Can We Use Anterior Segment Parameters of an Optical Biometer and a Combined Topography System Interchangeably?

Basak BOSTANCI CERAN[1], Arzu Seyhan KARATEPE HASHAS[1], Emrullah TASINDI[2]

ABSTRACT

Purpose: To compare and analyze the agreement between the anterior segment parameters and pupillometric measurements obtained by Aladdin optical biometer, and Sirius corneal topographer.

Material and Methods: Medical records of healthy patients applying for refractive surgery were reviewed. Anterior chamber depth (ACD), white-to-white distance (WTW) and keratometry (K), as well as pupillometric measurements, were compared. Subjects with a history of ocular surgery or disease, refractive errors greater than 3 D and using ophthalmic medication or contact lenses were excluded.

Results: Eighty eyes of eighty patients were included. Mean ACD and WTW measured by Aladdin were 3.65±0.25mm and 12.15±0.24mm and Sirius were 3.73±0.22mm and 12.48±0.32mm, respectively. The difference in ACD and WTW was statistically significant between two devices ($p=0.026$, $p=0.001$ respectively). Mean K1 and K2 were 42.53±0.90 D and 43.98±0.86D with Aladdin, whereas they were 42.49±0.85D and 44.20±0.97D by Sirius, respectively. The difference was statistically nonsignificant ($p=0.776$, $p=0.310$ respectively). Mean photopic and mesopic pupil diameters were 3.21±0.33mm and 4.99±0.44mm with Aladdin while they were 3.65±0.48mm and 4.43±0.63mm with Sirius, which was different between two devices ($p<0.01$,$p<0.01$ respectively).

Conclusion: Keratometric measurements obtained by Aladdin seemed to be in agreement statistically with Sirius topographer, however, poor agreement was observed for mean ACD, WTW, and pupillometric measurements. Studies with larger sample sizes are warranted to evaluate whether the magnitude of these differences is clinically important or to see whether two devices can be used interchangeably for these parameters.

Keywords: Anterior chamber depth, Axial length, Biometry, Low coherence interferometry, Pupillometry.

INTRODUCTION

Accurate quantitative measurement of the anterior segment parameters is important for the preoperative assessment of the cataract and refractive surgery patient. Cataract surgery is evolving to be a refractive procedure in which achieving target refraction is a necessity for satisfactory results. Keratometric (K) findings are fundamental for biometry formulas.[1,2] Also, newer IOL calculation formulas necessitate anterior segment parameters like anterior chamber depth (ACD) and white-to-white (WTW) measurements.[3,4] These two parameters are also important for the decision-making of a refractive surgery patient if a phakic IOL is being planned in addition to keratometry.[5] Also for the refractive surgery patient, in order to decrease dysphotopsia, mesopic as well as the photopic pupil sizes must be evaluated for careful patient selection.[6]

Various devices have been introduced to obtain precise anterior segment parameters including optical coherence tomography (OCT), ultrasonic biometry (UBM), optical biometry and Scheimpflug imaging. Device interchangeability for these devices, on the other hand, is investigated by some studies.[7-10]

The aim of the present study was to assess whether keratometry readings, ACD, WTW and pupillometric findings with Aladdin optical biometer and Sirius corneal topographer are interchangeable.

Material and Methods

Medical records of consecutive patients who applied for refractive surgery procedures or cataract surgery were reviewed. Patients with a history of ocular surgery

1- Assistant Prof. MD., Okan University Hospital, Ophthalmology Department, İstanbul, Turkey

2- Prof. MD., Okan University, Ophthalmology Department, İstanbul, Turkey

Received: 16.05.2019
Accepted: 25.11.2019
Glo-Kat 2020; 15: 38-44
DOİ: 10.37844/glauc.cat.2020.15.8

Correspondence Adress:
Basak BOSTANCI CERAN
Okan University Hospital, Ophthalmology Department, İstanbul Turkey

Phone: +90 532 631 0521
E-mail: drbbostanci@gmail.com

or disease, refractive errors greater than 3 D and using ophthalmic medication or contact lenses were excluded from the study. The study was performed in adherence with the tenets of the Declaration of Helsinki.

