Comparison of ACMaster and Orbscan™ II in Terms of Corneal Thickness and Anterior Chamber Depth Measurements

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Summary

The ACMaster (Carl Zeiss Meditec AG) is a new instrument for non-contact measurement of corneal thickness, anterior chamber depth and lens thickness in phakic and pseudophakic eyes. Measurements are based on laser interferometry, are fast and highly accurate. The comparison with the Orbscan™ II (Bausch&Lomb) served to compare reproducibility and ascertain possible measurement differences.

For the test, 96 phakic eyes were measured. The mean values of corneal thickness and anterior chamber depth were 544 µm (CT) and 3.710 mm (ACD) for the ACMaster and 582 µm (CT) and 3.616 mm (ACD) for the Orbscan™ II (Bausch&Lomb).

The standard deviations found were 1 µm/0.004 mm (CT/ACD) for the ACMaster and 5 µm/0.175 mm for the Orbscan™ II.

Thus, the ACMaster has a four times higher reproducibility and is very well suited for exact measurements of corneal thickness and anterior chamber depth.

1. Introduction

With laser interference biometry, a very accurate method for axial length measurements has been available for some years. It is based on the principle of partial coherence interferometry. This method has been restricted to axial length measurements (IOLMaster®, Carl Zeiss Meditec AG) until now, but a new instrument (ACMaster) that also allows the anterior eye segment to be measured has become available.

The ACMaster measures corneal thickness, anterior chamber depth and lens thickness in phakic and pseudophakic eyes.

Moreover, these parameters can be measured under various conditions of accommodation, so that the possible movement of potentially accommodating intraocular lenses or the thickening and the forward movements of human eye lenses become measurable, for example. High-accuracy corneal thickness measurements are important, for refractive surgery of the cornea in particular. Here, in recent years Orbscan™ instruments were often used for the pre-LASIK measurement. In addition, the corneal thickness was increasingly used for the correction of intraocular pressure values after applanation tonometer measurements.

The measurement of anterior chamber depth is of growing importance in refractive surgery, e.g. for the implantation of phakic anterior chamber lenses or intraocular contact lenses (ICL). That way, it is possible to pre-operatively explore the space available for an IOL in the anterior eye segment or to determine the distance between an ICL and the human lens at near accommodation, for example.

Two different methods have been available for the measurement so far:

- Ultrasound measurement
- Measurement with Scheimpflug cameras/slit scanning techniques.

Recently, instruments employing new measuring techniques based on laser interference were launched.

To ascertain how the new instruments compare to the well-known techniques, we compared the Orbscan™ II from Bausch&Lomb, which is used in many refractive laser surgery centers, to the ACMaster from Carl Zeiss Meditec with respect to the reprodu-cibility of measurements. Not only that, we were interested in the systematic result differences between the two instruments.

2. Materials und Methods

In the study, the following instruments were used:

- ACMaster, Carl Zeiss Meditec AG
- Orbscan™ II, Bausch&Lomb.

Corneal thickness and anterior chamber depth were determined in five repeat measurements on each of the 96 eyes. The average age of those tested was 26.6 years (24 ... 55 years). Additionally, the mean values and standard deviations were determined.

In the measurements, the optical axis of the eye was used as reference. On the ACMaster, this was positively adjusted by means of the reflection images.

On the Orbscan™ II, however, this point was ascertained graphically via the reflection of the placido disc and the reflection of the slit image. In the repeat measurements, deviations of up to 30° Tabo were measured. These deviations can be traced to the complicated adjustment procedure of the test person in front of the instrument and the duration of the measurement. When taking measurements at different points, differences in the results are normal.

3. Results and Analysis

3.1 Corneal thickness

The mean corneal thickness was found to be 544 µm with the ACMaster and 582 µm with the Orbscan™ II (Fig. 1).

