Observer Variance with ACMaster and Orbscan™ II as Regards Corneal Thickness and Anterior Chamber Depth Measurements

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Summary

The ACMaster (Carl Zeiss Meditec AG) is a new instrument for the non-contact measurement of corneal thickness (CT), anterior chamber depth (ACD) and lens thickness (LT) in phakic and pseudophakic eyes.

The observer variance of the new instrument was tested and compared with the Orbscan™ II (Bausch&Lomb).

30 eyes were measured five times each by two observers. The mean values of corneal thickness and anterior chamber depth obtained with the ACMaster were 550.1/549.6 µm; 3.7128/3.7179 mm; with the Orbscan™ II 588.2/586.8 µm and 3.6224/3.6128 mm.

The standard deviations were 1.0/1.1µm and 0.0040/0.0042 mm (CT/ACD) on the ACMaster and 5.0/5.2 µm and 0.0140/0.0280 mm on 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.

No observer variance could be ascertained on either instrument.

1. Introduction

In refractive surgery, it is of great importance to know the intraocular distances, especially when it relates to corneal thickness and anterior chamber depth. In addition, corneal thickness is used in modern glaucoma diagnosis and therapy for the correction of the intraocular pressure values measured with applanation tonometers, as thicker corneas lead to overestimated and thinner corneas to underestimated intraocular pressures and thus to erroneous diagnostic and therapeutic conclusions.

With laser interference biometry, which has been used since 1999 with the IOLMaster® marketed by Carl Zeiss, a new measuring method has been established. In recent years, this method was available only for axial length measurements. But now, this method can also be used to measure the anterior eye segment. Our study aimed to find out whether the observer variance, well known from the axial length measurement, which is a great advantage for the efficient use of the instruments, has also been implemented on the new instrument.

Until a few years ago, ultrasound pachymeters and A-Scan instruments, primarily, were used for these measurements. The major drawbacks of these methods are the contact between ultrasound probe and eye, limited measuring accuracy, limited reproducibility and observer variance.

Recently, slit scanning techniques (e.g. Orbscan™) have been used as well, which, like the ACMaster, also provide non-contact measurements.

2. Materials and Methods

The following instruments were used:

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

To avoid measuring errors caused by different room lighting conditions, the horizontal illuminance at instrument level (1.50 m) at the point of measurement was adjusted to approximately 15 lx before the measurements were taken.

In general, the test persons were measured first with the ACMaster and then with the Orbscan™ II. The order of observers was fixed. Measurements were performed on 30 eyes.

Corneal thickness and anterior chamber depth (here, anterior chamber depth is understood to be the distance between the anterior cornea surface and the anterior lens surface) were determined by five repeat measurements and the mean values and standard deviations were calculated. In the measurements, the optical axis of the eye was used as reference.

3. Results and Result Analysis

The measured data for observer variance is given in the table below. The following mean values and corresponding standard deviations were found:

Table

ACMaster

	CT	SD	ACD	SD
Observer I	0.5501	0.0011	3.7128	0.004
Observer II	0.5496	0.0010	3.7179	0.0042

Orbscan™ II

	CT	SD	ACD	SD
Observer I	0.5882	0.0050	3.6224	0.0140
Observer II	0.5868	0.0052	3.6128	0.0218

For Observer I, the differences of the Orbscan™ II / ACMaster measurements of corneal thickness and anterior chamber depth were as follows: mean 37.9 µm/-0.0905mm, minimum 29.0 µm/ -0.0240 mm and maximum 62.4 µm/-0.1534 mm. For Observer II, the following values were found: mean 37.1 µm/-0.1051 mm, minimum 17.0 µm/ -0.0192 mm and maximum 49.6 µm/-0.1494 mm.

On average, the differences of the measured values between the observers obtained with the Orbscan™ II amounted to 1.4 µm for the corneal thickness and 0.0096 mm for the anterior chamber depth; on the ACMaster the corresponding values were 0.4 µm and 0.0051 mm.

The correlation of measured values obtained with the Orbscan™ II is less than that delivered by the ACMaster (Fig. 1 to Fig. 4).

