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Purpose: To compare biometric data obtained by new optical biometer Argos and conventionally used biometer IOL Master 700.
Patients and methods: Retrospective analysis of biometric data of 57 patients (106 eyes) who were examined at TANA Ophthalmology Clinic s.r.o in Olomouc. Measurement of patient was carried out on both devices on the same day by the same optometrist within standard preoperative calculation of intraocular lens before cataract surgery. Evaluated and statistically analysed biometric data were axial length, anterior chamber depth, average keratometry and lens thickness.
Results: Correlation between all compared data was high, with statistical significance $p < 0.01$. Bland-Altman plots showed good agreement with 95 % limit of agreement. Axial length, average keratometry and lens thickens did not show significant differences ($p = 0.941$; $p = 0.773$; $p = 0.860$). IOL Master 700 showed flatter average keratometry, however the differences were numerically small and insignificant. Anterior chamber depths obtained by Argos were longer, with significance $p < 0.05$.
Conclusion: Segmental refractive index technology used by Argos caused differences in anterior chamber depths. Overall axial length was however not, in our cohort of patients, by this affected. In general, optical biometers Argos and IOL Master 700 show excellent agreement in measured biometric data.
Key words: biometry, SS-OCT, segmental refractive index, Argos

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INTRODUCTION

Modern cataract surgery requires high accuracy in predicting the resulting postoperative refraction. The calculation of the optical power of the intraocular lens (IOL) depends on several measured biometric parameters such as keratometry, anterior chamber depth (ACD), white-to-white measurement (WTW), lens thickness (LT) and axial length (AXL) [1,2]. The axial length of the eye is considered the most critical factor affecting the optical power of the chosen IOL [3].

Biometry has undergone extensive technological development from ultrasonic to optical biometry, which has almost completely replaced it [4]. In clinical practice, optical biometry devices based on the principle of partial coherence interferometry (PCI) and optical low coherence reflectometry (OLCR) are available. These include IOL Master 500 (Carl Zeiss Meditec AG, Jena, Germany), Aladdin (Topcon, Tokyo, Japan), Pentacam AXL (Oculus, Wetzlar, Germany), Lenstar LS900 (Haag-Streit, Verkauf, Switzerland) and Galilei G6 (Ziemer, Port, Switzerland) [5-7].

However, the optical biometry device IOL Master 700 (Carl Zeiss Meditec AG, Jena, Germany) using advanced swept-source optical coherence tomography (SS-OCT) technology is currently considered the so-called "gold standard". SS-OCT operates with a longer wavelength light source (1060 nm) than

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conventional PCI biometry devices, which provides better tissue penetration and thus greater measurement success in maturing or advanced subcapsular cataracts [8]. In addition, the obtained OCT scan of the fovea can serve as an indicator of inaccurate fixation and thus reduce the error in AXL measurement.

Argos (Movu Inc., Santa Clara, CA, USA) is the latest optical biometry device using the SS-OCT method with integrated Verion software (Alcon Laboratories Inc., Fort Worth, TX). Unique is the measurement of segmented AXL using a precise refractive index for each segment of the eye (cornea 1.375; anterior chamber fluid 1.336; lens 1.410; vitreous 1.336). Another feature is the enhanced retinal visualization (ERV) mode, which allows signal amplification in the retinal area when measuring denser cataracts [9,10].

The aim of this work is a retrospective comparison of the biometry data obtained during measurements on these two devices using the SS-OCT method.

COHORT AND METHODS

In this retrospective study conducted at the TANA Ophthalmology Clinic s.r.o. in Olomouc, 57 patients (106 eyes) were enrolled who underwent examinations on Argos and IOL Master 700 devices between February 2021 and May 2021 as part of the preparation for cataract surgery.

Measurements on both devices were performed in each patient on the same day, in the miosis, according to the manufacturer's recommendations. The same optometrist performed biometry on all enrolled patients. The average age of the patients was 61.5 ±9.2 years.