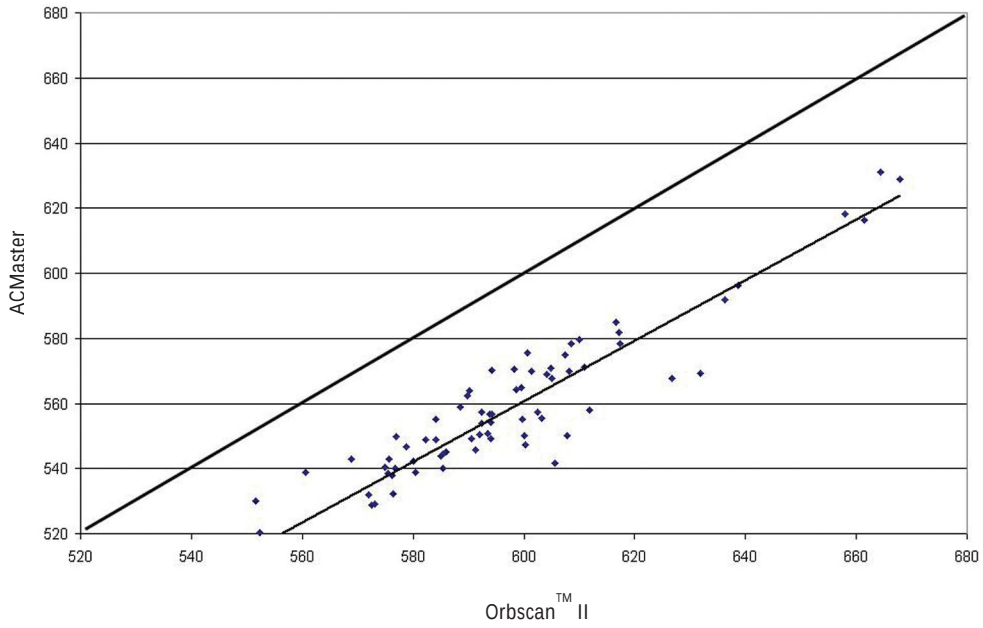

Fig. 1
Comparison of corneal thickness values (µm) measured with ACMaster and Orbscan™ II

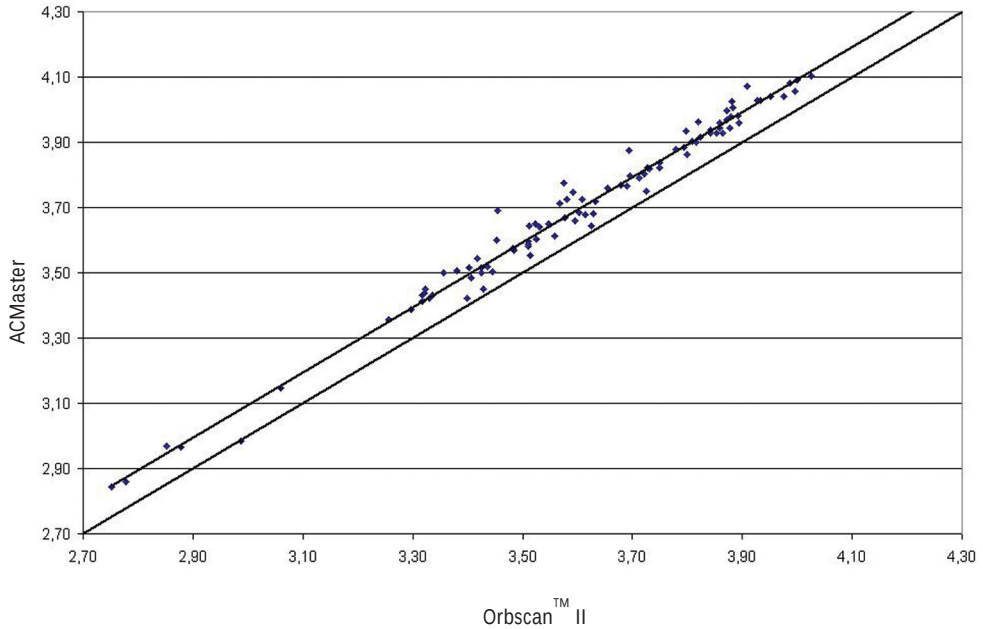

Fig. 2
Comparison of anterior chamber depth values (mm) measured with ACMaster and Orbscan™ II

The mean values of standard deviation were 1 µm and 5 µm. On average, the Orbscan™ II measures 38 µm thicker. The following regression function could be determined:

$$CT_{ACMaster} = \frac{5}{6} CT_{Orbscan} + 0{,}058$$

The measured values correlate very well; however, on the ACMaster the scatter is distinctly less. In most cases (more than 99%), the standard deviations of the ACMaster are within 2 µm. The standard deviations of the Orbscan™ II were found to be approximately five times higher (maximum approx. 13 µm). For a graphic analysis, refer to Fig. 3.

3.2 Anterior chamber depth

The mean anterior chamber depth measured was 3.710 mm on the ACMaster and 3.616 mm on the Orbscan™ II; the mean values of the standard deviation were found to be 0.004 mm and 0.018 mm.

Compared to Orbscan™ II, the anterior chamber depth values measured on the ACMaster are always greater, on average by 0.094 mm (Fig. 2).

The following regression function was determined:

