Quantitative ocular anatomy in vivo: Comparison of axial length and anterior chamber depth values obtained by a single observer by means of optical biometry and immersion and applanation ultrasound biometry

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SUMMARY

The aim of the present work was to analyze and compare axial length and anterior chamber depth values obtained by means of IOL-Master™, immersion and applanation ultrasound. Axial length and the anterior chamber depth measurements were carried out by a single observer in 30 volunteers (n=30; mean age, 68±10.7 years of age; range 44 to 83 years) using IOLMaster™ (Zeiss Humphrey System, CA, USA), immersion and applanation ultrasound biometry. Ultrasound measurements were carried out with the Compuscan A-B Storz (San Louis, MO, USA). The IOLMaster™ provided axial length measurements that were 0.04 mm (p=0.936) and 0.13 mm (p=0.606) higher than those from immersion and applanation ultrasound respectively. The mean difference between the optical and applanation measurements was -0.11 mm, and -0.03 mm between the optical and immersion measurements. In conclusion, there are no significant differences between IOLMaster™, immersion and applanation ultrasound axial length and anterior chamber depth values.

INTRODUCTION

Several studies have analyzed the possible differences in the mean ocular axial length (AL) values obtained in the same sample using applanation ultrasound and IOLMaster™ biometry (Eleftheriadis 2003; Findl et al., 2003; Goyal et al., 2003; Rose and Moshegov, 2003). Other studies have analyzed the differences in mean AL values between immersion ultrasound and IOLMaster™ (Haigis et al., 2000; Kiss et al., 2002; Packer et al., 2002).

In yet other words, the differences in anterior chamber depth (ACD) values obtained with IOLMaster™ biometry and ultrasound biometric techniques have been analyzed (Santodomingo-Rubido et al., 2002; Findl et al., 2003; Nemeth et al., 2003; Tehrani et al., 2003; Reddy et al., 2004).

To our knowledge, however, no study has addressed the possible differences in AL and ACD values when measurements are carried

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out in the same eye by a single observer using IOLMaster™ immersion and applanation ultrasound biometry. Consequently, the aim of the present work was to analyze the differences in AL and ACD values between IOLMaster™, immersion ultrasound and applanation ultrasound biometry when the measurements are carried out by a single observer.

Materials and Methods

Thirty eyes of 30 volunteers (18 female and 12 male), 68±10.7 years of age (range 44 to 83 years) were analyzed in a prospective study. Two other patients (both with mature cataracts) were excluded from the study because IOLMaster™ measurements could not be performed on them.

The work was performed in accordance with the World Medical Association's Declaration of Helsinki and written informed consent was obtained from all subjects after the purpose of the study had been explained to them.

The ACD and the AL were measured with IOLMaster™ (Zeiss Humphrey System, CA, USA), immersion and applanation ultrasound following the manufacturer's instructions manuals. Immersion and applanation ultrasound measurents were accomplished with the Compuscan A-B Storz (San Louis, MO, USA) using a 10 Mhz applanation probe. Ultrasound biometric sound velocities of 1532 m/s were taken for the aqueous and the vitreous humours and 1641 m/s for the lens.

All measurements were carried out by a single experienced physician. The mean of three consecutive ACD and AL measurements were recorded. Measurements were carried out in the following order: IOLMaster™, immersion ultrasound, and applanation ultrasound. This sequence of measurements was used in order to avoid corneal indentation during applanation ultrasound, which might lead to shorter AL and ACD measurements (Reddy et al., 2004).

Repeated measures analysis of variance (ANOVA) was used to analyze the differences between AL and ACD measurements with the three techniques (Reddy et al., 2004). The difference in measurements between the methods was assessed using the paired t test (Reddy et al., 2004). A p value less than 0.05 was considered statistically significant.

Results

Table 1 offers the AL and ACD values obtained in the study. The mean difference between the IOLMaster™ and applanation biometry was 0.17 mm (p-value=0.941, paired t test; 95% CI -1.029 to 1.365 mm), the mean difference between the IOLMaster™ and immersion biometry was 0.04 mm (p-value=0.996, paired t test; 95% CI -1.154 to 1.240 mm), and the mean difference between the applanation and immersion biometry 0.13 mm (p=0.967, paired t test; 95% CI -1.072 to 1.322 mm).

