Received: 5.5.2007 **Accepted: 22.1.2008**

Original Article

Comparison of ultrasound and optic biometry with respect to eye refractive errors after phacoemulsification

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Abstract

BACKGROUND: Phacoemulsification is one of the best surgical treatments for the cataract. Secondary to the technical advances in estimating the intraocular lens (IOL) power, the refractive errors, one of the most important surgical complications after surgery, is now reduced. Currently, two methods of biometry are used to calculate the IOL power, ultrasound biometry and optical biometry. Both methods have their own advantages and it is controversial to use which of them before surgery. We would like to know if there is any difference between these two biometry methods to reduce refractive errors after cataract surgery.

METHODS: Present research was a cohort study on the patients undergone phacoemulsification due to cataract in Feiz and Farabi academic hospitals and Aban ophthalmology clinic. We compared eye refractions after cataract surgery in two groups of patients. Ultrasound biometry was done for the first group and the optical biometry for the second one. Mean absolute refractive error (MAE) was compared in the two groups by t test.

RESULTS: Eye refractions of 132 patients were studied; 76 patients in group one and 56 patients in group two. The MAE measured 0.67 ± 0.70 diopters for the first group and 0.79 ± 0.76 diopters for the second one and the difference was not significant (P = 0.342).

CONCLUSIONS: According to our results the refractive errors after phacoemulsification was the same for both ultrasound and optical biometry methods. The claim of optical biometry, however, to gain a higher precision and thus a significantly better prediction of individual postoperative refraction after cataract surgery is not yet fulfilled. To determine which method is definitely better, more studies are required.

KEY WORDS: Cataract, phacoemulsification, biometry, refractive error.

JRMS 2008; 13(2): 43-47

Cataract surgery is the most frequently performed surgical procedure in ophthalmology. In the United States, intraocular lenses (IOLs) are implanted in more than 98% of all cataract extractions. Of all the various methods of aphakic correction, IOL implantation provides the most natural visual function and convenience to the patient. The last decade has seen great improvements in the accuracy with which the surgeon can determine the IOL power required to achieve emmetropia. The development of better

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Instrumentation for measuring the axial length (AL) of the eye and the use of more precise mathematical formulas to perform the appropriate calculations have contributed to these improvements [1]. Ocular biometry, phacoemulsification, and IOL power prediction formulas have improved considerably the refractive outcome of cataract surgery. This outcome depends on the accurate prediction of the power of the implanted IOL, which in turn depends mainly on preoperative biometry data, IOL power calculation formulas, and manufacturer IOL power quality control. The most important step for an accurate calculation of the IOL power is the preoperative measurement of the ocular AL [2]. Today, ultrasound biometry is a well established and precise method for the measurement of ocular distances, especially determination of the axial length and its ocular segments for the calculation of the required power of IOL. Recently, laser interference biometry is an alternative to ultrasound [3,4]. Both methods have their own advantages and it is controversial to use which of them before surgery. Due to the technical advances in estimating the intraocular lens (IOL) power, the refractive errors, one of the most important surgical complications after surgery is now reduced. Ultrasound biometry AL measurement errors have been demonstrated to be responsible for 54% of the predicted refraction errors after IOL implantation, with a postoperative refractive error of 0.28 diopters (D) resulting from an AL shortening of 0.1 mm [5]. In the past several years an optical imaging technique, partial coherence interferometry (PCI), has been demonstrated to measure with high precision and accuracy of the AL of normal and cataractous eyes [6,7]. The high precision, resolution, accuracy, and reproducibility of the AL measurements of the IOL Master have been demonstrated [8-10]. In one study, immersion ultrasonography provided highly accurate axial length measurements and permitted highly accurate IOL power calculations [11]. In this study the IOL Master were compared to the applanation ultrasound in a cohort of 132 patients who underwent cataract surgery. The postoperative refractive error was determined and compared in these two types of biometry.

Methods

Patients who underwent uncomplicated cataract surgery by phacoemulsification in Feiz and Farabi academic hospitals and Aban ophthalmology clinic, with IOL implantation through a temporal clear corneal incision were included in the study. Eye refractions of 132 patients were studied. All eyes had no other ocular pathology apart from age related cataracts and had no history of ocular surgery and corneal scar. Patients with corneal suture were excluded from the study. We compared eye refractions after cataract surgery in two groups of patients. Ultrasound biometry was done for the first group (76 patients) and optical biometry for the second one (56 patients). Biometry was performed by applanation ultrasonography (Ultrascan Digital, 1000, S/N: 1913) in the first group and by IOL Master (Carl Zeiss Meditec Ag, 07740 Jena, Germany, S/N: 892092) in the second group. AL measurements were performed by one experienced technician. All patients had phacoemulsification through a two-step 3.2 mm temporal self-sealing clear corneal incision, employing a chop technique. A foldable IOL (Alcon) was injected in the capsular bag. All surgeries were performed by the same experienced surgeon. At follow up visits, approximately 1 week following the operation, autorefractions (Topcon Corporation, 75-1 Hasunawa, Cho, Itabashi-Ku, Tokyo, Japan. Class 1, 2005, S/N: 4010859) were performed by the same examiner. The stability of the postoperative refraction at the time of postoperative examination has been previously demonstrated [12]. Astigmatic errors were not considered in this study. We compared the mean absolute refractive error (MAE) with t test in the two groups.

