Immersion A-scan compared with partial coherence interferometry

Outcomes analysis

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ABSTRACT

Purpose: To compare 2 methods of axial length measurement, immersion ultrasonography and partial coherence interferometry, and to elucidate surgical outcomes based on immersion measurements.

Setting: Oregon Eye Institute, Eugene, Oregon, USA.

Methods: Axial length measurements in 50 cataractous eyes were obtained by optical biometry (IOLMaster®, Zeiss Humphrey Systems) and immersion ultrasound (Axis II, Quantel Medical), and the results were compared. Intraocular lens (IOL) power calculations in the same eyes after cataract extraction and posterior chamber IOL implantation were evaluated retrospectively based on the postoperative spherical equivalent prediction error.

Results: Immersion ultrasonography and partial coherence interferometry measurements correlated in a highly positive manner (correlation coefficient = 0.996). Outcomes analysis demonstrated 92.0% of eyes were within ±0.5 diopter of emmetropia based on immersion axial length measurements.

Conclusion: Immersion ultrasonography provided highly accurate axial length measurements and permitted highly accurate IOL power calculations. *J Cataract Refract Surg 2002; 28:239–242 © 2002 ASCRS and ESCRS*

Axial length measurement remains an indispensable technique for intraocular lens (IOL) power calculation. Recently, partial coherence interferometry has emerged as a new modality for biometry.[1] Postoperative results achieved with this modality have been considered "analogous" to those achieved with the ultrasound immersion technique.[2] Reportedly "user-friendly" and less dependent on technician expertise than ultrasound methods, noncontact optical biometry is, however, limited by dense media, eg, posterior subcapsular cataract. A second limitation of the optical method is the lack of a lens thickness measurement, a required variable in the Holladay 2 IOL power calculation software, version 2.30.9705. However, according to Holladay, the lens thickness can be estimated by the formula 4.0 + (age/100). Also, optical biometry can provide keratometry measurements, obviating the need for a second instrument.

Immersion ultrasound is an accurate method of axial length measurement, generally considered superior to

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applanation ultrasound techniques.[3,4] The absence of corneal depression as a confounding factor in measurement reduces the risk of intertechnician variability. In addition to having a short learning curve, immersion ultrasound is not limited by media density and measurement capability. But optical biometry may be superior in eyes with posterior staphyloma because of more precise localization of the fovea.

In this study, we compared axial length measurements obtained by optical biometry using the IOLMaster® (Zeiss Humphrey Systems) and by immersion ultrasound using the Axis II® (Quantel Medical). We then examined the postoperative refractions in eyes that had cataract extraction with posterior chamber IOL implantation to determine the accuracy of the immersion ultrasound technique.

Patients and Methods

In 50 cataractous eyes, the axial length was measured preoperatively with the Axis II and the IOLMaster. With the Axis II immersion technique, the Prager shell was used. Patients were placed in a sitting position in an examination room chair with the head reclined gently against the headrest. The average "total length" reported by the unit was entered into the Holladay II IOL power calculation formula. With the IOLMaster, the selected axial length with the highest signal-to-noise ratio was used as the basis for comparison. The measured axial lengths were plotted, and a linear regression trend line was fit to the data. The Pearson correlation coefficient was determined to assess the relationship between the immersion and optical measurements according to the formula

$$\rho = 1/(1 - n)\sum((x - \mu)/s)((y - \mu)/s).$$

Keratometry was performed with the IOLMaster. The 3 reported sets of values were compared for consistency and correlated with the axis and magnitude of the eye's preoperative astigmatism. An averaged value of 3 measurements or of the 2 closest measurements (in case 1 measurement appeared to be an outlier) was entered into the formula. In selected cases, autokeratometry (HARK 599, Zeiss Humphrey Systems) and/or computerized corneal topography (EyeSys Technologies) was used to better delineate the preoperative keratometry. The corneal white-to-white diameter was determined with the Holladay-Godwin corneal gauge.