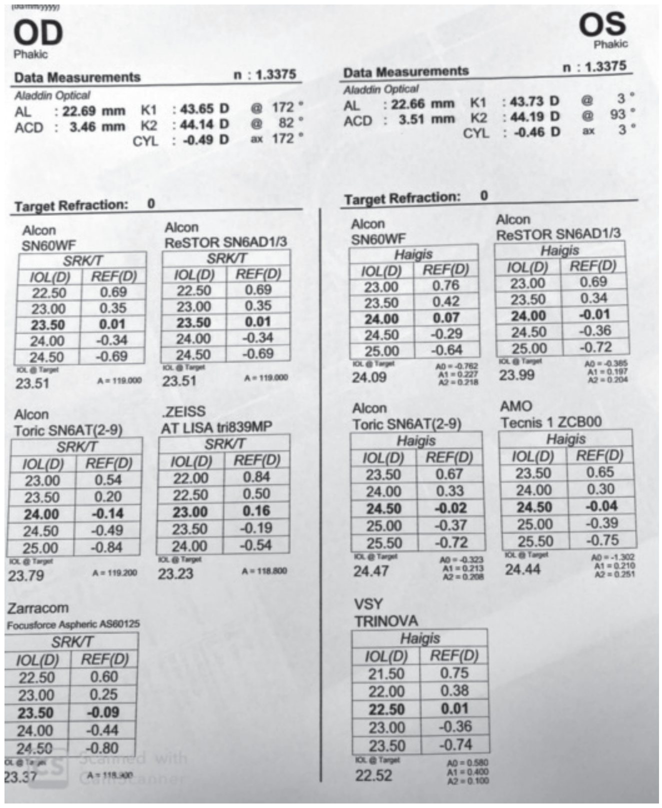
All eyes had a complete ophthalmic examination before measurement with Aladdin optical biometer and Sirius corneal topographer. Both measurements were performed through undilated pupils by the same experienced examiner under the same room lighting conditions. The order of measurements was randomized. The following parameters were compared between two devices: flat keratometry (K1), steep keratometry (K2), ACD in mm's, WTW in mm's, and pupil diameter under mesopic and scotopic conditions.

Sirius topographer

The Sirius topographer (Costruzione Strumenti Oftalmici, Florence, Italy) combines a monochromatic 360-degree rotating Scheimpflug camera with a Placido disc for evaluation of the anterior segment. Twenty-five radial sections are obtained in each scan using a 475 nm blue light emitting diode (LED) light. More than 30,000 points on the corneal anterior and posterior surfaces and 25 radial sections of the cornea and anterior chamber can be assessed simultaneously by acquiring the radius curvature measurements in the flat and steep meridians on a 3.0 mm-diameter field of the central cornea. Sagittal and tangential curvature of the anterior and posterior cornea, refractive power, pachymeter, and wavefront analysis can be obtained with Sirius device in addition to ACD, lens thickness, WTW, and pupil diameters under different luminance levels. (Figure 1)

Aladdin optical biometer

Aladdin (Topcon, Tokyo, Japan) corneal biometer and topography system combine optical low-coherence interferometry with a full Placido based corneal topographer. The optical low coherence reflectometry (OLCR) technology used in the Aladdin has an 850-nm superluminescent diode to penetrate even high-density cataracts. Additionally, with the "Real Corneal Radii" (RCR) technology, the device is reported to gather approximately 1,000 data points at the 3-mm diameter and measure the corneal radii as reliably and reproducibly as the company's auto-kerato refractometers. It performs 8 measurements in one acquisition and obtains biometric parameters like AL, ACD, keratometry, corneal topography, WTW and pupil diameters. Axial length is measured by using a diode laser whereas ACD is measured using a blue LED horizontal slit projection. Topography-based keratometry is obtained by evaluation of 1024 points of four Placido



rings. Pupillometry can be measured in 3 modes: dynamic, photopic and mesopic and the measurements are taken with infrared LED and white LED. (Figure 2)

