

Agreement of Ocular Biometry Measurements with the Aladdin vs. Lenstar Running Head: *Ocular Biometry Measurements with Aladdin vs. Lenstar*

ABSTRACT

Purpose: To establish the agreement of the Aladdin biometer with the Lenstar biometer for routine measurements before cataract surgery.

Setting: Virginia Eye Consultants

Design: Prospective, Single-Center, Cross-Sectional

Methods: Biometry data was measured for the same eye by both the Aladdin and Lenstar biometers on separate preoperative visits. Measured parameters included: axial length (AL), anterior chamber depth (ACD), keratometry (K1/K2/K2 axis), lens thickness (LT), central corneal thickness (CCT) and white-to-white (WTW). Adverse events were monitored.

Results: In data collected on 101 treated eyes (65 OD) from 101 patients (mean age of 67.9 ± 7.2 years), mean AL was 23.88 ± 1.23 mm with the Aladdin and 23.89 ± 1.23 mm with the Lenstar. Mean ACD was 3.24 ± 0.36 mm with the Aladdin and 3.25 ± 0.37 mm with the Lenstar. The average K1 and K2 readings were 43.63 ± 1.65 D and 44.59 ± 1.76 D with the Aladdin versus 43.61 ± 1.67 D and 44.61 ± 1.77 D with the Lenstar. LT was 4.61 ± 0.39 mm with the Aladdin and 4.45 ± 0.45 mm with the Lenstar. Mean CCT was 0.55 ± 0.04 mm with the Aladdin and 0.55 ± 0.04 mm with the Lenstar. Mean WTW was 11.63 ± 0.41 mm with the Aladdin and 12.03 ± 0.49 mm with the Lenstar. There was high correlation between all anterior segment parameter measurements obtained by the two devices. No adverse events occurred.

Conclusions: Aladdin measurements are as reliable and reproducible as one of the leading biometers on the market with the advantage of a full corneal topographer incorporated.

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Introduction

Ocular biometry has become an essential tool in refractive cataract surgery planning, providing ocular measurements for accurate intraocular lens (IOL) power calculations. Inaccurate measurements can result in skewed calculations that negatively impact postoperative refraction and visual acuity. Therefore, measurement devices must be rigorously scrutinized in their ability to measure ocular parameters in a repeatable and precise manner. While many biometers exist, the IOLMaster (Carl Zeiss, Jena, Germany)¹⁻⁴ and Lenstar (Haag-Streit, Köniz, Switzerland)⁵⁻⁸ have been the most well-validated in the literature to date. However, since the development of these devices many years ago, technological advances have allowed for the creation of new biometers with the potential for quicker and more efficient measurements, including automated corneal keratometry and topography.

Introduced in 2012, the Aladdin (Topcon Medical Systems, Inc., Oakland, NJ, USA) is an optical low-coherence interferometer (OLCI) device capable of automatic and simultaneous measurement of axial length (AL), anterior chamber depth (ACD), pupillometry, corneal keratometry (K) and white to white topography (WTW). While the Aladdin measures ACD similar to the IOLMaster using an LED projection across the anterior chamber, AL is measured using an 820 nm superluminescent diode. Furthermore, a 24-ring Placido disk ring reflection with an approximate working distance of eight cm is utilized for keratometry and corneal topography measurements. Photopic and mesopic pupil size is determined via infrared and white LED light.

Prior studies have reported the repeatability and reproducibility of the Aladdin's measurements compared to the most well-validated biometers.^{9,10} Mandal et al. compared the accuracy and reproducibility of biometry by the Aladdin to the IOLMaster, finding no statistical difference between the two biometers for mean keratometry, anterior chamber parameters, or IOL power calculations.¹¹ Huang et al. followed these findings in 2015 when he and co-workers assessed the precision of ocular biometry with the Aladdin. The group reported axial length, anterior chamber depth, keratometry and white-to-white (WTW) were highly repeatable in healthy subjects, with a minor loss of WTW precision in patients

with cataracts. They noted very little disagreement between operators.⁹ Finally, in 2017 McAlinden et al. compared the Aladdin to the Lenstar, finding high levels of repeatability between the two devices suggestive of interchangeability when measuring normal eyes with refractive error.¹⁰

The current study aimed to determine agreement between common parameters using the Topcon Aladdin and Haag-Streit Lenstar biometers for eyes undergoing cataract surgery. To achieve this, the present study compares measurements taken with the Aladdin and Lenstar in a cohort of patients scheduled to undergo cataract surgery.