A single surgeon (I.H.F.) performed phacoemulsification in the 50 eyes. The Holladay II IOL power calculation formula was used to select the IOL for implantation in each case. This program automatically personalized the surgeon's A-constant during the course of the study. To provide uniform results, the Collamer IOL (CC4204BF, Staar Surgical) was implanted in all eyes. The surgical technique has been described.[5] Briefly, a temporal clear corneal incision was followed by a continuous curvilinear capsulorhexis, cortical cleaving hydrodissection and hydrodelineation, and nuclear disassembly using horizontal chopping with high vacuum and flow but low levels of ultrasound energy. The IOL was inserted into the capsular bag via an injection device.

The postoperative refraction was measured 2 to 3 weeks postoperatively. The stability of the postoperative refraction at this time after a small temporal clear corneal incision has been well documented.[6–8] All patients had autorefractometry (HARK 599) and subjective manifest refraction. Only eyes obtaining 20/30 or better best corrected visual acuity were included in the study. The postoperative refraction was then entered into the Holladay IOL Consultant (Holladay Consulting, Inc.). Using the Surgical Outcomes Assessment Program (SOAP), the spherical equivalent prediction error was measured and analyzed.

Results

Axial Length Measurements

The axial length measurements obtained with the Axis II and the IOLMaster were highly correlated (Pearson correlation coefficient = 0.996) (Figure 1). The mean of the axial lengths measured by immersion ultrasound was 23.40 mm (range 21.03 to 25.42 mm) and by optical biometry, 23.41 mm (range 21.13 to 25.26 mm). Technicians noted that immersion measurements required 5 minutes and optical measurements, about 1 minute.

Surgical Outcomes Assessment

The Holladay IOL Consultant report reflected a personalized A-constant of 119.365 (anterior chamber depth [ACD] 5.512) compared to the manufacturer's suggested constant of 119.0 (ACD 5.55). The frequency distribution of the postoperative spherical equivalent prediction error revealed that 48% of eyes achieved the

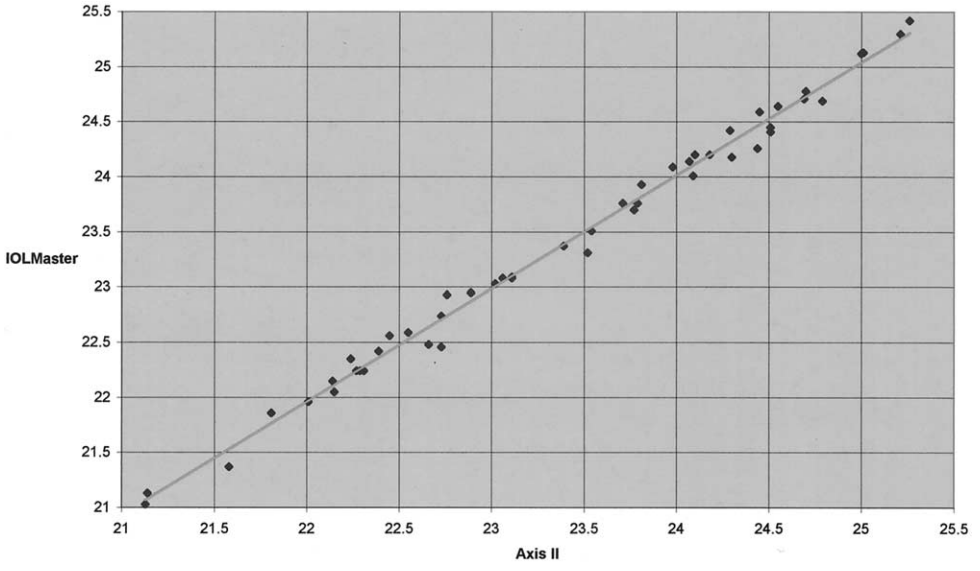

Figure 1. (Packer) Comparison of axial length measurements by immersion ultrasound (abscissa) and optical coherence interferometry (ordinate). The linear regression trend line reflects the high correlation between the 2 sets of values (correlation coefficient = 0.996).

targeted refraction precisely. The cumulative distribution graph demonstrated that 92% of eyes were within ±0.50 D of the targeted refraction and 100% of eyes were within ±1.00 D (Figure 2). The mean absolute error measured 0.215 D, while the mean error of −0.105 D reflected the trend toward myopia.

