Comparison of Ocular Biometry Using the New SC-OCT-based Optical Biometer and OLCI in Patients With Clear Lens.

Abstract

Purpose: To compare biometrical measurements performed with the new IOLMaster-700 (Carl Zeiss Meditec AG, Jena, Germany) from those obtained with the Aladdin (Topcon, Tokyo, Japan).

Methods: A prospective, cross-sectional, observational, comparative study was proposed. Twenty-four eyes were assessed using two biometry devices. Measurements of axial length (AL), anterior chamber depth (ACD), mean keratometry (KM), flattest (Kf) and steepest keratometry (Ks) and white-to-white (WTW) were done with both devices in a random order.

Results: No statistically significant differences (p>0.05) between the two biometry were found for AL (24.22±0.92mm [range 22.66 to 26.09 mm] with IOL Master and 24.22±0.91mm [range 22.65 to 26.09 mm] with the Aladdin), ACD (3.59±0.26mm [range 3.05 to 4.11 mm] with IOL Master and 3.42±0.60mm [range 3.05 to 4.02 mm] with the Aladdin) and Kf (42.43±1.21 D [range 40.55 to 45.15 D] with IOL Master and 42.41±1.25 D [range 40.66 to 45.36 D] with the Aladdin). In Km (42.99±1.23 D [range 41.07 to 45.31 D] with IOL Master and 42.90±1.27 D [range 41.06 to 45.55 D] with the Aladdin), Ks (43.55±1.38 D [range 41.20 to 46.57 D] with IOL Master and 43.40±1.42 D [range 41.21 to 46.62 D] with the Aladdin) and WTW (12.32±0.40mm [range 11.6 to 13.1 mm] with IOL Master and 12.03±0.36 mm [range 11.46 to 12.87 mm] with the Aladdin), there was a statistical difference.

Conclusions: Measurements with the new IOLMaster-700 correlated well with those obtained with the Aladdin in patients with clear lens; although a statistical difference was found in KM, Ks and WTW. This difference was not clinically significant.

Key words: Ocular biometry; axial length; keratometry; White to white distance; anterior chamber depth.

Introduction

In recent years, intraocular refractive procedures have gained popularity, with improvements in surgical technique and the introduction of multifocal and toric lenses, refractive lens exchanges in patients with refractive errors, presbyopic patients and therapeutic purposes, turning the knowledge of the performance of biometry, necessary not only in patients with cataracts but also in healthy patients with transparent lens.

The IOL Master 700 (Carl Zeiss Meditec AG, Jena, Germany), is the new Zeiss partial coherence interferometry device that includes optical coherence tomography with SWEPT technology. Swept source OCT uses time encoded spectral information by sweeping a narrow line width laser through a broad optical bandwidth, producing an image with anatomical details of the complete eye in a longitudinal section. View of the anatomical structure allows us to make sure that the antero-posterior axis falls directly on the fovea. The IOLMaster calculates keratometry readings using telecentric keratometry, a distance independent keratometry, which analyses six light spots projected onto the anterior cornea in a 2.3mm diameter and uses a LED light of 590nm for measuring the white-to-white distance.

Another new feature of the IOLMaster 700 is the measurement of lens thickness. This value is necessary to predict the postoperative position of the intraocular lens through calculation of the C constant as described by Olsen et al when using the paraxial thick-lens formula.
The Aladdin (Topcon, Tokyo, Japan) is an optical low-coherence interferometer (OLCI) device released in 2012; axial length is measured using OLCI with an 820nm super luminescent diode. ACD measurement is achieved similarly to the IOLMaster, using a blue light emitting diode (LED) horizontal slit projection across the anterior chamber. Corneal topography, including keratometry, is based on a 24 Placido disk ring reflection with a working distance of \(\sim 8\) cm. The Aladdin analyses over 100,000 points.

The purpose of this study is to compare the ocular biometry obtained by the new model of IOLMaster (IOLMaster 700) to that measured with the Aladdin in a group of healthy individuals with transparent lens.