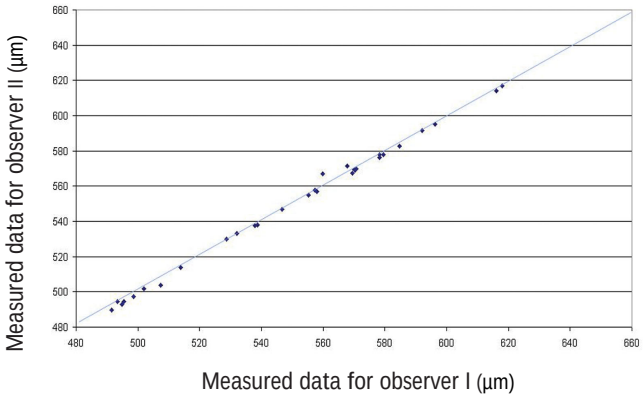

Fig. 1
Comparison of the results of corneal thickness measurements of both observers obtained with the ACMaster

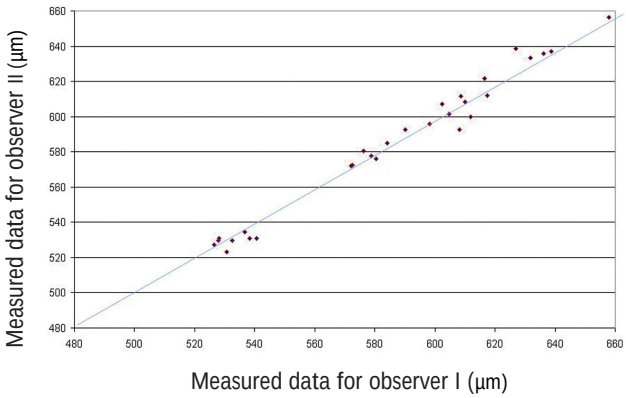

Fig. 2
Comparison of the results of corneal thickness measurements of both observers obtained with the Orbscan™ II

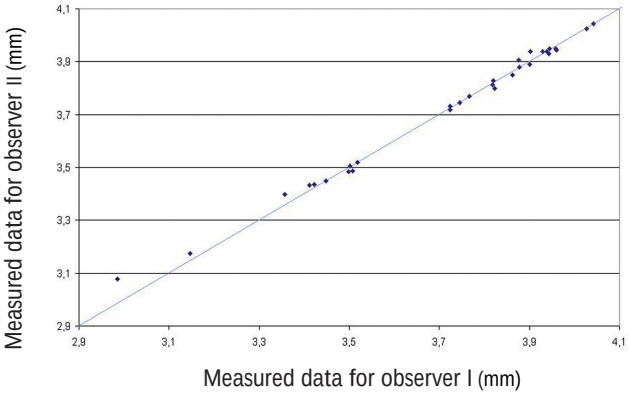

Fig. 3
Comparison of the results of anterior chamber depth measurements of both observers obtained with the ACMaster

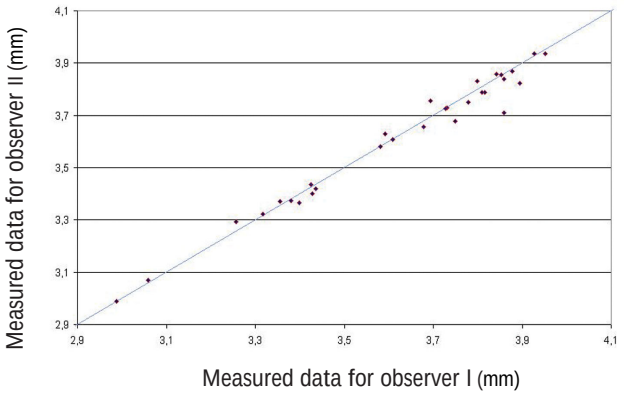

Fig. 4
Comparison of the results of anterior chamber depth measurements of both observers obtained with the Orbscan™ II