Results

132 patients (65 females and 67 males), were included in this cohort study, of whom 56 patients underwent optical biometry and 76 patients had biometry by applanation ultra-

sound. The mean age of patients was 71.67 (SD 6.85) years (range of 45–87 years). The preoperative mean axial length was 22.97 ± 1.2 mm in the optical group (range of 20-27.5 mm) and 23.13 ± 1.1 mm in the ultrasound group with a range of 20.1-27 mm (P>0.05). In all patients, preoperative and postoperative refractive errors measured with autorefraction. In both groups, the mean absolute refractive errors (MAE) were determined. Frequency of preoperative refractive error in the first group (ultrasound biometry) was as follows: myopia 24.2% (range: -0.25 to -8.75 D), hyperopia 54.5% (range: +0.25 to +4.25 D) and emmetropia 21.3% (0 ± 0.25 D). In the second group (optical biometry), preoperative refractive errors included myopia 28.5% (range: -0.25 to -7.50 D), hyperopia 46.4% (range: +0.25 to +3.75 D) and emmetropia 25.1% (0 ± 0.25D). The mean absolute refractive error (MAE) before the surgery in ultrasound group was 2.15 ± 0.64 D and in optical biometry group was 2.47 ± 0.16 D. Frequency of postoperative refractive error in first group (ultrasound biometry) was myopia 42.1%, hyperopia 40.8% and emmetropia 17.1%. In the second one (optical biometry) was myopia 32.1%, hyperopia 53.6% and emmetropia 14.3%. The postoperative MAE was 0.67 ± 0.70 diopters for the first group and 0.79 ± 0.76 diopters for the second one (table 1). There was not any significant difference between the two groups (P = 0.342).

Table 1. Preoperative and postoperative refractions and types of cataract in the study groups.

Type of Biometry	Refraction						Type of cataract			Number of patients	MAE ± 2SD Post operative Refraction
	Post-operation			Pre-operation							
	Emmetropia	Hyperopia	Myopia	Emmetropia	Hyperopia	Myopia	Posterior sub capsular	Cortical	Nuclear		
Ultrasound	17.1%	40.8%	42.1%	21.3%	54.5%	24.2%	9	25	42	76	0.67 ± 0.70
Optical	14.3%	53.6%	32.1%	25.1%	46.4%	28.5%	10	18	28	56	0.79 ± 0.76o

Discussion

In this study we evaluated the refractive errors after phacoemulsification by ultrasound and optical biometry methods. Our results showed that there was no significant difference between them. Astigmatism was not included in this study, because biometry can not change this parameter. Although the refractive outcome was similar in the two groups, we did not evaluate the accuracy of each method in specific situations such as type of cataract (posterior subcapsular, nuclear or cortical), cataract density and preoperative refraction (myopia, hyperopia and emmetropia). AL is the most influential parameter in IOL calculation. To ensure that errors have not occurred, it is helpful for the surgeon to compare measurements between both eyes of the patient. Any significant disparity in required IOL power should result in a check of the data. The IOL Master uses laser interferometry to measure AL. Although the device can yield rapid measurements with tolerances of 8 to 10 times that of ultrasound, doing so requires patience and cooperation on the part of both the patient and the technician operating the device. The employment of the optical biometry instead of ultrasound biometry has improved significantly the refractive results of cataract surgery [13]. This method has simplified considerably the process of ocular biometry. It is a non-contact technique, which does not require use of topical anesthesia, thus providing comfort to the patient and preventing corneal abrasions and the transmission of infections. Furthermore, it has greater accuracy than ultrasound biometry because it measures the ocular AL along with the visual axis, as the patient fixates at the measurement beam, whereas during ultrasound biometry a misalignment between the measured axis and the visual axis may result in erroneously longer AL measurements. This is especially important in eyes with posterior pole staphyloma because of the more precise localization of the fovea. However, the advent of the IOL Master has not rendered ultrasonic biometry obsolete as a significant number of eyes, approximately 8–10%, still require ultrasound biometry, which is still essential in every ophthalmic practice [13,14]. In some recent studies, this failure was seen in approximately 20% of cataract patients. Failure is typically due to posterior subcapsular cataract and dense nuclear cataract [15,16]. Moreover, in eyes with non-optimal fixation as in cases of age related macular degeneration may result in inaccurate AL measurements as the measurements are not on the visual axis. Also, positioning the patients with mobility problems on the IOL Master machine may occasionally be a problem [2]. In our study, the mean absolute refractive error of IOL Master biometry was not significantly different than that of ultrasound. Thus, the claim of optical biometry, however, to gain a higher precision and thus a significantly better prediction of individual postoperative refraction after cataract surgery is not yet fulfilled. For the IOL Master to supersede the ultrasound biometry, modifications to the design to allow the bypassing of posterior sub nuclear dense and cataract capsular cataract are required.

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