Morphometric study of the ocular anterior chamber depth with the non-contact optical IOLMaster™

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SUMMARY

Laser interferometric biometry is a modern technique that allows us to study the eye without having to touch the ocular surface. With non-contact optical biometry, it is possible to determine the ocular anterior chamber depth values in vivo. Following on from this, we analysed ocular anterior chamber depths in a sample of healthy subjects at the Rahhal Ophthalmology Clinic and the Department of Morphological Science of the Faculty of Medicine, Valencia, Spain.

To this end, we measured the ocular anterior chamber depth with the non-contact IOLMaster™ (Zeiss Humphrey System, CA, USA) in 100 patients (n=100; mean age 29.15±8.18 years; 50.0% women and 50.0% men).

We established three groups of patients according to cycloplegic spherical equivalent refraction: group A consisted of eyes of below – 10.00 diopters; group B comprised eyes ranging between – 10.25 and – 16.00 diopters; and group C included eyes with a value equal to or higher than –16.25 diopters.

Mean ocular anterior chamber depth values were 3.52±0.28 mm, 3.59±0.38 mm and 3.78±0.24 mm in groups A, B and C respectively. Differences in mean ocular anterior chamber depth among groups were significant (p=0.004). Differences in mean values between women and men were not significant in group A (p=0.613), group B (p=0.631) or Group C (p=0.065).

In sum, partial coherence interferometry is an efficient anatomical tool for study of the ocular anterior chamber depth of healthy subjects. However, further research is necessary in order to detect its validity when carrying out morphometric studies on pathological eyes.

Key Words: Optical biometry – Interferometry – Non-contact – Anterior chamber depth – Spherical equivalent refraction

INTRODUCTION

Applanation ultrasound is a valid technique for study of the ocular globe in vivo. Nevertheless, applanation ultrasound biometry has the risk of the transmission of infection and corneal lesions because the ultrasound probe comes into contact with the ocular surface.

Recently, new anatomical tools have been developed in order to avoid contact with the ocular surface when carrying out morphometric studies in vivo.

One of these modern anatomical tools is optical biometry, which is based on partial coherence interferometry. This is a new technique that allows us the study of ocular anatomy by emitting light waves instead of acoustic waves.

With laser interferometric biometry, it is possible to study the eye without anaesthetising the cornea, thereby avoiding the risk of infection and corneal lesions. This technique has been

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used to study corneal thickness (Hitzenberger et al., 1992; Hitzenberger et al., 1994) and ocular axial length (Hitzenberger et al., 1993; Drexler et al., 1998; Haigis et al., 2000; Lam et al., 2001).

Ocular anterior chamber depth can also be studied with partial coherence interferometry (Drexler et al., 1998). Currently, however, there are few references to specific studies of the ocular anterior chamber depth using this technique (Lam et al., 2001).

In the light of above, in the present work we wished to contribute to the body of knowledge of in vivo ocular anterior chamber depth anatomy by carrying out optical biometry on a group of healthy young subjects.

Materials and Methods

We carried out a prospective study at the Rahhal Ophthalmology Clinic and the Faculty of Medicine of Valencia (Spain). The work was performed in accordance with the World Medical Association's Declaration of Helsinki and written informed consent was obtained from the patients before the procedures started.

We measured the ocular anterior chamber depth in 100 eyes of 100 different subjects with the non-contact optical IOLMaster™ (Zeiss Humphrey System, CA, USA).

Subjects were 50 women (50%) and 50 men (50%), with a cycloplegic spherical equivalent refraction of -12.40±5.28 diopters (range: – 4.50 to – 21.00 diopters). The mean age of the group was 29.15±8.18 years (range: 20 to 51 years).

Exclusion criteria included active ocular disease, previous ocular surgery and systemic disease with ophthalmic repercussions.

The principles of optical biometry with the IOLMaster™ have been well described previously (Haigis et al., 2000). The method involves the use of an infrared diode laser of 780 nm. This instrument measures –through an interferometer– the time that elapses for light to be reflected from different types of tissues; this time will depend on the microstructures of the tissues in question.

As done by Lam et al. (2001), we followed the procedures recommended by the manufacturer in order to obtain ocular anterior chamber depth measurements. When the anterior chamber depth mode is activated, the system automatically activates lateral temporal slit illumination. The patient must look at the fixation light and not into the lateral slit light which flickers during the measurement. The screen of the biometer shows the image of the fixation point, the image of the cornea and the image of the lens. For valid measurements, the fixation point must lie between the images of the cornea and the lens.

Examinations were done at the same time of the day (09:00-12:00 AM). One investigator (JASG) took three consecutive readings of the ocular anterior chamber depth. The mean of these three readings were the values used in the study. Only the left eye of each patient was analysed. The choice of limiting the study to the left eye instead of the right eye was made in a random fashion.