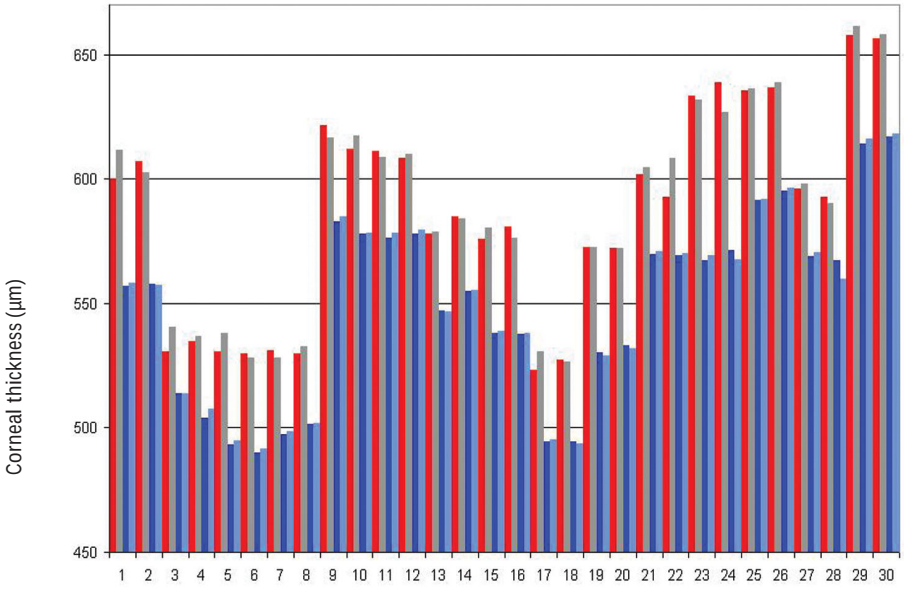

Fig. 5
Results of corneal thickness measurements with ACMaster and Orbscan™ II on 30 eyes by two observers

Key to Fig. 5 to Fig. 7
- Observer I Orbscan™ II
- Observer II Orbscan™ II
- Observer I ACMaster
- Observer II ACMaster

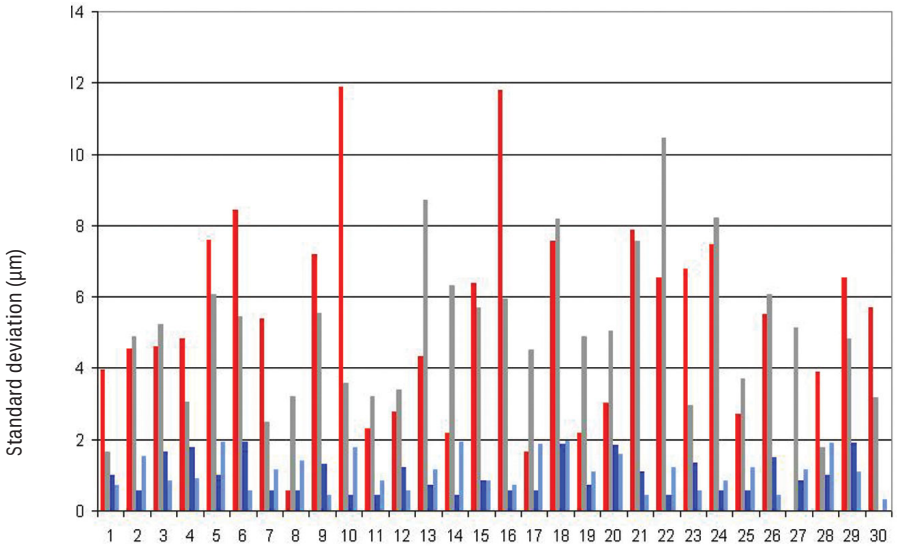

Fig. 6
Comparison of the standard deviations of the individual measurements of corneal thickness

