

Partial Coherence Laser Interferometry in Highly Myopic versus Emmetropic Eyes

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Purpose: To investigate the reliability of partial coherence laser interferometry for optical biometry in highly myopic eyes.

Methods: Axial length measurements by the IOLMaster (Carl Zeiss Meditec, Germany) with signal-to-noise ratio (SNR) ≥ 2 were performed in 52 consecutive myopic subjects with axial length ≥ 26.5 mm and 45 emmetropic patients before cataract surgery. Axial length measurements and SNR were analyzed and compared among the two study groups.

Results: Axial length measurements were feasible in 46 of 52 (88.5%) highly myopic eyes and in 41 of 45 (91.1%) eyes with normal axial length. To achieve two reliable axial length values with SNR ≥ 2 , a mean number of 2.06 ± 0.25 measurements was necessary in myopic eyes and 2.10 ± 0.37 in emmetropic counterparts. Mean SNR after two measurements was 4.98 ± 2.44 in myopic eyes versus 5.56 ± 2.32 in control eyes. Even though successful measurement was independent of preoperative visual acuity, patients with visual acuity better than 20/63 showed significantly higher SNR values.

Conclusions: Partial coherence laser interferometry shows satisfying feasibility and good signal quality for axial length determination in highly myopic eyes with stable retinal condition and clear media.

Keywords: Axial Length; Partial Coherence Interferometry; Biometry; High Myopia

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INTRODUCTION

The most common indication for secondary intervention after implantation of intraocular lenses (IOLs) is deviation from target refraction.¹⁻⁴ Accurate axial length (AL) determination is considered as an important factor for prevention of such complications.

Optical biometry using partial coherence laser interferometry (PCLI) offers advantages in accuracy and reproducibility of AL determination as well as being more comfortable for both the

patient and the investigator as compared to conventional ultrasonic biometry.⁵⁻¹² However, feasibility is limited with dense cataracts, retinal detachment and fixation problems.^{7,13,14}

Ultrasonic biometry is confounded by certain problems in clinical conditions such as globe deformities, myopic staphyloma, eccentric fixation or silicone oil tamponade.^{3,15-17} In comparison to acoustic measurement, PCLI allows evaluation of the ocular length along the visual axis, which could be an advantage in highly myopic eyes, especially when staphylomas are present.

The IOLMaster (Carl Zeiss Meditec, Germany) employs PCLI to calculate axial length with high precision. AL measurement by the IOLMaster is based on reflection of the interference signal from the retinal pigment epithelium (RPE).⁵⁻¹² Eyes with high myopia, in comparison to emmetropic eyes, demonstrate characteristic alterations in the posterior pole including rarefaction of Bruch's membrane and the RPE, and lacquer crack lesions.¹⁸⁻²⁰ It is unclear whether these morphological alterations of the RPE in high myopia affect signal quality with PCLI.

The majority of studies on biometry and high myopia are focused on postoperative refractive errors following cataract surgery.^{21,22} In these eyes optical biometry seems to be superior to ultrasound biometry. However, the refractive error acquires more significance with increasing AL and is also dependent on IOL power calculation formula.

The purpose of the current study was to evaluate whether PCLI is viable in highly myopic eyes and whether the signal quality is comparable to emmetropic control eyes. While there is no data available on feasibility and signal quality during AL measurement in highly myopic eyes, it might be useful to identify or to exclude these parameters as possible sources of error in biometry under this special condition.

METHODS

In this retrospective analysis we included myopic subjects with axial length exceeding 26.5 mm who underwent cataract surgery at the University of Cologne, Department of Ophthalmology. Clinical examinations included objective refraction, determination of best corrected visual acuity, and slit lamp examination of the anterior and posterior segment. Moreover, documentation included patients' age, sex and ocular history.

