Axial length measurement in eyes implanted with phakic posterior chamber intraocular lenses

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ABSTRACT: Purpose: To determine where eye length measurements obtained with an optical biometer before and after Implantable Collamer Lens (ICL) implantation would show any change.

METHODS: We have analyzed a prospective study a sample of 32 eyes of 19 consecutive patients implanted with an ICL (Staar Surgical, CA). Spherical equivalent refraction ranged from −5.50 to −21 diopters (D) (mean −13.73±4.48 D). Axial length was measured using the IOL Master® (Carl Zeiss, Jena, Germany) non-contact optical biometer before and after ICL implantation.

RESULTS: Mean axial length value was 27.28±2.05 mm (ranging from 24.43 to 33.36 mm) and 27.31±1.98 mm (ranging from 24.56 to 32.76 mm), before and after the surgery, respectively. Mean axial length difference between both values was −0.03±0.12 (ranging from −0.17 to 0.10 mm). The paired t-test revealed no statistically significant differences in axial length between before and after ICL implantation (P=0.1653). Both measurements correlated in a highly positive manner (R = 0.99, P < 0.0001).

CONCLUSION: This study shows that axial length measurement before ICL implantation is comparable to measurements carried out after surgery. Optical biometry achieves valid and reliable axial length measurements in eyes implanted with ICL.

KEYWORDS: Axial length, ICL, optical biometry.

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INTRODUCTION

Implantation of a posterior chamber phakic intraocular lens for the surgical correction of myopia has been proved to be a safe procedure with regard to visual and refractive results¹⁻⁹. Recent multicenter clinical studies of the United States Food and Drug Administration (FDA) for the STAAR myopic Implantable Collamer Lens (ICL, STAAR Surgical, Monrovia, CA) demonstrated the safety and effectiveness of this lens in the treatment of moderate to high myopia²,³,⁵,⁶,⁹. In addition, recent published outcomes from the clinical FDA toric ICL clinical trial¹⁰ and other studies¹¹⁻¹⁵ showed also good efficacy and predictability for this lens.

Considering the increasing number of implants for this phakic intraocular lens, the question arises whether this lens will affect the results of axial length measurement. We need to consider that the speed of sound through the various materials of phakic lenses, in general, is widely different and is different from the average velocity used to measure the eye. Then, differences between axial length estimation may happen if this measurement is done before or after ICL implantation. It is obvious that an accurate biometry is necessary to calculate the power of any intraocular lens for cataract surgery, and becomes highly relevant when a phakic intraocular lens is implanted in the cataractous eye. Then, the purpose of this study is to analyze if there is any change in the axial length measurement before and after a myopic or toric ICL implantation using optical biometry.

PATIENTS AND METHODS

All patients included in this non-randomized, prospective study underwent a myopic or a toric ICL implantation at the Instituto de Microcirugía Ocular, Barcelona or at the Fernández-Vega Ophthalmological Institute, Oviedo (Spain) between November 2009 and
July 2010. Surgery was performed by two surgeons (DEA and JFA) after a written informed consent was obtained. The eyes included in this study had primary myopia and astigmatism with no previous surgery and no abnormal findings diagnosed in the preoperative ophthalmologic examination. All patients were inappropriate for other methods of refractive correction due to one of the following exclusion criteria: insufficient corneal thickness for excimer ablation or abnormal/irregular corneas. Patients with endothelial cell counts less than 2200 cells/mm², anterior chamber depth (ACD) from the endothelium less than 2.8 mm, abnormal iris or other eye diseases were excluded.

Patients were enrolled with baseline errors between −5.50 to −21.00 D of myopia (sphere) and 3.00 or 5.00 D of astigmatism (cylinder). All patients presented a stable refraction for 12 months before study enrollment with a best-spectacle corrected visual acuity (BCVA) of at least 20/25 in the study eye. All patients enrolled in the study were between 22 and 44 years old.

The Staar ICL is a Collamer (collagen-copolymer), biocompatible, UV-absorbing, foldable lens with a refractive index 1.45 at 35°C. This lens is designed to correct myopia between −3 to −23 D and astigmatism (if toric) between +1 to +6 D with powers in half-diopter increments. The lens has an optical diameter from 4.65 to 5.5 mm and available lengths from 11.5 to 13.0 mm. To determine the appropriate size of the lens, the white-to-white distance was evaluated with an Orbscan II (Bausch&Lomb, Rochester, NY) and the ACD distance using both an Orbscan II and an anterior segment OCT (Visante, CarL Zeiss-Meditec, Gena, Germany). The appropriate lens power was determined with a proprietary software program (ICL calculating software, STAAR Surgical, Monrovia, CA), with a target refraction of emmetropia in all cases. The ICMV4 and TICMV4 models were implanted in these eyes.