Using cycloplegic spherical equivalent refraction as the criterion, eyes were classified in the following three groups: group A consisted of eyes of below - 10.00 diopters; group B comprised eyes ranging between - 10.25 and - 16.00 diopters; and group C included eyes with a value equal to or higher than -16.25 diopters.

The statistical work was carried out using the SPSS statistical programme (SPSS v10.0, SPSS Inc, Redmon, WA). A p-value of less than 0.05 was considered to be statistically significant. The normal distribution of the sample was contrasted by applying the Kolmogorov-Smirnov test. The Kruskal Wallis test was used to see whether there were significant differences in mean ocular anterior chamber depth among the three subgroups.

Analysis was carried out to determine wheter there were statistically significant differences between the mean ocular anterior chamber depth of women and men by applying the Student t-test in group A and group B and the Mann-Whitney test in group C.

Results

The mean ocular anterior chamber depth of the sample (mean±SD) was 3.61±0.33 mm, with a minimum of 2.72 mm and a maximum of 4.43 mm.

A progressive increase in mean ocular anterior chamber depth was observed in the presence of a greater degree of spherical equivalent refraction; the mean values were higher in eyes with a greater degree of spherical equivalent refraction.

Mean ocular anterior chamber depth values were 3.52±0.28 mm, 3.59±0.38 mm and 3.78±0.24 mm in group A, group B and group C respectively. Differences in mean values among groups were significant ($p = 0.004$; Kruskal Wallis test).

Table 1 shows the mean anterior chamber depth values for women and men. Men had higher mean values in groups A, B and C. Nevertheless, these differences observed in mean values between women and men were not significant (table 1).

Figure 1 shows the minimum and maximum ocular anterior chamber depth values for the all of eyes studied and for women and men in each

Table 1.- Mean ocular anterior chamber depth values for women and men (mm±SD).

	Women	Men	Between women and men
Group A	3.48±0.25	3.53±0.30	p = 0.613 (S-t)
Group B	3.62±0.26	3.56±0.47	p = 0.631 (S-t)
Group C	3.83±0.12	3.66±0.37	p = 0.065 (MW)

S-t = Student t-Test; MW = Mann Whitney test.

group analysed. The minimum and maximum values also showed a progressive increase in the presence of a greater degree of spherical equivalent refraction.

Women had the highest minimum values while men had the highest maximum values in each group. Differences between minimum and maximum values were always relatively smaller for women.

DISCUSSION

Here we report the results of the ocular anterior chamber depth measurements in a large sample of healthy subjects. To our knowledge, this study reports the largest series of subjects in which ocular anterior chamber depth has been analysed by means of partial coherence interferometry.

We used the IOLMaster™ in our work. This machine is designed to calculate intraocular lens power but it is also able to measure ocular axial length and ocular anterior chamber depth in vivo (Haigis et al., 2001; Lam et al., 2001).

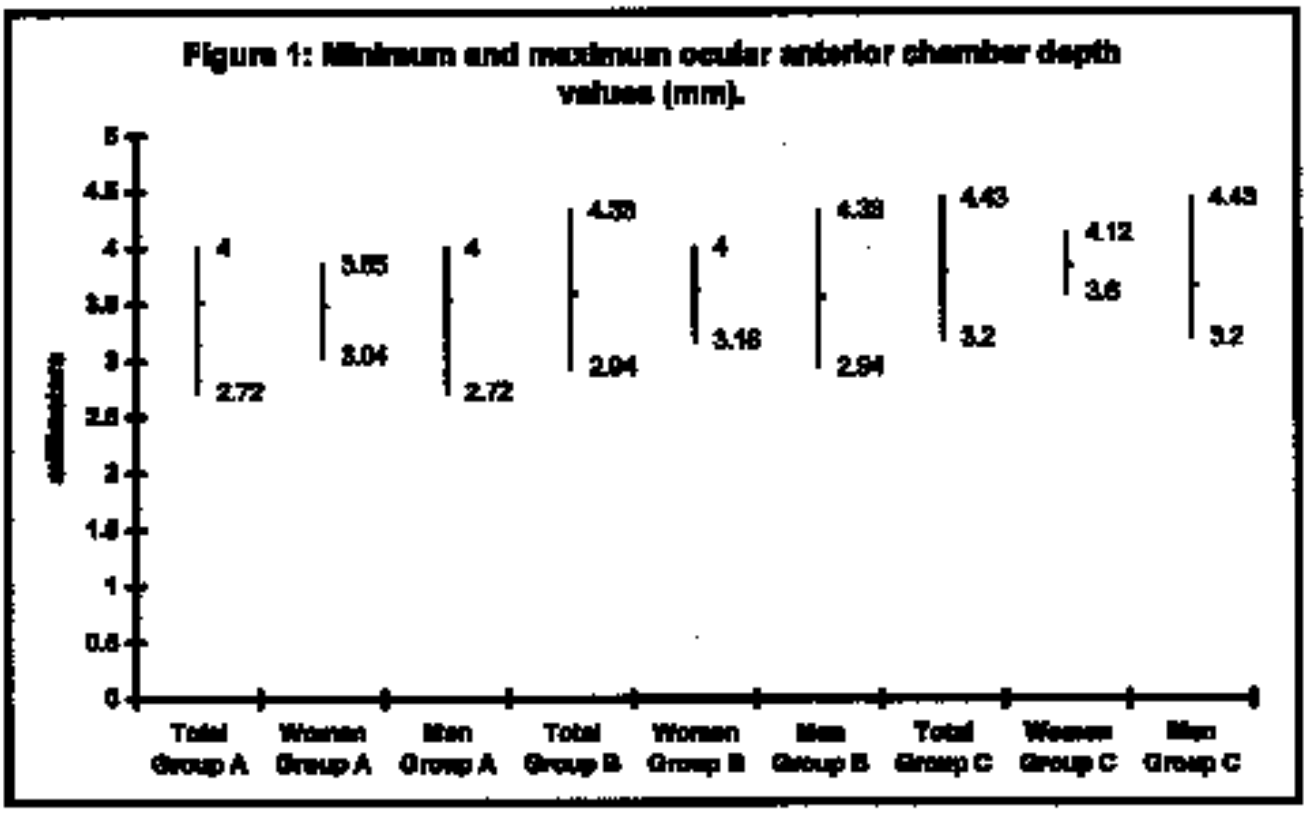
The IOLMaster™, based on partial coherence interferometry, allows ocular biometry to be implemented whilst avoiding contact with the ocular surface. Classical contact applanation ultrasound biometry has enabled researchers to establish ocular anterior chamber depth values (Midelfart and Aamo, 1994; Osuobeni, 1999, Hosny et al., 2000; Wong et al., 2001; Muñoz et al., 2001).

