Validity and repeatability of the Aladdin ocular biometer

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ABSTRACT

Aim To assess the accuracy and reproducibility of biometry undertaken with the Aladdin (Topcon, Tokyo, Japan) in comparison with the current gold standard device, the IOLMaster 500 (Zeiss, Jena, Germany).

Setting University Eye Clinic, Birmingham, UK and Refractive Surgery Centre, Kiel, Germany.

Methods The right eye of 75 patients with cataracts and 22 healthy participants were assessed using the two devices. Measurements of axial length (AL), anterior chamber depth (ACD) and keratometry (K) were undertaken with the Aladdin and IOLMaster 500 in random order by an experienced practitioner. A second practitioner then obtained measurements for each participant using the Aladdin biometer in order to assess interobserver variability.

Results No statistically significant differences (p>0.05) between the two biometers were found for average difference (AL)=0.01±0.06 mm, ACD (0.00±0.11 mm) or mean K values (0.08±0.51 D). Furthermore, interobserver variability was very good for each parameter (weighted κ≥0.85). One patient’s IOL powers could not be calculated with either biometer measurements, whereas a further three could not be analysed by the IOLMaster 500. The IOL power calculated from the valid measurements was not statistically significantly different between the biometers (p=0.842), with 91% of predictions within±0.25 D.

Conclusions The Aladdin is a quick, easy-to-use biometer that produces valid and reproducible results that are comparable with those obtained with the IOLMaster 500.

INTRODUCTION

The correct selection of an appropriate intraocular lens is crucial to achieve optimum refractive outcomes following cataract surgery. Preoperative biometric measurements of axial length (AL), anterior chamber depth (ACD) and corneal power (K) are applied into a power calculation formula, resulting in calculation of the required IOL power for implantation.1 However, sources of error can arise from the inaccurate measurement of these parameters leading to the implantation of incorrect IOL powers and residual refractive error.2 At the present time, there are two principal techniques to measure AL: ultrasound and optical interferometry/reflectometry. The current limitations of ultrasound include relatively low-resolution measurements of AL and when the applanation technique is used, corneal contact can increase the risk of corneal abrasion and infection3 4 as well as lead to compression of the globe during measurement.5 Immersion ultrasound biometry overcomes the issue of globe compression; however, it still requires contact between the small scleral shell and the eye.

Partial coherence interferometry (PCI) has become the technique of choice due to its precision, resolution and non-invasive nature.4 Unlike ultrasound biometry, it also has the advantage of measuring AL directly through the visual axis, particularly beneficial in eyes with staphyloma or myopia.6 Furthermore, optical biometry provides greater accuracy for measuring pseudophakic and silicone-filled eyes.7 8 However, the PCI infrared laser path may be impeded by pathology such as dense cataracts, corneal scarring, vitreous haemorrhage or retinal detachment, hence the requirement to maintain ultrasound biometry equipment and skills for such circumstances.9

In 2001, the IOLMaster (Carl Zeiss Meditec, Berlin, Germany) was released, demonstrating accurate and reproducible measurements for cataract biometry assessment10 11 and in the study of refractive error.12 13 Furthermore, the latest IOLMaster 500 V5 software has improved signal processing allowing for ~95% of cataractous eyes to be measured.17 The IOLMaster calculates keratometry readings using its built-in automated keratometer, which analyses six light spots projected onto the anterior cornea in a 2.3 mm diameter. Posterior corneal curvature and corneal thickness are not directly analysed, requiring assumptions to be made in order to calculate IOL power.14 This can be problematic when calculating optimal IOL power following corneal refractive surgery. ACD is measured by analysis of the distance between the anterior surface of the cornea and the anterior surface of the crystalline lens, illuminated by an orange-yellow slit beam of 0.7 mm width at a 30° angle vertically across the anterior chamber.15

The Aladdin (Topcon, Tokyo, Japan) is an optical low-coherence interferometer (OLCI) device released in 2012, which is able to automatically measure six biometry variables simultaneously reportedly in 5 s: AL, ACD, keratometry/corneal topography white to white and pupillometry. AL is measured using OLCI with an 820 nm superluminescent 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 ~8 cm. The Aladdin analyses over 100 000 points. Pupillometry is undertaken with infrared LEDs and white LEDs to assess photopic and mesopic pupil size.
This study evaluated the validity and interobserver reproducibility of ocular measurements undertaken with the Aladdin biometer in comparison with the IOLMaster 500.

METHODS

The eyes from 75 patients with cataract (mean age 74.9 ±8.5 years, 61% women) and 22 young healthy participants (mean age 36.6±13.3 years, 64% women) participated in this prospective evaluation. The study was explained to each participant and written informed consent was obtained. The study was approved by the National Research Ethics Committee, UK, and conforms to the tenets of the Declaration of Helsinki (2008).16 Each participant underwent biometry measurement on both the IOLMaster 500 and the Aladdin in random order by the same examiner. Aladdin measurements were also subsequently repeated by another examiner in a subset of 22 patients after 5–10 min to assess interobserver variation.