Exclusion criteria were a history of ocular trauma, previous refractive surgery or posterior segment surgery and corneal disease affecting best corrected visual acuity.

Statistical Analysis

Quantitative values were defined by mean and standard deviation. Subsequently, they were analyzed using the Kolmogorov-Smirnov normality test. Measurements were compared using the Wilcoxon test. The agreement of measurements between devices was analyzed using the Bland-Altman plot. The 95% limit of agreement (LoA) was defined as the mean difference increased or decreased by 1.96 times the standard deviation of the differences. Due to the calculation method, a positive value of the difference indicates a larger value measured by the Argos device.

The correlation between the values measured on each device was determined using Spearman's correlation coefficient (r_s). Statistical significance was set as $p < 0.05$.

RESULTS

The success rate of the biometry measurement on the IOL Master 700 device was 99.1% (105 eyes). One measurement could not be performed for brunescent cataract. However, this measurement was reliably made using the Argos device in ERV mode. The overall success rate of the Argos device was therefore 100% (106 eyes). Table 1 summarizes the observed biometric parameters obtained from both devices.

Spearman's correlation coefficient of axial length was high rs = 0.999 with significance p<0.01. The resulting axial lengths were not significantly different. The significance level using the Wilcoxon test was p = 0.941. The Bland-Altman goodness-of-fit plot for axial length shows a significant dependence of the difference in measured axial lengths on their mean value ($p < 0.01$).

The correlation between the resulting anterior chamber depth values was again very high (rs = 0.994, $p < 0.01$). Values measured by the Argos device were significantly longer than those of the IOL Master 700 ($p < 0.05$).

A comparison of average keratometry also showed a high correlation with rs=0.978 (p<0.01). The average keratometry obtained with the IOL Master 700 measurements was flatter, but the difference was very small and not significant (p = 0.773).

Table 1. Summary of the comparison of values measured by the Argos and IOL Master 700, LoA – limits of agreement; SD – standard deviation

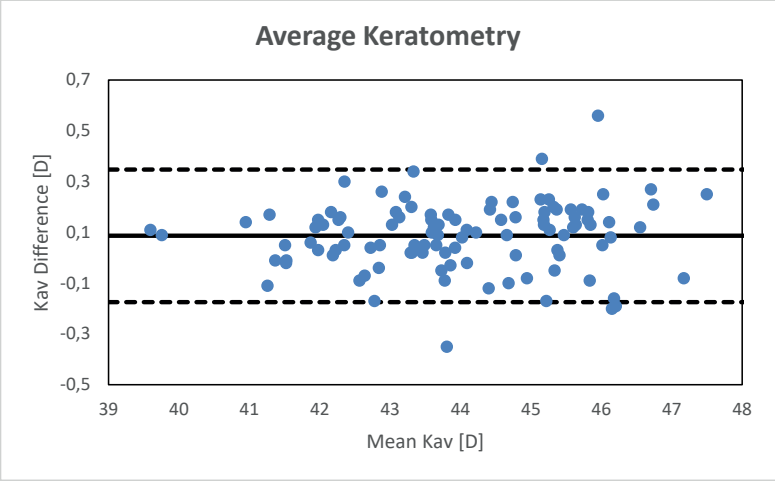
Parametr	Device	Mean ±SD	Range	p value	95% LoA	Spearman correlation coefficient
Axial length [mm]	Argos	23,37 ±1,13	20,26–26,01	p = 0,941	-0,073–0,088	r_s = 0,999 (p < 0,01)
	IOL Master 700	23,37 ±1,16	20,13–26,09			
Anterior chamber depth [mm]	Argos	3,15 ±0,36	2,08–4,07	p < 0,05	0,072–0,191	r_s = 0,994 (p < 0,01)
	IOL Master 700	3,02 ±0,37	1,94–3,91			
Average keratometric value [D]	Argos	44,03 ±1,65	39,65–47,62	p = 0,773	-0,174–0,345	r_s = 0,978 (p < 0,01)
	IOL Master 700	43,95 ±1,64	39,54–47,37			
Lens thickness [mm]	Argos	4,60 ±0,35	3,81–5,64	p = 0,860	-0,060–0,074	r_s = 0,988 (p < 0,01)
	IOL Master 700	4,60 ±0,35	3,83–5,61			