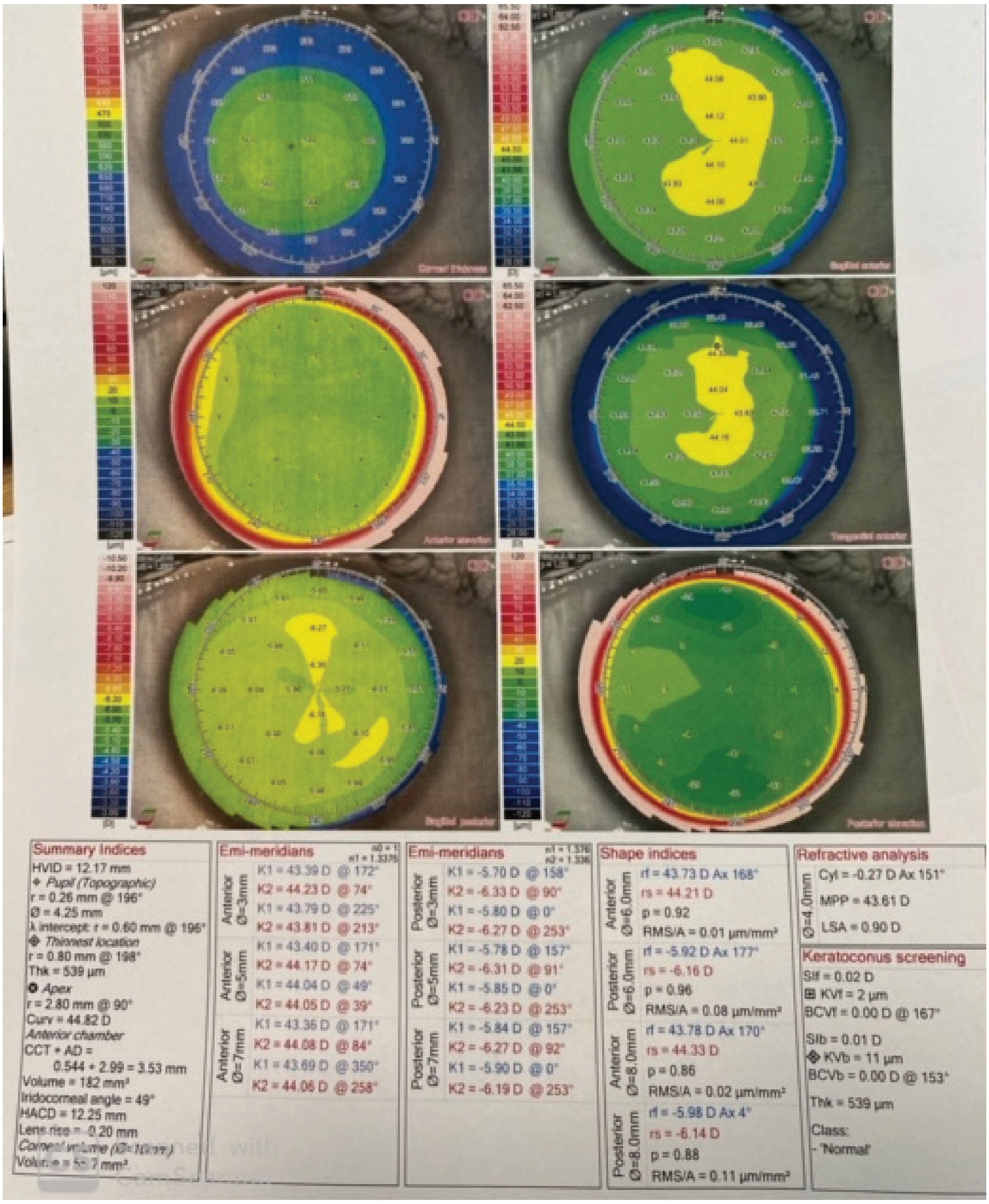
Measurement Technique

Measurements were taken in a random order. Each patient was seated in front of the devices and requested to place their chin on the chinrest and forehead against the forehead bar. An instruction was given to fixate on an internal target within the equipment. After a few blinks for permitting the tear film to spread over the cornea, measurements were obtained. At least 3 reliable measurements were obtained with each device and only high-quality measurements were included in the analysis. After completion of the measurements with the first device, the patients were asked to rest for 5 minutes. All measurements were taken in the same room under the same lighting conditions by the same experienced examiner. The luminance of the examination room during assessments was 3 lux.

Statistical Analysis

Statistical analysis was performed using SPSS for Windows software (Version 15.0, SPSS Inc.).

Data were shown to have normal distribution by the Kolmogorov-Smirnov test. (>.05). Also, the Pearson correlation was used to determine the correlation between two devices. For comparison, Wilcoxon analysis was used



for WTW, K1, and ACD; student t-test was used for K2 and pupil diameter under photopic and mesopic luminance. A p value less than 0.05 was accepted as statistically significant.