$$ACD_{ACMaster} = 1.1\, ACD_{Orbscan} - 0.2$$

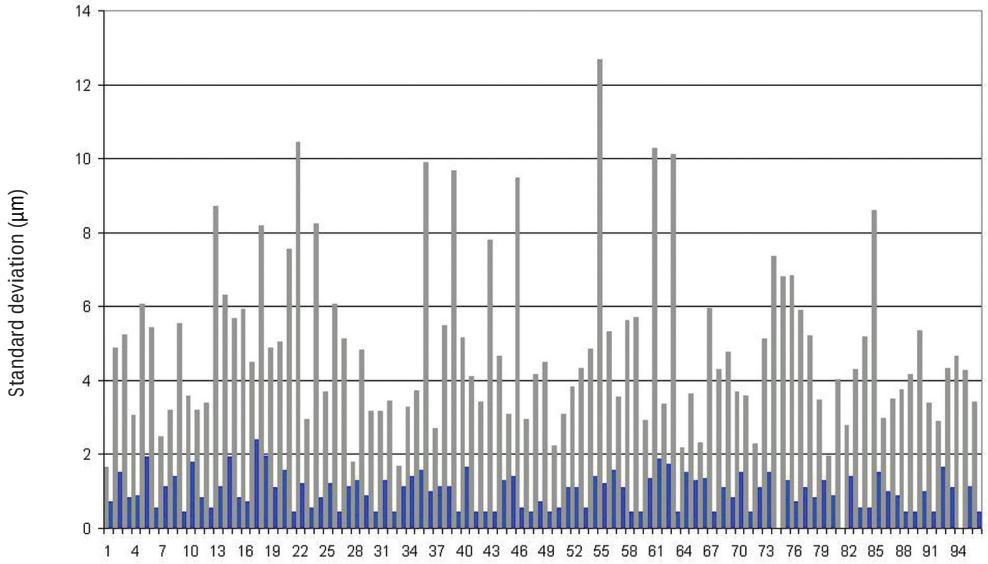

Fig. 3
Standard deviations of corneal thickness measurements with ACMaster and Orbscan™ II

Key to Fig. 3 and Fig. 4
Orbscan™ II
ACMaster

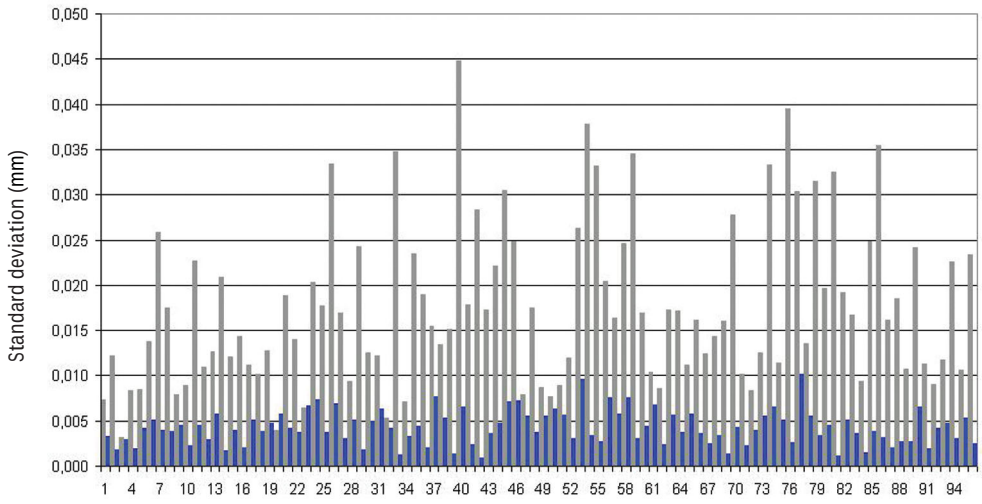

Fig. 4
Standard deviations of anterior chamber depth measurements with ACMaster and Orbscan™ II

The scatter of the measured values around this regression function is minimally above the standard deviation of the ACMaster. The standard deviations of the measurements per eye with the ACMaster were within 8 µm in 98% of all measurements.

As with corneal thickness measurements, the standard deviation of the Orbscan™ II is approximately five times higher. A graphic analysis is shown in Fig. 4.

The anterior chamber depth measurements demonstrated that the values measured with the ACMaster are greater than those obtained with the Orbscan™ II and, as with corneal thickness measurements, the standard deviations are lower.

A previous study (comparison of anterior chamber depth measurements of IOLMaster® and ACMaster) also showed that the values measured with the ACMaster are greater by approx. 0.1 mm compared to those measured with the IOLMaster®.

As the IOLMaster®, like the Orbscan™ II, determines the values by image analysis, there are grounds for the assumption that these relations are due to the measuring methods applied. Since the anterior chamber depth measurement on the IOLMaster® is linked to the ultrasound method via comparative measurements by means of the immersion technique, it is likely that when comparing the measured values with those of immersion ultrasound instruments a difference of approx. 0.1 mm on average will occur, too. This will be examined in future studies.

In summary, it may be said that the new method of laser-interferometric biometry of the anterior eye segment with the ACMaster yields accurate results and features a high reproducibility of both corneal thickness and anterior chamber depth measurements.

Note

ACMaster uses the following group refractive indices at a wavelength of λ = 850 nm to calculate the intraocular distances (CT, ACD, LT):

Cornea	n = 1,3851
Aqueous humor	n = 1,3454
Lens	n = 1,4065

References:

Drexler,W., Hitzenberger, C.K., Baumgartner, A., Findl, O., Sattmann, H. und Fercher, A. F. (1998). Investigation of Dispersion Effects in Ocular Media by Multiple Wavelength Partial Coherence Interferometry. Exp. Eye Res. (1998) 66, 25-33.

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