Materials & Methods

STUDY DESIGN

This study was a prospective, single-center, cross-sectional trial designed to evaluate the agreement of the Aladdin biometer compared to Lenstar biometer from eyes in males and females 18 years or older undergoing routine cataract surgery. Lenstar biometry readings taken before the time of informed consent were used for comparison, with a maximum period of 45 days between initial pre-cataract surgery Lenstar testing and Aladdin testing. Subjects underwent measurements in only the eye scheduled to undergo surgery. If the subject was scheduled to have cataract surgery in both eyes, the Aladdin measurement was performed on the eye to be operated first. Subjects provided informed consent before measurements with the Aladdin. The study was reviewed and approved by an Institutional Review Board.

SUBJECT SELECTION

The study was conducted on patients treated at Virginia Eye Consultants between November 2015 and March 2017. Eligible patients were ≥ 18 years of age who had complete and comprehensive pre-cataract surgery testing, including Lenstar biometry reading. Exclusion criteria for the study included a history of ocular surgical procedures or ocular conditions that impacted device imaging, such as rendering the cornea opaque, and fixation issues that could hinder the ability to obtain high-quality images of either eye.

INSTRUMENTATION

Measured biometry data for both the Aladdin (Aladdin HW 3.0-Software v.: 1.3.x) and Lenstar (EyeSuite v.: 18.2.2.0) included axial length (AL), anterior chamber depth (ACD), keratometry (K1/K2, and K2 axis), lens thickness (LT), central corneal thickness (CCT), white-to-white (WTW). Measurements for each device were made on separate preoperative visits no more than a maximum of 45 days apart. For each device, all measurements were made on the same day within the shortest period possible, with no single sessions lasting more than two hours. To obtain the average, parameters were measured five times on the Aladdin and once for the Lenstar, as it captures five readings at once. Readings were captured in a dimly lit room without pupil dilation. All measurement techniques were otherwise performed per the manufacturer.

STATISTICAL ANALYSIS

Descriptive statistics were reported, including the mean difference and standard deviation of the differences in units measured between the Aladdin and Lenstar. The paired t-test was used to compare values obtained with both instruments. A p-value less than 0.05 indicated a statistically significant difference between the Lenstar biometry and Aladdin biometry. The agreement between the Lenstar and the Aladdin device was evaluated using Bland-Altman plot analysis. Bland-Altman plots were generated with the difference (Lenstar - Aladdin) on the y-axis and the average of the device results on the x-axis. The 95% limits of agreement (LoA) were calculated as the mean difference ± 1.96 SD.

PRIMARY AND SECONDARY ENDPOINTS

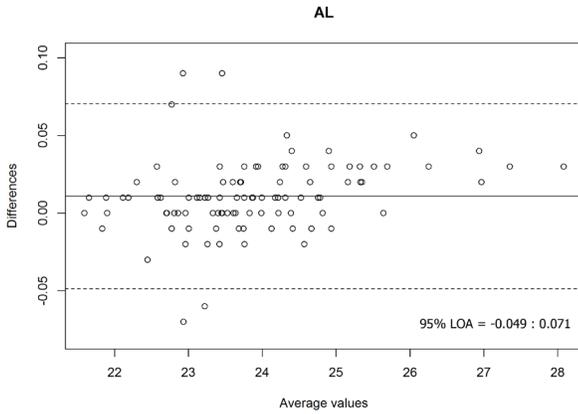
The primary endpoint was biometry data including axial length, anterior chamber depth, keratometry (power and axis), lens thickness, and corneal topography. Secondary endpoint included reporting of adverse events.