RESULTS

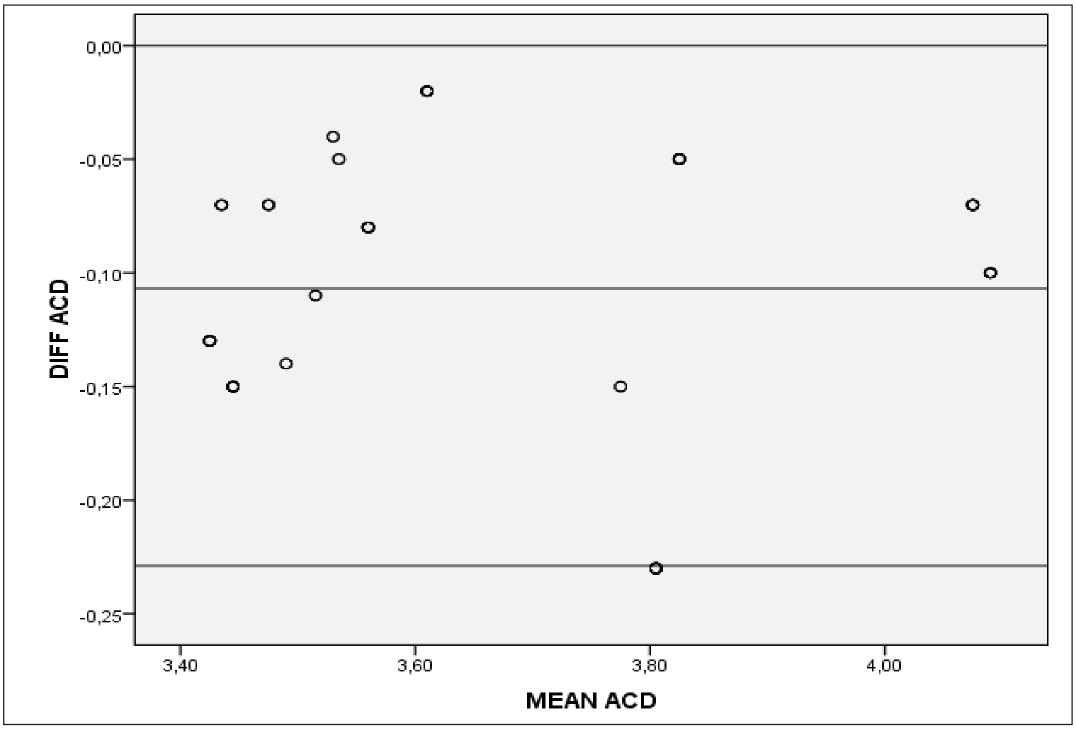
The study comprised right eyes of eighty patients. The mean age of the patients was 30.3±7,98. Table 1 shows the parameters assessed by both devices and the difference between mean values.