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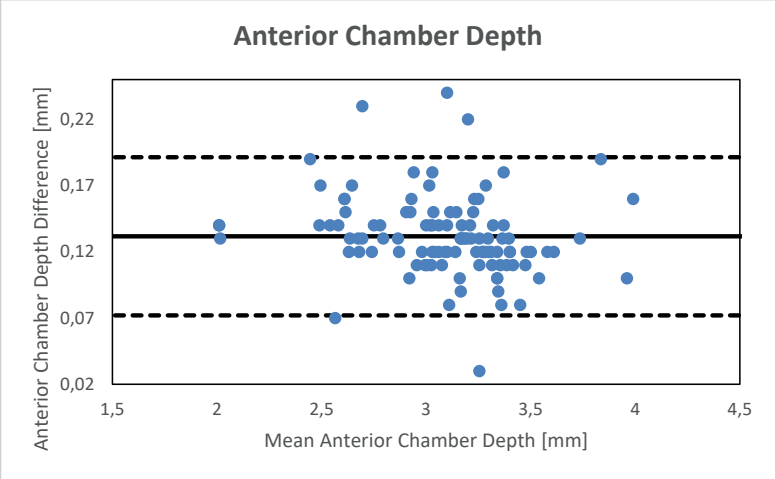
For lens thickness, the Spearman correlation coefficient was rs = 0.988 ($p < 0.01$), and there was no significant difference in the measured values ($p = 0.860$). Graphs 1, 2, 3 and 4 show the Bland-Altman plot of agreement at LoA 95%.

DISCUSSION

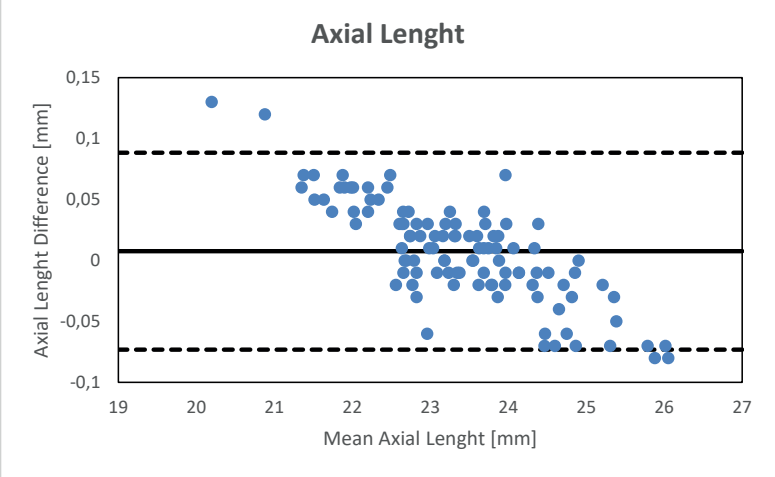
According to many published studies, SS-OCT technology demonstrates a high success rate [10,11,12].



Graph 1. Bland-Altman plot for the average keratometry measurements of each device, Kav – average of keratometric value