After ensuring the correct positioning of the participant against the chin and headrest, the IOLMaster 500 was focused and coarsely aligned with the participant’s eye using the overview mode. The participant was directed to focus on the illuminated target. The AL measurement mode was activated and fine alignment occurred while the participant was asked to observe the red fixation point. Five AL measurements were recorded and any with a signal to noise ratio below 2.0 were repeated. 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 500 traffic light system. Subsequent depression of the joystick button provided three consecutive keratometry measurements and the mean of these values was used for the IOL calculations. If any of the six measurement points were not correctly identified, the measurements were repeated.

Participants were equally carefully aligned for Aladdin biometry measurements. The equipment was optimally positioned as demonstrated by a clear view of the anterior eye and the appearance of a ‘green eye’ quality control image, which indicated when the working distance of approximately 80 cm was achieved. The participant was asked to fixate on a red focus point in the centre of the 24 placido rings and the joystick button depressed. This engaged alignment software shows arrows to clearly indicate the direction in which the equipment must be moved in order to fine-tune the alignment. A green circle indicated perfect alignment upon which the joystick button was again depressed and six AL readings, three K readings and three ACD readings were simultaneously obtained in under 5 s. Although not assessed in this study, keratorefractive indices, corneal indices, corneal wavefront and pupillometry measurements are also displayed.

Statistical analysis

Corneal curvatures were averaged to give an average K measurement that was subsequently used in the statistical analysis. Bias between measurements for the two biometers for each parameter and repeatability was calculated and presented as Bland–Altman plots.15 Interobserver agreement between measurements was evaluated using a weighted κ test and are also presented as Bland–Altman plots. Data obtained from each instrument were used to calculate IOL power using the SRK-T formula, targeted for emmetropia. As the data were normally distributed stated by the manufacturer. The average AL was 23.65 ±1.36 mm with the Aladdin and 23.64±1.36 mm with the IOLMaster with no statistical significance between them (p=0.0695). The mean difference was 0.01 mm with a 95% CI of 0.06 mm (figure 1). Interobserver repeatability was 0.00 mm with a 95% CI of 0.05 mm (weighted κ=0.929). One patient could not be measured with the Aladdin or the IOLMaster 500 and a further three patients could not be measured by the IOLMaster 500 (excluded from the analysis).

RESULTS

All measurements with the Aladdin were achieved within the 5 s stated by the manufacturer. The average AL was 23.65 ±1.36 mm with the Aladdin and 23.64±1.36 mm with the IOLMaster with no statistical significance between them (p=0.0695). The mean difference was 0.01 mm with a 95% CI of 0.06 mm (figure 1). Interobserver repeatability was 0.00 mm with a 95% CI of 0.05 mm (weighted κ=0.929). One patient could not be measured with the Aladdin or the IOLMaster 500 and a further three patients could not be measured by the IOLMaster 500 (excluded from the analysis).
The average ACD was 3.28±0.47 mm with the Aladdin and 3.28±0.43 mm with the IOLMaster with no statistical significance between them (p=0.874). The mean difference was 0.00 mm with a 95% CI of 0.11 mm (figure 2). Interobserver repeatability was –0.01 mm with a 95% CI of 0.06 mm (weighted \( \kappa =0.904 \)).

The average keratometry reading was 43.80±1.47 D with the Aladdin and 43.84±1.41 D with the IOLMaster, with no statistical significance between them (p=0.354). The mean difference was –0.08 D with a 95% CI of 0.51 D (figure 3). Interobserver repeatability was 0.01 D with a 95% CI of 0.17 D (weighted \( \kappa =0.886 \)). All patients could be measured with both biometers.

The IOL power calculated from the valid measurements was 19.33±3.77 D with the Aladdin and 19.34±3.80 D with the IOLMaster, with no statistical significance between them (p=0.842). Most patients predicted IOL power was within ±0.25 D of each other with the two biometers (91%), with the maximum discrepancy being 0.55 D.

**DISCUSSION**

This is the first study to investigate the quality of biometry measurements obtained with the Aladdin. IOL powers calculated with this novel biometer were both reliable and comparable with those of the IOLMaster 500, the most used and trusted instrument used for cataract biometry. This is despite the biometers’ slightly different technologies such as the IOLMaster using a laser and the Aladdin a superluminescent diode. These devices will support the use of the Aladdin biometer for cataract biometry assessment\(^{10} \ 11\) as well as the study of refractive error development.\(^{12} \ 13\)

There was not found to be a statistically significant difference between calculations of IOL powers between the two biometers, demonstrating that the Aladdin is able to produce clinically reliable results comparable with that of the IOLMaster. Furthermore, the Aladdin was able to perform biometry measurements on a higher proportion of cataracts than the IOLMaster, with only two IOL power predictions failing to be calculated by the Aladdin compared with six by the IOLMaster 500. The agreement in results between clinicians was rated ‘very good’ for AL, ACD and average K readings.

In summary, we have assessed the Aladdin biomter and found that it produces repeatable biometry measurements similar to the IOLMaster 500. Furthermore, optical biometry performed with the Aladdin instrument was generally fast, easy and convenient to undertake, and appeared to more easily penetrate dense cataracts and produce biometric results to calculate the required IOL power. Further studies are required to assess intraobserver repeatability, speed of use in a clinical setting and the effect of other ocular pathology on biometry measurements.

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