All PCLI measurements were performed on phakic eyes using the IOLMaster (Carl Zeiss Meditec, Germany). In detail, 52 consecutive eyes of 34 patients including 16 male and 18 female subjects with mean age of 62±11 (range 43 to 80) years underwent examination by experienced investigators who had to conduct

at least four axial length measurements with a signal-to-noise ratio (SNR) of 2.0 or higher per eye. Data of 45 consecutively measured eyes of 25 emmetropic patients including 13 male and 12 female subjects with mean age 65±17 (range 45 to 81) years with AL between 22 and 24 mm were taken into account as the control group.

IOLMaster examination for IOL calculation included AL and anterior chamber depth measurement and keratometry. SNR was automatically analyzed and had to be at least 2.0 to be taken into account. To determine the relevance of visual acuity and sufficient fixation for the quality of measurement, SNR was correlated against preoperative visual acuity.

Statistical analysis (Software Stat View for Windows, Version 5.0, SAS Institute Inc., Cary NC, USA) was performed using the parametric paired t-test, and the non-parametric Mann-Whitney, Kruskal-Wallis and Wilcoxon Signed Rank tests; significance was set at 0.05.

RESULTS

In 46 of 52 highly myopic eyes (88.5%) two or more measurements with $SNR \geq 2$ could successfully be performed. Reasons for failure were corneal opacities (n=2) and dense cataracts (n=4). A mean of 2.065 measurements had to be undertaken to reach two reliable measurements. Mean axial length was 28.79±1.92 (range 26.51 to 36.04) mm when only the first two measurements were taken into account. Mean difference between the first and the second AL value was 0.04±0.03 mm. Mean SNR after two measurements was 4.98±2.44. In the myopic group no correlation was found between SNR and axial length (Figure 1).

Considering the mean of three best measurements with the highest SNR (mean SNR was 5.96±2.92), a mean AL of 28.82±2.0 mm was obtained. This was not significantly different from the value obtained after only two measurements (P=0.31).

Visual acuity was less than 20/200 in 10 eyes, between 20/200 and 20/63 in 16 eyes, and better than 20/63 in 18 eyes. In 4 patients visual acuity data was not available. The highest SNR values were obtained in patients with visual

acuity better than 20/63 (Figure 2). Eyes with visual acuity below 20/200 showed significantly wider intra-individual range for the first two AL values than eyes with better visual acuity (Figure 3).

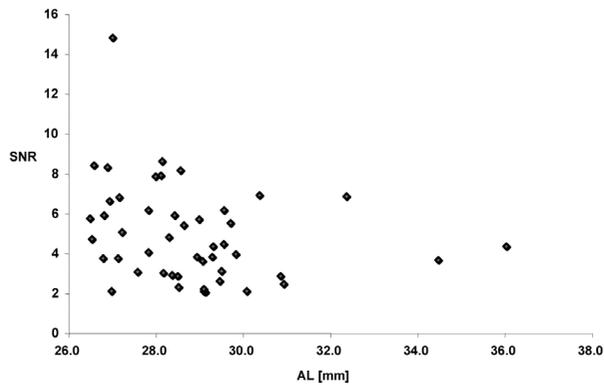


Figure 1. Correlation between signal to noise ratio (SNR) and axial length (AL) in highly myopic eyes.

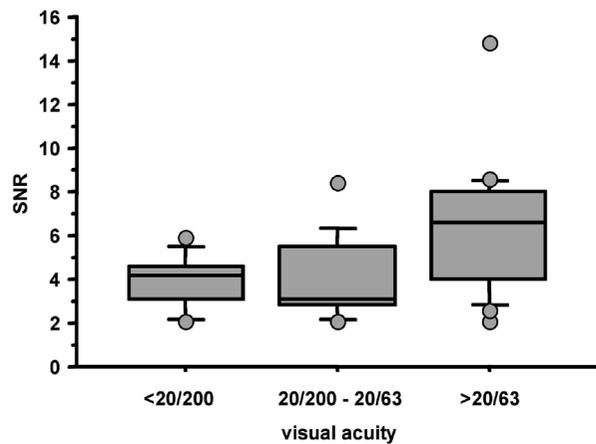


Figure 2. Correlation between signal to noise ratio (SNR) and visual acuity.