Results

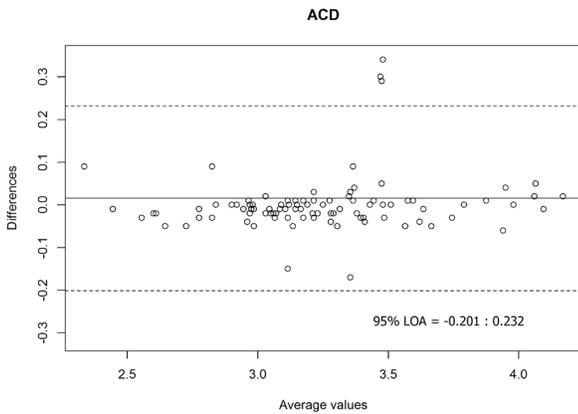
The analysis only included patients with a complete data set for all parameters measured for both biometers. A total of 101 treated eyes (65 OD, 64.4%) from 101 patients with a mean age of 67.9 ± 7.2 years (range 40-86 years) were included.

BIOMETRY

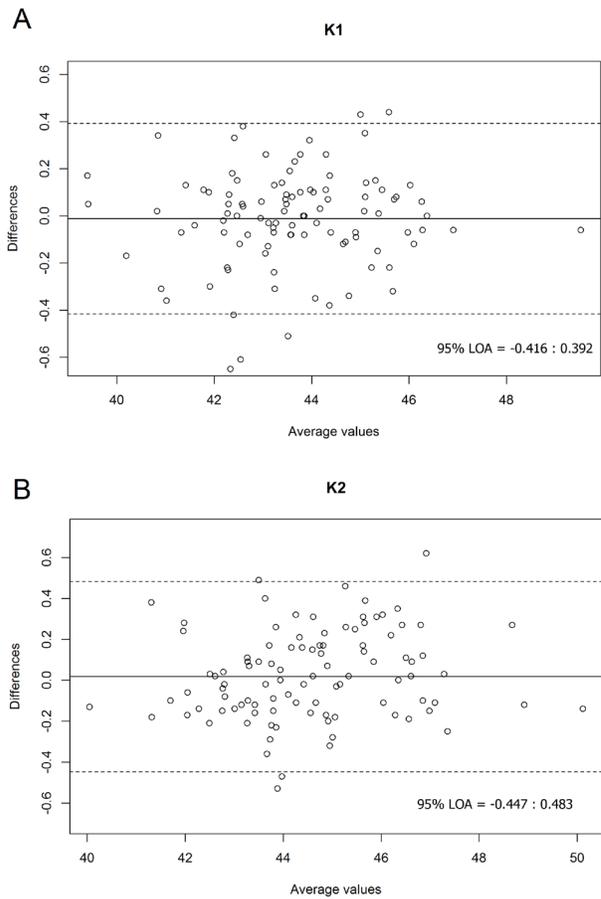
The average AL was 23.88 ± 1.23 mm with the Aladdin and 23.89 ± 1.23 mm with the Lenstar, with no statistical significance between devices ($p > 0.05$). The mean difference was 0.01 ± 0.03 mm and 95% limits of agreement (LoA) were $-0.049, 0.071$ (Figure 1).



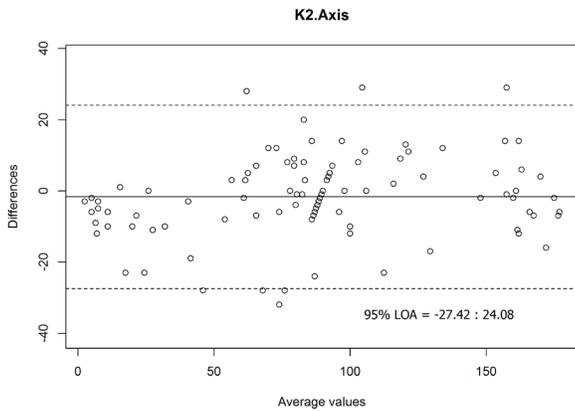
Mean ACD was 3.24 ± 0.36 mm with the Aladdin and 3.25 ± 0.37 mm with the Lenstar, with no statistical significance between devices ($p > 0.05$). The mean difference was 0.02 ± 0.11 mm and 95% LoA were $-0.201, 0.232$ (Figure 2).