Anterior segment parameters

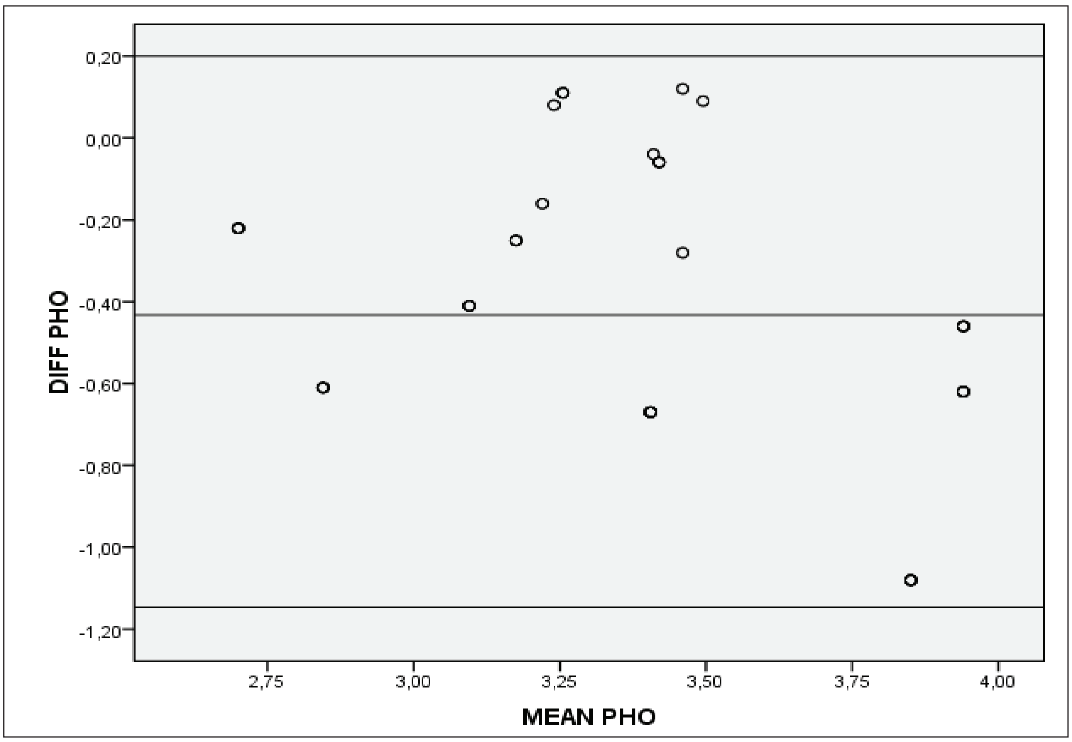
There was a statistically significant difference in ACD measurement between two devices (p=0.026), Aladdin device recording a lower mean value (Graph 1). Aladdin recorded a lower mean WTW distance compared to Sirius, the difference being statistically significant (p=0.001) (Graph 2). A comparison of the flat and steep keratometry values showed no statistically significant difference between the two devices. (p1=0.776, p2=0.310)

Pupillometry

Mean pupil diameter under photopic conditions was underestimated with Aladdin (p<0,01), however, under mesopic conditions mean pupil diameter was found to be higher with the same device (p<0.01) (Graph 3 and 4).