**Material and Methods**

This was a prospective, cross-sectional and observational study.

The study population consisted of healthy volunteers older than 18 years who were submitted to a complete ophthalmologic examination to rule out corneal pathologies or lens opacity. We excluded patients who had a history of previous eye disease, trauma, or surgery, as well as contact lenses users. The purpose of the study was explained to the patient as well as the risks and possible discomforts. Written informed consent was obtained.

The study was previously approved by the Ethics Committee of the University of Monterrey and adheres to the tenets of the Declaration of Helsinki.

Each participant underwent biometry measurement on both the IOLMaster 700 and the Aladdin in random order by an expert observer.

The statistical analysis was made with the average of the 3 measurements.

After ensuring the correct positioning of the participant against the chin and headrest, the IOLMaster 700 was focused and coarsely aligned with the participant’s eye using the overview mode. The participant was directed to focus on the illuminated target. With respect to the keratometry, participants were requested to observe a yellow light and to blink in order to produce a continuous tear film, thus improving the reflectivity of the cornea. Six peripheral measuring points were optimally focused on the cornea as demonstrated by a green light from the IOLMaster 700 traffic light system. Only measurements with green light were used for the AL measurements. Only studies with good visualization of the foveal pit were used and for keratometry and for the white-to-white distance measurements only readings with a green quality indicator were used.
For Aladdin biometry measurements, the participant was asked to fixate on a red focus point in the centre of the 24 Placido rings and the joystick button was pressed. This engaged alignment software to show arrows to clearly indicate the direction in which the equipment should be moved, in order to fine-tune the alignment. When a green circle indicated perfect alignment, the measurements were taken.

We analyzed the following parameters: axial length (AL); anterior chamber depth (ACD) - which is the distance between the tear film and lens anterior capsule; mean keratometry (Km); flattest keratometry (Kf); steepest keratometry (Ks) and white-to-white distance (WTW).

After confirming that the data were normally distributed (Kolgomorov–Smirnov test), paired two-tailed t tests (IBM SPSS V.21.0, New York, USA) (with a significance level p<0.05) were performed to compare metrics between the devices and bias between measurements for the two biometry for each parameter was calculated and presented as Bland–Altman plots.

Results

The study included 24 eyes of 24 patients with a mean age of 35.125±7.75 years (range 22-49); 18 (75%) were men and 6 (25%) women.

The average axial length was 24.22±0.92mm (range 22.66 to 26.09mm) with IOL Master and 24.22±0.91 (range 22.65 to 26.09mm) with the Aladdin, with no statistical significance (p= 1.000). The mean difference was 0.000mm with 95% limits of agreement between 0.0132 and +0.0132 mm. (Figure 1).

The average ACD was 3.59±0.26mm (range 3.05 to 4.11mm) with the IOLMaster and 3.42±0.60mm (range 3.05 to 4.02mm) with the Aladdin, with no statistical significance (p=0.122). The mean difference was 0.164mm with 95% limits of agreement between -0.0474 and +0.3757 mm (Figure 2).

The average KM reading was 42.99±1.23 D (range 41.07 to 45.31 D) with the IOLMaster and 42.90±1.27 D (range 41.06 to 45.55 D) with the Aladdin, with statistical significance (p=0.04). The mean difference was 0.085 D with 95% limits of agreement between +0.0042 and +0.1675 D (Figure 3).

The average Kf was 42.43±1.21 D (range 40.55 to 45.15 D) with the IOLMaster and 42.41±1.25 D (range 40.66 to 45.36 D) with the Aladdin with no statistical significance (p=0.55). The mean difference was 0.020 D with 95% limits of agreement between -0.0501 and +0.0909 D (Figure 4).