The mean difference between the IOLMaster™ and applanation ACD measurements was 0.11 mm (p-value=0.622, paired t test; 95% CI -0.377 to 0.164 mm); the mean difference between the IOLMaster™ and immersion biometry was -0.03 mm (p-value=0.959, paired t test; 95% CI -0.302 to 0.239 mm), and the mean difference between the applanation and immersion ultrasound biometry 0.08 mm (p-value=0.789, paired t test; 95% CI -0.346 to 0.196 mm).

Table 1. Values of ocular axial length and ocular anterior chamber depth obtained in the study (mean mm±SD).

	Optical biometry	Ultrasound biometry	
	Zeiss IOLMaster™	Immersion	Applanation
n	30	30	30
Ocular axial length	23.7±1.9	23.7±1.8	23.6±1.9
Ocular anterior chamber depth	3.1±0.3	3.0±0.4	3.0±0.4

No significant differences among the techniques were found in axial length (p=0.936, ANOVA) and anterior chamber depth values (p=0.606, ANOVA).

Discussion

Currently, IOLMaster™, applanation, and immersion ultrasound biometry can be used to obtain the AL and ACD values in vivo. The IOLMaster™ has some advantages, since it prevents the risk of transmitting infection, corneal abrasion, and no anesthetic eye drops are needed. On the other hand, IOLMaster™ biometry does have disadvantages because it requires patient co-operation and, more importantly, IOLMaster™ biometry cannot be performed accurately in the presence of mature cataracts, posterior subcapsular cataracts, vitreous hemorrhage, maculopathy, or retinal detachment (Haigis et al., 2000; Lege and Haigis, 2004). Several studies have shown that IOLMaster™ biometry cannot be performed

on 10.6% (Findl et al., 2003), 12% (Haigis et al., 2000), 15% (Lege and Haigis, 2004), 17% (Tehrani et al., 2003) and 20% (Rose and Moshegov, 2003) of patients analyzed. In the present study, IOLMaster™ biometry could not be carried out on 2 of 32 patients, owing to the presence of mature cataracts.

An explanation for the higher IOLMaster™ measurements may be a consequence of globe compression with applanation during the ultrasound transducer contact (Haigis et al., 2000; Findl et al., 2003; Goyal et al., 2003; Reddy et al., 2004).

Moreover, IOLMaster™ measures the AL along the visual axis, whereas ultrasound biometry measures along the optical axis (Lege and Haigis, 2004). The misalignment of the beam axis and the visual axis during ultrasound measurements may cause a difference in AL measurements between optical and acoustic biometry methods (Kiss et al., 2002; Findl et al., 2003; Goyal et al., 2003).

We found no significant differences in ACD values among the techniques. Previously, Santodomingo-Rubido et al. (2002) observed that the ACD measured with the IOLMaster™ was lower (-0.06±0.25 mm) than when measured by applanation ultrasound. Findl et al. (2003) obtained ACD values of 3.1±0.4 mm and 2.9±0.4 mm with the IOLMaster™ and applanation ultrasound biometry respectively. Reddy et al. (2004) observed that applanation ultrasound measurements were on average 0.43 mm lower than those obtained by the IOLMaster™. Nemeth et al. (2003), however, observed that the contact ultrasound values were 0.28 mm lower than those obtained with the IOLMaster™

A possible explanation for our non-significant differences among the techniques in AL and ACD may be that all ultrasound and IOLMaster™ measurements were carried out by a single experienced observer. Differences between IOLMaster™ and applanation ultrasound values may vary, depending on whether the measurements are carried out by less or more experienced observers. Findl et al. (2003) obtained differences of 0.15±0.14 mm in AL values between IOLMaster™ and applanation ultrasound while the difference was 0.22±0.23 mm with the less experienced operator group. The difference in ACD values was 0.21±0.21 mm and 0.29±0.31 mm in the experienced and less experienced groups, respectively.

In conclusion, with the equipment used here we failed to find significant differences between IOLMaster™, immersion, and applanation ultrasound ocular axial length and ocular anterior chamber depth values when the measurements were carried out by an experienced observer. Zeiss IOLMaster and the Storz Compuscan A-B may be useful tools for anatomists for the quantification of AL and ACD values *in vivo*.

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