Graph 1. *Bland Altman plot graph for for anterior chamber depth.*

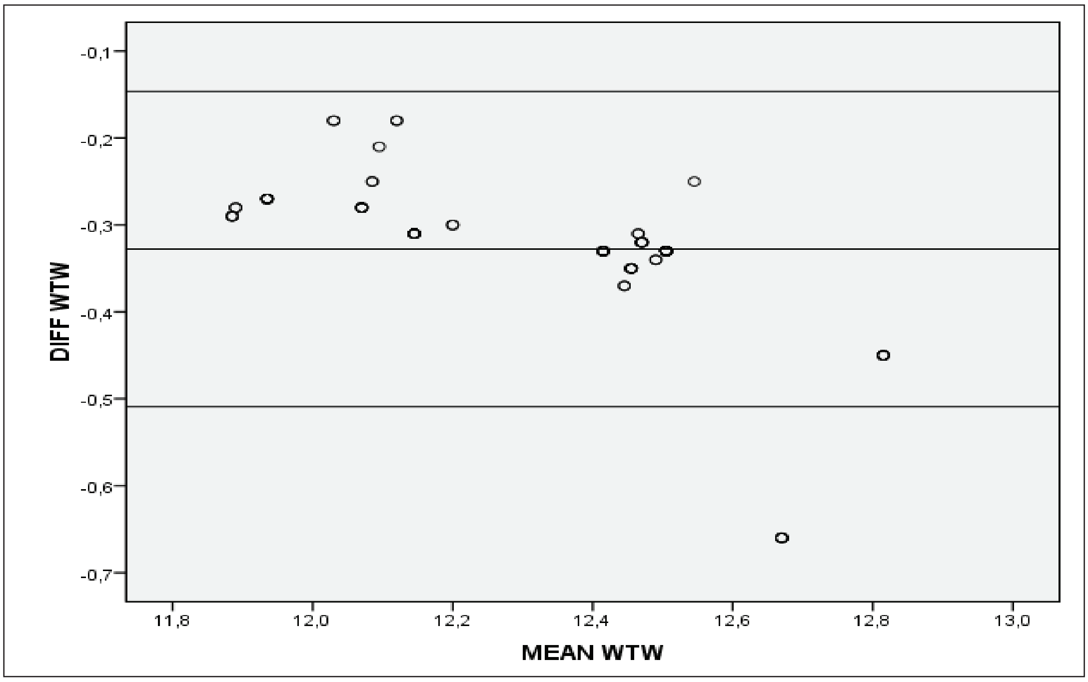


Graph 2. *Bland Altman plot graph for for white-to-white.*

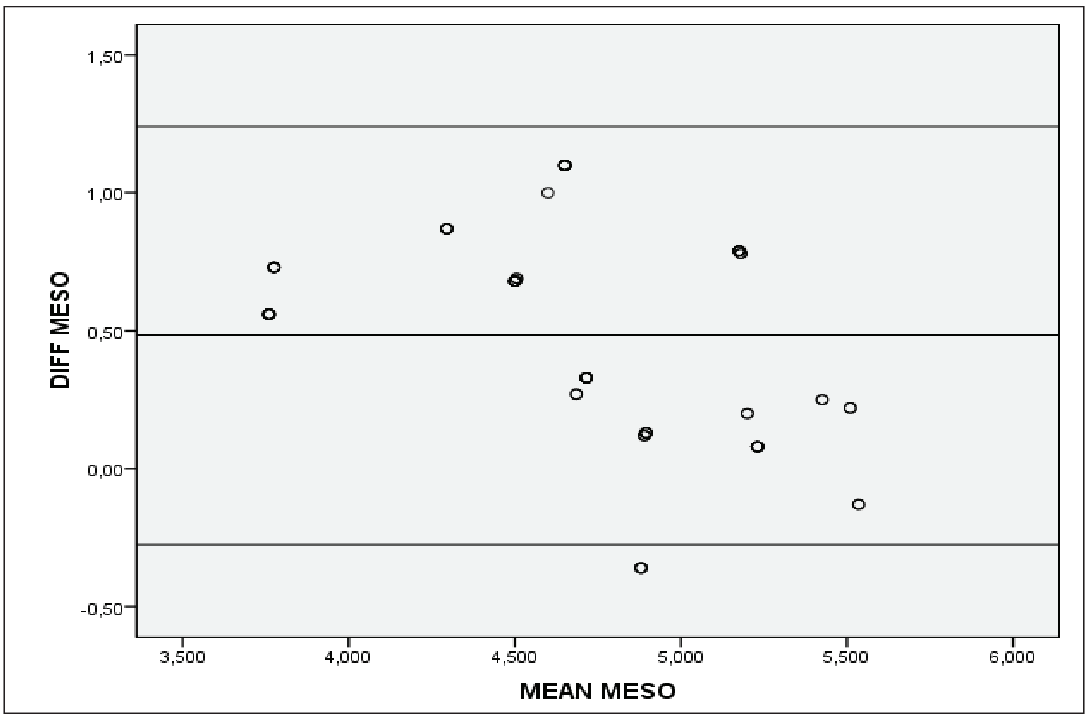
DISCUSSION

Advances in anterior segment imaging technology have significantly improved the refractive outcome of cataract and refractive procedures. Patients' requirements concerning visual outcome after those surgeries are rising in a parallel fashion. Accurate measurement of anterior segment parameters such as the ACD, corneal power, WTW or pupil diameter is crucial for intraocular lens selection or in the decision-making of refractive surgeries.

Today, many surgeons use at least two instruments, which evaluate the anterior segment parameters of the eye, one being a topographer and one biometer. During the decision process, a comparison of the measurement results of different devices is usually recommended and the decision



Graph 3. *Bland Altman plot graph for photopic pupil diameter.*



Graph 4. *Bland Altman plot graph for mesopic pupil diameter.*

is made in the light of all measurements. Even though the results of different devices are usually parallel, the interchangeability of them must be under investigation. The comparison of measurements obtained by different devices evaluates the interchangeability of these devices and indicates accuracy.[11]

Anterior chamber depth is one critic factor for patient evaluation. It is known that a 1 mm error in ACD causes 1-2 D of refractive error.[12] In addition to being crucial for IOL power calculation, ACD is also important for detection the risk of angle closure glaucoma and performing prophylactic treatments such as iridotomies.[13]

A-scan ultrasonography is often stated to be the gold standard for ACD measurements but due to the relatively high inter-observer variability of the device, non-contact methods like partial coherence interferometry and slit scanning tomography have become widely used.[14-17] The mean ACD measured by Aladdin in our study was 3.65±0.25mm whereas it was 3.73±0.22mm with Sirius. There was a statistically significant difference in ACD measurement between two devices (p=0.026), In a similar study by Polat et al, the mean ACD was 3.35 mm with the Aladdin device versus 3,42 mm with the Sirius system.[12] Although a statistically significant difference was found in the ACD measurements of the Aladdin and Sirius, the difference was clinically negligible when choosing an IOL. When using the Haigis formula, each 0.1 mm change in ACD results in a 0.06 D change in the calculated IOL power.[3] The mean difference in ACD measured by the two devices was 0.08 mm which is clinically negligible.