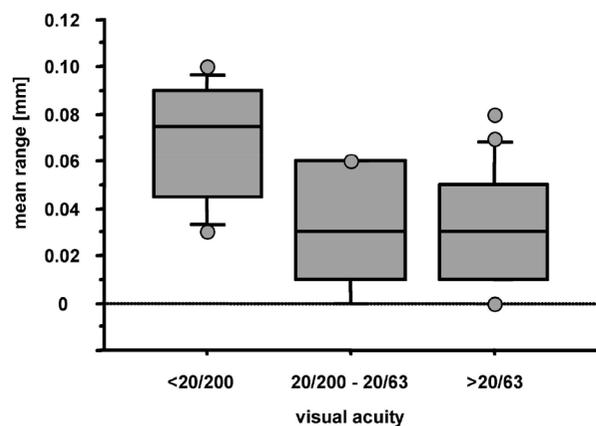


Figure 3. Correlation between visual acuity and mean range between first and second axial length values.

In the 45 control eyes with AL between 22 and 24 mm, a mean number of 2.10 ± 0.37 examinations were required to obtain two reliable AL values. Measurements were successful in 41 eyes (91.1%) and failed in 4 eyes due to dense cataract ($n=2$), corneal scars ($n=1$) or retinal pathology ($n=1$). After two measurements, AL was 23.26 ± 0.45 mm with a mean difference of 0.03 ± 0.02 mm between the two AL values and mean SNR of 5.56 ± 2.32 .

There was no significant difference regarding SNR values between myopic and emmetropic eyes ($P=0.38$).

DISCUSSION

Previous studies have reported successful PCLI measurements in 83 to 91% of all examined subjects not distinguishing among hyperopic, myopic or emmetropic eyes.^{8,14,16} Our results show that optical biometry demonstrates similar feasibility in highly myopic and emmetropic eyes such that successful measurements were achieved in 88.5 % of myopic and 91.1 % of control eyes. It is striking that even in eyes with extreme myopia, successful measurements could be achieved.

No statistical difference was observed between SNR in myopic eyes and control eyes based on the first two measurements. Following only two measurements with SNR better than 2.0, the device seems to provide reliable AL values in emmetropic and myopic eyes as well. Nevertheless, in routine practice at least four measurements are recommended to detect possible outliers.

Inaccurate measurement of preoperative AL can be responsible for postoperative refractive errors in myopic eyes.¹⁻⁴ One reason for inaccuracy of ultrasound biometry in high myopia lies in the presence of posterior staphylomas leading to discrepancy between the optical and acoustic axes.³ The higher resolution of PCLI in comparison to ultrasound biometry has already been demonstrated.^{23,24} In some case reports it had been shown that optical axial length determination is superior to ultrasound biometry in myopic eyes especially if the eye is affected by posterior staphyloma.¹⁶

In highly myopic eyes, the RPE shows specific morphological alterations, which might

influence the reflection of the interference signal emitted by the IOLMaster.¹⁸⁻²⁰ However, our results show robustness of measurements even in extremely myopic eyes. Since the predictability of postoperative refraction after cataract surgery in highly myopic eyes is a well-known problem, this level of signal quality for measurements with optical biometry might increase its reliability and prevent errors. In fact, regarding the refractive outcome of cataract surgery in highly myopic eyes, recent studies reported better results for optical biometry using the IOLMaster.^{21,22} On the other hand AL measurement has lost some of its relevance as a possible source of error since recent studies have identified wrong prediction of postoperative anterior chamber depth as the most important source of error for incorrect IOL power predictions in optical biometry.²⁵⁻²⁷

Based on our results, which demonstrated a good feasibility of AL measurements with satisfying signal quality parameters, we may support the recommendation to use PCLI in patients with highly myopic eyes.

Conflicts of Interest

None.

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