Currently, non-contact techniques are seen as an alternative to classical contact techniques in that they have an important number of advantages. The main advantage is that with non-contact techniques, the risk of infection and the risk of corneal lesions due to contact with the ultrasound probe is avoided.

In our study, all measurements were carried out by one practitioner. Measurements must be carried out by the same practitioner during applanation ultrasound studies because there are significant differences in the results of different observers when morphometric studies are carried out on the same sample (Bovelle et al., 1999).

Fortunately, non-contact biometry with the IOLMaster™ allows ocular anterior chamber depth measurements to be performed by different observers with no significant differences among them (Lam et al., 2001). The latter authors obtained a mean ocular anterior chamber depth of 3.60±0.25 mm and 3.60±0.24 mm from practitioner 1 and 2, respectively, on the same sample.

Here, by means of a non-contact technique we were able to avoid the shortening of the ocu-



lar globe due to compression during contact with the ultrasound transducer. It has been reported that this shortening is the possible cause of shorter ultrasound ocular axial lengths on comparing the results obtained after applying applanation ultrasound and partial coherence interferometry on the same sample (Drexler et al., 1998; Haigis et al., 2000).

Recently, Lam et al., (2001) observed the same problematic situation when they compared the ocular anterior chamber depth values obtained with the IOLMaster™ and those obtained with applanation ultrasound. They noted a mean value of 3.44±0.24 mm with applanation ultrasound and a mean value of 3.60±0.25 mm with the IOLMaster™ for the same sample.

In the present work we failed to find significant differences in mean ocular anterior chamber depth values between women and men. Neither did Midelfart and Aamo (1994) obtain significant differences between women and men. Other studies have reported that men have higher average ocular anterior chamber depth values than women (Osuobeny, 1999; Wong et al., 2001).

We found a progressive increase in mean ocular anterior chamber depth in the presence of a greater degree of spherical equivalent refraction; the differences in mean values among groups A, B and C were significant. A similar evolution of the mean values has been reported previously (Hosny et al., 2000). In contrast to our findings, Osuobeny (1999) observed that anterior chamber depth did not vary significantly with the magnitude of the spherical equivalent.

Thus, it appears that optical biometry by means of the IOLMaster™ can progressively replace conventional ultrasound biometry. We believe that optical biometry by means of the IOLMaster™ could be the most appropriate technique in healthy subjects. In contrast, we also believe that ultrasound biometry would be the most appropriate technique when carrying out morphometric studies in unhealthy eyes because pathologies as common as mature cataracts may prevent partial coherence interferometric measurements from being satisfactory carried out (Hitzenberger et al., 1993; Haigis et al., 2000). Furthermore, the manufacturers of the IOLMaster™ recommend against measuring aphakic eyes because no precision can be guaranteed.

In conclusion, partial coherence interferometry is an efficient anatomical tool for the study of the ocular anterior chamber depth of healthy subjects. However, further research is required in order to confirm its validity when carrying out morphometric studies on pathological eyes.

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