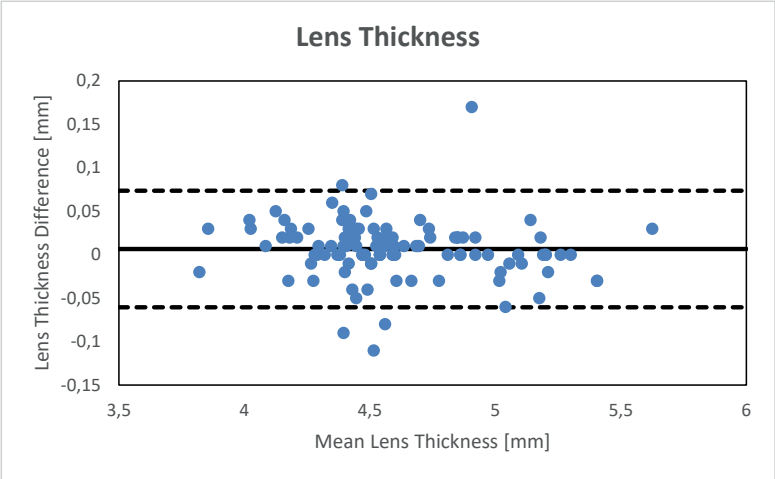


Graph 2. Bland-Altman plot for the anterior chamber depth measurements of each device



Graph 3. Bland-Altman plot for the axial length measurements of each device

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Graph 4. Bland-Altman plot for the lens thickness measurements of each device

These results were also observed in our cohort. The only unsuccessful measurement on the IOL Master 700 device was a case of brunescent cataract, which was reliably measured on the Argos device using ERV mode. The ERV mode allows a tenfold amplification of the signal compared to the standard measurement mode [9]. In the overall cohort, however, this is a non-significant difference between the biometry devices.

The axial length of the eye is a necessary parameter to calculate the dioptric value of the intraocular lens, which accounts for 54% of the refractive error [3,13]. A measurement error of 1 mm results in a dioptric value change between 2.70 and 3.00 diopters [14]. The values of axial lengths are theoretically more accurate when using the segmented refractive index (Argos) than when calculating with the equivalent refractive index (IOL Master 700). This statement applies especially to anatomically non-standard eyes. For example, a long eye usually has a larger vitreous space, resulting in a shorter resulting axial length when measured with the segmented refractive index, as the refractive index of the vitreous is smaller than the equivalent refractive index [15]. According to Faria-Riberio et al., a uniform equivalent refractive index of 1.3549 is optimized for an axial length of about 24 mm with a lens thickness of about 3.6 mm [16]. Thus, in summary, segmented axial length does not change the overall axial length dimension in most eyes measured [5,10,17,18,19]. However, Shammas et al. confirmed differences in very long (< 26 mm) and very short (> 22 mm) eyes [20]. Our study did not include threshold values for axial lengths. Thus, the statistically significant correlation between the larger eye length and the expected lower measured value on the Argos device was not observed in the pooled comparison. However, the compared axial lengths of our cohort showed excellent agreement between measurements and correlation with no significant difference.

The anterior chamber depth values obtained with the Argos device were longer. The difference was significant, but numerically small. This result was also confirmed by Omoto et al. [5]. The difference is again very likely caused by an unequal refractive index. On the other hand, Yang et al. confirmed excellent agreement with no significant difference [21]. Preoperative anterior chamber depth has the greatest impact on the calculation of IOL optical power when using third-generation formulas, the Haigis formula, and the calculation of phakic IOLs [22]; therefore, it is important to consider this discrepancy in clinical practice.

There was no statistically significant difference between the measured average keratometry. Keratometry obtained with the IOL Master 700 device was slightly flatter. Both biometry devices define the keratometric index as 1.3375. The Argos records keratometry in a 2.2 mm optical zone, while the IOL Master 700 records in a 2.5 mm zone. The flatter keratometric values of the IOL Master 700 device are affected by this difference in the measurement system.

The lens thickness dimensions did not show a statistically significant difference and were highly correlated.

Limitations of the study were the lack of a wide range of borderline axial eye lengths (< 22 mm; > 26 mm), the small number of densities of lens opacities, and the retrospective design of the study. Evaluation of predictive refractive error after IOL implantation was not part of this study.

CONCLUSION

The segmented refractive index technology used by the Argos device caused the difference in anterior chamber depth values. However, the compared total axial length was not affected by this in our cohort of patients. Overall, the Argos and IOL Master 700 optical biometry devices show excellent agreement in the measured biometry parameters. The differences found should be taken into account in clinical practice and comparative studies of predictive refractive error after IOL implantation should be performed.

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