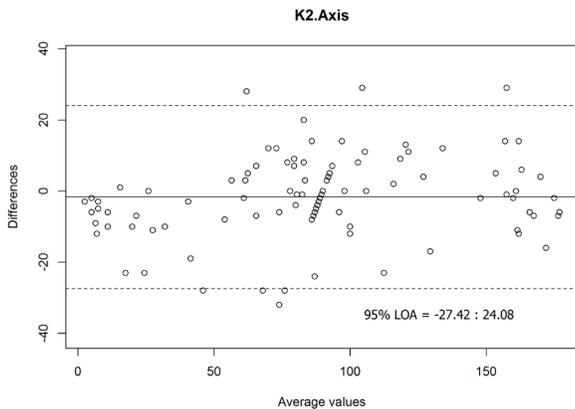
The average K1 and K2 readings were 43.63 ± 1.65 D and 44.59 ± 1.76 D respectively with the Aladdin, and 43.61 ± 1.67 D and 44.61 ± 1.77 D with the Lenstar. There was no statistical significance between each instruments' mean keratometric readings ($p > 0.05$). The mean difference was -0.01 ± 0.21 D for K1 and 0.02 ± 0.24 for K2. 95% LoA were $-0.416, 0.392$ for K1 and $-0.447, 0.483$ for K2 (Figure 3a, 3b).



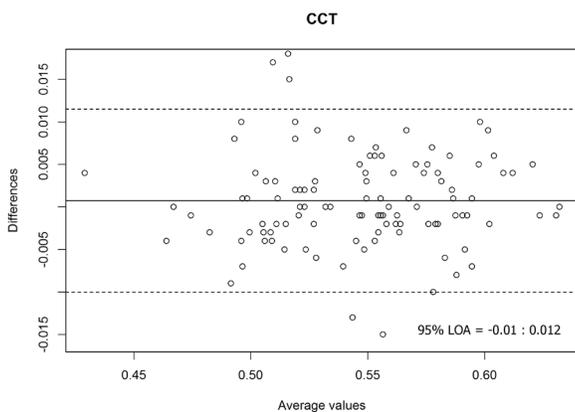
The average K2 axis was 89.84 ± 46.90 degrees with the Aladdin and 88.17 ± 50.04 with the Lenstar, with no statistical significance between devices ($p > 0.05$). The mean difference was -1.67 ± 13.4 degrees and 95% LoA was $-27.42, 24.08$. (Figure 4).



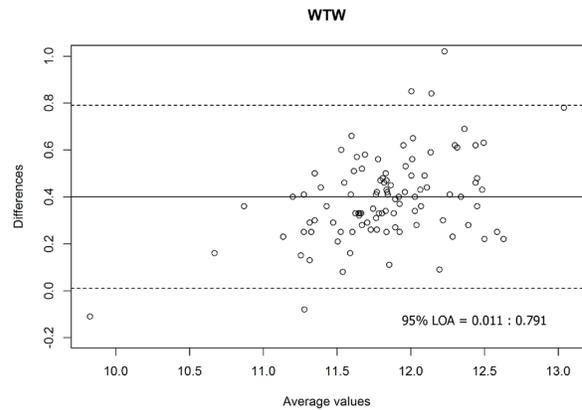
Average LT was 4.61 ± 0.39 mm with the Aladdin and 4.45 ± 0.45 mm with the Lenstar and, the difference was statistically significant ($p < 0.05$); the mean difference was -0.16 ± 0.26 mm and 95% LoA was $-0.663, 0.343$ (Figure 5).



Mean CCT was 0.54 ± 0.04 mm with the Aladdin and 0.55 ± 0.04 mm with the Lenstar, with no statistical significance between the devices ($p > 0.05$) (Figure 6).



The mean difference was 0.0008 ± 0.0056 mm and 95% LoA was $-0.010, 0.012$. Finally, there was a significant difference in WTW ($p < 0.0001$), measured to be 11.63 ± 0.41 mm with the Aladdin and 12.03 ± 0.49 mm with the Lenstar for a mean difference of 0.40 ± 0.20 mm ($p > 0.05$) and 95% LoA was $0.011, 0.791$ (Figure 7).



There was a high level of correlation between all anterior segment parameter measurements obtained by the two devices. Pearson's coefficient was found to be $r = 1.000, 0.992, 0.991, 0.955, 0.965, 0.819, 0.990,$ and 0.919 for AL, K1, K2, K2 axis, ACD, LT, CCT, and WTW, respectively.

SAFETY

No adverse events or complications were reported for any patient with the use of either device.