All patients underwent pre- and postoperative axial length measurement using the IOL Master non-contact optical biometer (Carl Zeiss, Jena, Germany). The IOL Master® optical biometer uses partial coherence interferometry with a 780 mm laser diode infrared light to measure axial length. The measurement process using this system is fast and the non-contact character of the method reduces the risk of infection and avoids corneal compression hence improving axial length accuracy. Partial coherence interferometry has been shown to have the same accuracy as immersion biometry. The measurement of the axial length was done preoperative and at one month after the surgery.

Data analysis was performed using SPSS for Windows version 16.0 (SPSS Inc., Chicago, IL). Normality was checked by the Shapiro-Wilk test, and the t-test was performed to compare pre- and post-surgery outcomes. Differences were considered to be statistically significant when the P value was <0.05 (i.e., at the 5% level).

RESULTS

Thirty-two eyes of 19 consecutive patients (10 males and 9 females) implanted with the ICL were included in this study. Spherical equivalent refraction ranged from −5.50 to −21 D (mean −13.73±4.48 D). The mean preoperative BCVA was 0.90±0.07 (Snellen decimal visual acuity, ranging from 0.80 to 1.0), the mean spherical ICL power was −13.53±4.37 D (ranging from −5.50 to −21.00 D) and the mean cylinder was −4.17±1.04 D (ranging from 0 to + 5.00 D). Mean implanted ICL size was 12.41±0.34 mm (ranging from 12.00 to 13.00 mm).

Mean axial length value was 27.28±2.05 mm (ranging from 24.43 to 33.36 mm) and 27.31±1.98 mm (ranging from 24.56 to 32.76 mm), before and after the surgery, respectively. Mean axial length difference between both values was −0.03±0.12 mm (ranging from −0.17 to 0.10 mm). The paired t-test revealed no statistically significant differences in axial length between before and after ICL implantation (P = 0.1653). Figure 1 shows the axial length values measured both before and after ICL implantation. Continuous line represents the best linear fit showing a high correlation between values (R = 0.99, P < 0.0001).

DISCUSSION

The results found in the present study point out that ICL implantation does not affect axial length measurement. We have obtained a mean reduction in the axial length value of 0.03±0.12 mm after ICL implantation.
implantation, but being no statistically significant (P = 0.1653). Measurements of axial length before and after the surgery highly correlate as is shown in figure 1. Our results, obtained in a sample of 32 eyes, showed that there were no differences in axial length measurement before and after ICL implantation.

Unfortunately, there are no previous studies analyzing the theoretical effect on axial length measurement using partial coherence interferometry of phakic intraocular lenses. However, it is interesting to discuss a previous work carried out by Hoffer analyzing this effect with ultrasound biomicroscopy. As we have introduced the speed of sound through the various materials of phakic intraocular lenses is variable and changes with the material (collamer, PMMA, silicone or acrylic) and the power (thickness) of the lens. Ultrasound velocity for collamer material is 1740 m/s and the correction value in axial length using ultrasound biomicroscopy after a collamer ICL implantation is very small, with about 11% of the lens thickness added to the axial length measured. Optical biometry may be affected in a similar way. Then, the expected effect on axial length measurement is low in eyes with myopic lenses with very thin centers (0.1-0.2 mm). Similarly it would happen for toric lenses. Although hyperopic lenses have a thicker center (0.3-1.0 mm), the expected change for axial length up to ICL powers of +20 D would be about 0.1 mm giving an effective error in intraocular lens power calculation about a quarter of diopter. Then, the effect on axial length of hyperopic ICL is also minimal being not a concern for a surgeon in a clinical practice. Clinical research studies on eyes implanted with hyperopic ICLs should be performed in order to prove this statement.

In summary, the present study has confirmed that there is not a significant change on the axial length measurement after myopic or toric ICL implantation using partial coherence interferometry (IOL Master® optical biometer). Axial length measurements show a high correlation before and after ICL implantation, showing that optical biometry is a valid and reliable technique for axial length measurement in eyes implanted with ICLs. This application is practical to measure axial length in eyes implanted with ICLs needing cataract surgery.

REFERENCES