Discussion

The near-perfect correlation of immersion ultrasound and optical coherence biometry measurement techniques indicates the high level of accuracy of both these methodologies. The high rate of achieving the targeted refraction by using immersion ultrasound measurements and the Holladay II formula compared favorably with previously reported results. For example, Haigis and coauthors[2] achieved accurate predictions within ±1.00 D in 85.7% of eyes with immersion ultrasound. Sanders and coauthors[9] indicate that achievement of about 90% of eyes within ±1.00 D of the targeted refraction and a mean abso-

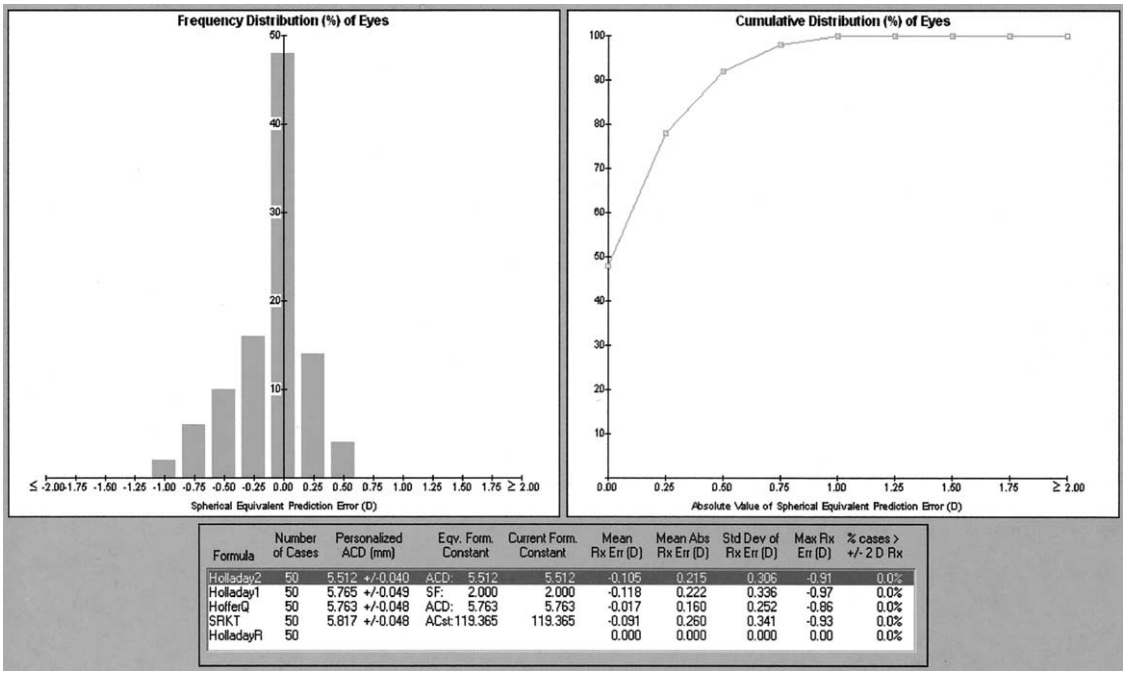

Figure 2. (Packer) Holladay IOL Consultant Surgical Outcomes Analysis.

lute error of approximately 0.5 D represents an acceptable outcome.

Technicians report that the immersion ultrasound method with the Prager shell is well tolerated by patients and relatively easy to learn. Its applicability to all types of cataracts and its ability to generate a phakic lens thickness represent significant advantages, especially for surgeons who use the Holladay II calculation formula.

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