolution (Figure 2).

CONCLUSION

Measurement of biometric data with SS-OCT Anterion is reliable, quick, and the results are comparable with the results of measurement on Lenstar and are clinically acceptable. The values of AL, AST and estimated IOL were identical between the two biometers, without any statistically significant difference. The parameter of AL manifested the highest agreement between the compared data. Despite differences in the measurements of the parameters LT, WTW and K, the estimated IOLs were identical. Besides biometric data, Anterion provides comprehensive tomographic examination of the cornea and OCT scan of the anterior segment.

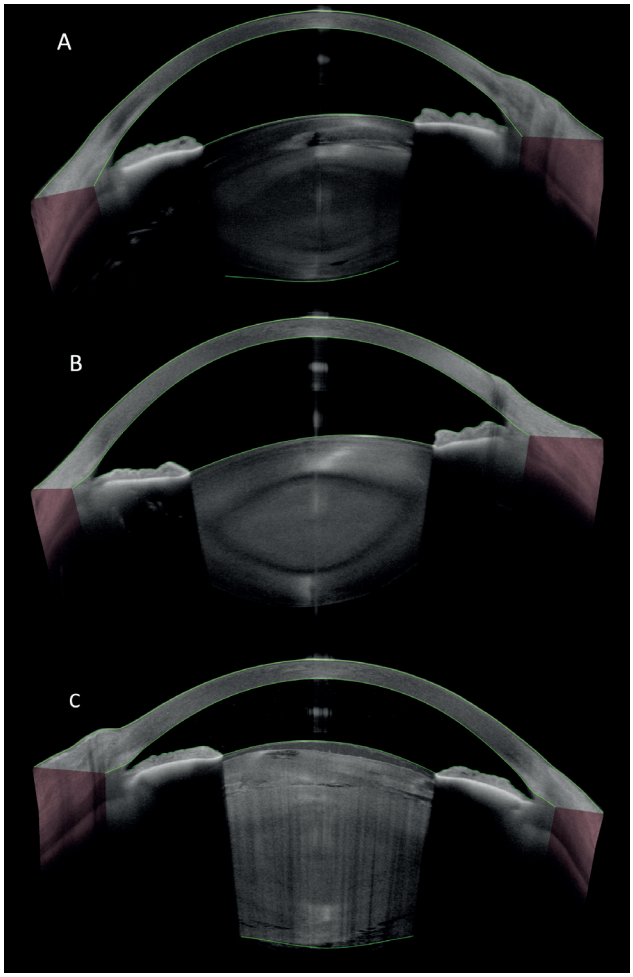

Figure 2. Anterior segment OCT scans from the Anterion biometric outcomes, displaying imaging of cortical (**A**), corticonuclear (**B**), and mature (**C**) cataracts. The scans reveal a thickened lens and liquefied masses beneath the anterior capsule

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