![Figure 1](image1.png)

![Figure 2](image2.png)

![Figure 3](image3.png)

![Figure 4](image4.png)
The average Ks was 43.55±1.38 D (range 41.20 to 46.57 D) with the IOLMaster and 43.40±1.42 D (range 41.21 to 46.62 D) with the Aladdin with statistical significance (p=0.02). The mean difference was 0.151 D with 95% limits of agreement between +0.0193 and +0.2832 D (Figure 5).

The average WTW was 12.32±0.40mm (range 11.6 to 13.1mm) with the IOLMaster and 12.03±0.36mm (range 11.46 to 12.87mm) with the Aladdin, with statistical significance (p=0.001). The mean difference was 0.29mm with 95% limits of agreement between +0.2010 and +0.3848 mm (Figure 6).

**Discussion**

Although both biometry have different technologies to measure the AL (IOLMaster 700 presents laser and optical coherence tomography with SWEPT technology and Aladdin, a super luminescent diode), in patients with clear lens they do not generate different values. This is consistent with previous reports on the IOLMaster 500 and the Aladdin by Mandal et al15 in patients with cataract and also the reported by Srivannaboon et al16 and Akman et al17 comparing IOLMaster 700 vs. IOLMaster 500. The only difference found was the ability of IOLMaster 700 to obtain biometric data from patients with in eyes with posterior subcapsular and dense nuclear cataracts.

Keratometric measurement was one of the two parameters that differ between both devices, with the Km presenting a mean difference of 0.085 D between IOLMaster (42.99±1.23D) and Aladdin (42.90±1.27 D). This could be explained to the difference in the measurement of both devices since the IOLMaster used a telecentric keratometry and the Aladdin used Placido rings. Mandal et al15 reported a mean difference of 0.08 D between IOLMaster 500 and Aladdin similar to that found by us with the new model IOLMaster 700 that uses the same keratometer. Although this is the only study comparing telecentric keratometry versus Placido ring devices, other authors evaluated other technologies including Placido rings such the Galilei tomography, which combines Placido rings with photography with a dual Scheimpflug camera. Shirayama et al18 obtained statistically significant difference in the mean corneal power values between the IOL Master (43.92 D) and the Galilei (43.80 D).

The difference between the devices is mainly due to a difference in the measurement of the steepest keratometry, since flattest keratometry were very similar (IOLMaster 42.43±1.21D and Aladdin 42.41±1.25D), while in Ks the difference was 0.151D (IOLMaster 43.55±1.38D...
and Aladdin 43.40±1.42 D). This differs from the report by López de la Fuente et al.20 whom compared measurements of the anterior segment obtained with three different devices, including the IOLMaster 500 and the Galilei in healthy subjects and found a non statistical difference between them in the flat SimK measurements of 0.155±0.156D, and the steep SimK measurements of 0.171±0.168D. Both measurements in our study were slightly higher than those found on the Galilei.

The white-to-white distance is used to calculate the size of the IOL to be implanted. This feature is important because if a smaller phakic IOL than required is placed, it can cause a cataract.20 On the other hand, if a larger phakic IOL is placed instead, it can cause angle-closure glaucoma.21

Our value of the white-to-white distance (12.32±0.40 mm with the IOLMaster and 12.03±0.36 mm with the Aladdin) is slightly higher than that reported by Martin et al.21 (11.47 ± 0.36 mm in myopic patients in whom a phakic IOL was placed). The mean difference found in our study (0.29 mm) its smaller than the steps of size of the Visian ICL phakic IOL’s.22 Baumeister et al.23 found that the mean absolute WTW measurements with Orbscan were shorter by 0.24mm compared to those of IOLMaster.

Although we found a statistical difference between the measurements of the new IOLMaster 700 and the Aladdin in mean keratometry, steepest keratometry and white-to-white-distance, the differences were not clinical significant; therefore, we think that the measurements with the new IOLMaster-700 correlated well with those obtained with the Aladdin in normal eyes.

This study presented some limitations including the small number of eyes studied and the inclusion of only healthy patients. However, we think that it is important to study this group of population, because of the increased frequency of refractive lens exchange surgery.

References