REFERENCE

- Figure 1: Bland-Altman plot of Axial Length (AL)
- Figure 2: Bland-Altman plot of Anterior Chamber Depth (ACD)
- Figure 3a: Bland-Altman plot of K1,
- Figure 3b: Bland-Altman plot of K2
- Figure 4: Bland-Altman plot of K2 Axis
- Figure 5: Bland-Altman plot of Lens Thickness (LT)
- Figure 6: Bland-Altman plot of Central Corneal Thickness (CCT)
- Figure 7: Bland-Altman plot of White-to-White (WTW)

Discussion

Accurate determination of anterior segment parameters is essential for optimizing intraocular lens (IOL) power calculations before cataract surgery, with errors in AL, ACD, and keratometry contributing to inaccurate IOL power calculations most frequently.¹² Olsen et al demonstrated imprecise ACD, AL, and corneal power can contribute to up to 42, 36, and 22% of refractive error following IOL implantation.¹³ As cataract surgery becomes increasingly more common¹⁴ and the expectations of patients continue to rise¹⁵ with the use of more advanced IOLs and techniques,¹⁶ the more importance biometric measurements carry in facilitating the best clinical outcomes for patients. New devices must be extensively validated in their agreement and reproducibility in comparison to current gold standards, especially when instruments utilize newer, faster, alternative methods for performing some or all measurements, as is the case with the Aladdin.

The current study investigated the agreement of the Aladdin biometer with the Lenstar biometer, a frequently used instrument with well-established accuracy and repeatability in the literature. Our study found a high level of agreement between the Aladdin and Lenstar biometers for all biometric parameters, although there was a statistically significant difference for LT and WTW. These findings are in line with previous studies, which have reported excellent agreement with the Aladdin and other frequently used biometers, including the IOLMaster. This includes a recent study by McAlinden et al. directly comparing the Aladdin to the Lenstar, which similarly found good agreement across all biometric parameters. The exception to this was white-to-white measurements, which the authors reported poor agreement with the Lenstar.¹⁰ As suggested previously in the literature, the most likely explanation for such a discrepancy is the use of different methodology and demarcation of the limbus boundaries.¹⁷ In this case, the Aladdin uses corneal topography to determine WTW, compared to the high-resolution photography used by the Lenstar. Further support is provided by another study by Polat et al. comparing Aladdin to the Sirius system (CSO, Firenze, Italy), which similarly utilizes corneal topography through a combined Scheimpflug-Placido disk. In this study, WTW measurements also showed a statistically significant difference, although there was a high degree of correlation between devices.¹⁸

Central corneal thickness is an additional parameter closely correlated with the degree of myopia in patients undergoing refractive surgery.¹⁹ Despite this, the ability to accurately measure CCT and LT between different optical biometers is much less often reported than other standard anterior chamber parameters. Like the other parameters evaluated, both lens thickness and central corneal thickness measurements were in very high agreement between the two devices, although there was a statistically significant difference in LT between the two devices. This finding is particularly important for LT, as it is a factor required in formulas for IOL power calculation are reliant. Overall, the findings of the present study add to the evidence supporting the Aladdin as a reliable and accurate instrument for performing biometric measurements compared to the frequently implemented Lenstar biometer.

Advantages of the current study include the ability to make numerous anterior chamber measurements in the same eye of a large cohort within a short time span with both the Aladdin and Lenstar. This study design promotes direct comparison within this population to assess the accuracy and effectiveness in performing these measurements in an unbiased manner. Similar to other studies comparing biometric devices, the current study's main limitation is the exclusion of patients with ocular disease other than refractive error. While extensive comorbid surface disease may confound readings, the assessment of the Aladdin in patients with lone refractive errors is essential due to its extensive use in preparing for refractive surgery.

CONCLUSION

The Aladdin biometer is a valid and effective option for cataract biometry assessment and evaluation compared to the Lenstar biometer.

WHAT WAS KNOWN

Aladdin is an ocular biometer with some evidence supporting its agreement with well-established gold standard devices for measuring biometric parameters.

WHAT THIS STUDY ADDS

Further evidence that the Aladdin biometer has good agreement with the Lenstar biometer across a broad spectrum of biometric parameters.

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