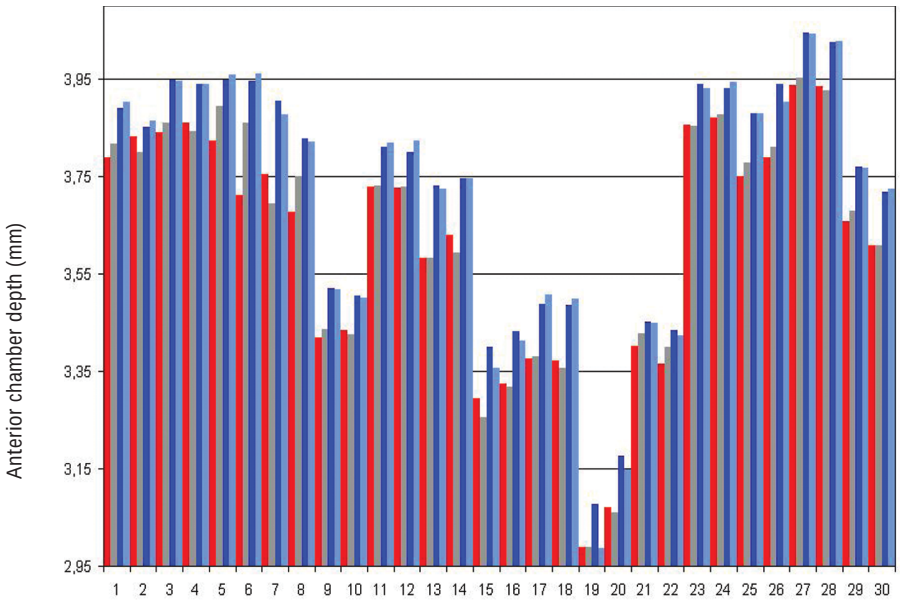

Fig. 7
Measurements of anterior chamber depth with ACMaster and Orbscan™ II on 30 eyes by two observers

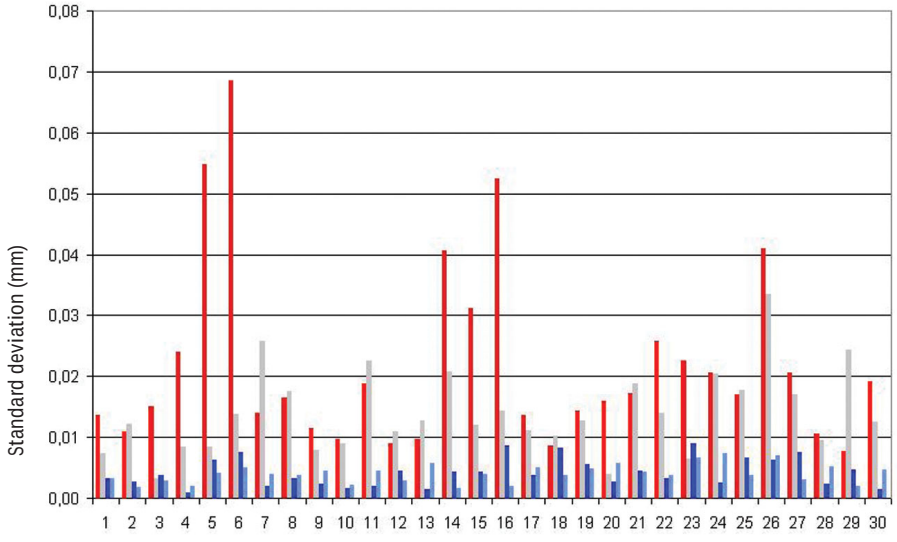

Fig. 8
Standard deviations of individual measure-ments of anterior chamber depth with ACMaster and Orbscan™ II for both observers

The variances between observers were distinctly smaller than the standard deviation of the respective measurements.
Thus, observer variance could neither be ascertained for the measurement of the corneal thickness nor for the measurement of the anterior chamber depth on either instrument. This statement is confirmed by means of the random distribution of the measuring points around the angle bisector shown in the diagrams (Fig.1 to 4).
On average, the corneal thickness was 37 or 38 µm less with the ACMaster, the anterior chamber depth was 90 or 105 µm greater. The good correlation of the measurements is illustrated by Figs. 5 and 7.
The standard deviations per eye are shown in Fig. 6 and Fig. 8. On the ACMaster, they are distinctly smaller than on the Orbscan™ II.
Looking at the results of the ACMaster measurements, it is obvious that the standard deviations of CT measurements are smaller than those of ACD measurements.
As we could demonstrate with another study, this is obviously due to micro movements of the anterior lens surface during accommodation processes, among others, as we also found that the mean standard deviation of anterior chamber depth values was also age-related.

Conclusions

The mean corneal thickness measured by the two observers was 550.1/549.6 µm on the ACMaster and 588.2/586.8 µm on the Orbscan™ II; the mean anterior chamber depth was 3.7128/ 3.7179 mm on the ACMaster and 3.6224/3.6128 mm on the Orbscan™ II.
Thus, the ACMaster measures the corneal thickness by approx. 37 µm less than the Orbscan™ II; the anterior chamber depth, however, was approx. 100 µm longer.
The correlation of the measured values is good.
The reproducibility obtained with the ACMaster (1 µm) is distinctly better than for the Orbscan™ II (5 µm).Observer variance could not be ascertained; the mean variance among observers was within the standard deviations.
With the ACMaster, a high-precision system for the measurement of corneal thickness and anterior chamber depth is available.

Note

ACMaster uses the following group refractive indices at a wavelength of $\lambda = 850$ 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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