Corneal power acquisition is another important parameter for IOL power selection. Also, the flattening and steeping effect of refractive procedures are calculated depending on the initial keratometry measurements of the patients. Topographers are widely used for keratometric evaluation of the patients. Aladdin optical biometer seemed to be in agreement with Sirius corneal topographer depending on our findings which can be explained by the fact that both devices acquire measurements from similar paracentral points on the cornea and corneal curvature is analyzed by a Placido disk system in both. In a similar study, Shirayama et al. compared the corneal powers in 20 healthy volunteers and found that the measurements were taken by the Galilei (Ziemer, Port, Switzerland), which uses dual Scheimpflug cameras and a Placido disk, were comparable with those obtained by the IOLMaster having a 0.12 diopter (D) mean central corneal power difference.[18] This finding may be interpreted that combining a Scheimpflug camera and a Placido disk system may result with the acquisition of valid corneal power in clinical application. Similarly, Chen et al compared mean K values obtained by Lenstar and Sirius and found similar results.[19]

On the other hand, there are also studies demonstrating significant differences in keratometry findings between various devices.[20-22] Different refractive indices are used in several devices like 1.3375 for the IOLMaster, and Pentacam and 1.3320 for the Lenstar. Care should be given when selecting which index of refraction is used since it may result in different corneal powers while using keratometry results from various devices interchangeably.[23]

White to white measurement is necessary for third generation IOL formulas and also for decision making in capsular tension ring, anterior chamber or phakic IOL;[4,24] although some studies report that it cannot precisely predict the real sulcus-to-sulcus distance.[25] In our study we found a statistically significant difference in WTW measurement, Aladdin recording a lower mean WTW distance compared to Sirius (p<0.001). Salouti et al compared the horizontal corneal diameter using Galilei, EyeSys and Orbscan II system reported that it is not advisable to use WTW measurements of different devices interchangeably.[26] Huang et al reported significantly lower mean WTW measurements using the Sirius (11.42±0.46 mm), compared to IOLMaster (11.8±10.42 mm) and speculated that the difference might have clinical implications like leading to incorrect sizing of a phakic IOL while relying on Sirius measurements.[27] Thus, these devices should not be considered interchangeable for WTW assessments in clinical practice. Incoherent methods for acquiring and analyzing images might be responsible for the disparity of these two devices, although the exact cause is not ascertained.

Assessment of the pupil diameter is recommended prior to any vision correction surgery in order to decrease dysphotopsia. Obtaining a true pupil size might be challenging due to the accommodative reflex, lack of adequate time for dark adaptation, unreliable technology, and poor technique.[28] While various instruments work with an LED inside the device for fixation there are many others, which use infrared technology to capture pupil size. In our study, although both instruments use LED technology for obtaining pupillometric measurements, there was a significant difference between them, which can be speculated to be secondary to different acquisition and analyses of the images. Dynamic pupillometry function of the Aladdin optical biometer, on the other side, might be helpful for evaluating the pre-refractive surgery patient since it enables the surgeon to see the movements of the pupil in real time on the screen and record the different ranges of motion comparing it to the corneal diameter to ascertain the centricity of a pupil and calibrate that to the particular patient's needs.

As a result, keratometry measurements obtained by Aladdin optical biometer seemed to be in agreement statistically with Sirius topographer, however, this finding must be validated by randomized studies. On the other hand, poor agreement was observed for mean ACD, WTW and pupillometric measurements.

The greatest limitation of our study is the sample size since subjects with any history of ocular disease and patients with refractive errors greater than 3 D were excluded. Studies with larger sample sizes are warranted to evaluate whether the magnitude of these differences is clinically important or to see whether two devices can be used interchangeably for obtaining anterior segment and pupil parameters.

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