RESEARCH ARTICLE

Effect of pupil dilation on IOLMaster® measurements in Pakistani Eyes

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Abstract

Objective: To analyse the effect of pupil dilation on intraocular lens instrument IOLMaster 500 biometric measurements, and to determine the effect of these measurements on intraocular lens power calculations in Asian eyes.

Methods: The prospective study was conducted at the Aga Khan University Hospital, Karachi, between January and April 2017, and comprised all patients scheduled for cataract surgery who underwent scanning with IOLMaster 500. For each patient, pre-dilation and post-dilation measurements were taken. The intraocular lens power was determined through Sanders/Retzlaff/Kraff Theoretical, Holladay, and Hoffer Q formulae. Data was analysed using SPSS 24.

Results: There were 276 eyes of 138 participants who had a mean age of 59.7±11.1 years. Anterior chamber depth changed significantly with pupil dilation (p=0.001). No significant changes were observed in the axial length (p=0.410), keratometry measurements (p=0.931), and intraocular lens power calculations (p>0.05).

Conclusions: The change in anterior chamber depth, though significant, was perhaps clinically non-significant. intraocular lens power did not exhibit any significant differences post-mydriasis.

Keywords: Mydriasis, Lenses, Intraocular, Lens, Implantation, Phakic intraocular lenses, Biometry.

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Introduction

Cataract surgery has transformed in the past few decades. Modern cataract surgery is safe, with much faster postoperative recovery periods. Not surprisingly, the procedure is now one of the most performed worldwide.[1,2] However, one of the biggest challenges that still remain with phacoemulsification is accurate calculation of intraocular lens (IOL) power.

Precise and accurate IOL power calculations are central to a successful cataract procedure and postoperative patient satisfaction. IOL power is affected by three variables; keratometry (K) measurements, anterior chamber depth (ACD) and axial length (AL). A mistake in calculation of any of these variables may thus be a source of error.[3] Patients scheduled for cataract surgery routinely undergo pupil dilation as part of a comprehensive examination. Mydriasis may produce changes in the corneal shape and, hence, corneal power. Accommodation changes and fixation may also be more difficult in the presence of mydriasis, which can introduce errors in AL measurement.[4]

A few studies have been done to examine the effect of pupil dilation on IOLMaster measurements.[4-8] However, most of these studies have been conducted in the Western population and similar literature from Asian nations is sparse. The current study was planned to fill the gap by determining the accuracy of IOLMaster biometric measures pre- and post-dilation in an Asian setting.

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Patients and Methods

The prospective study was conducted in the outpatient ophthalmology clinics at the Aga Khan University Hospital (AKUH), Karachi, between January and April 2017. After approval from the institutional ethics review committee, the sample size was calculated using openepi.com.[9] We used an assumed mean AL of 23.4±1.36mm in both measurements,[5] the correlation between both measurements to be 0.8, and a difference <0.2mm between both measurements to be clinically insignificant, with a statistical significance of 5% and a statistical power of 80%.

All patients aged >18 years scheduled for cataract surgery who underwent scanning with IOLMaster 500 and willing to participate were included. Those with pre-existing ocular pathology, such as glaucoma, uveitis and retinal disease, and previous ocular surgery, were excluded.

After taking informed consent, biometric measurements were done using IOLMaster 500 (Carl Zeiss, Germany) due to its better accuracy in biometric measurements in comparison with ultrasound.[10,11] It is a noncontact optical instrument that uses infrared light (λ=780nm) of short coherence for measuring AL and ACD, and for performing K. IOL power was calculated using the built-in software.

All patients underwent consecutive biometric measurements, pre- and post-pupillary dilation. ACD was defined as the distance from the anterior corneal surface to the anterior lens surface, and AL as the distance from the anterior corneal surface to the retinal pigment epithelium. Central corneal thickness (CCT) was the distance from the

anterior corneal surface to the posterior corneal surface.

Pupillary dilation was achieved using 1% tropicamide and 10% phenylephrine due to reduced problems with glare accomodation.[12] The second set of measurements was taken after 45 minutes to ensure maximum mydriasis. All patients also underwent a complete ophthalmological examination, including slit-lamp fundoscopy. IOL power was predicted based on the Hoffer Q, Holladay, and the Sanders/Retzlaff/Kraff Theoretical (SRK/T) formulas. The accuracy of these formulas has been excellent.[13-19] Each eye acted as its own control, and the measurements were paired. All readings were taken in a standardised environment under mesopic lightening.

Data was analysed using SPSS 24. The variations were analysed using paired t tests. P<0.05 was considered significant.

Results

Of the 158 subjects initially enrolled, 138(87.34%) were included, translating into 276 eyes. The mean age of the participants was 59.7±11.1 years. No significant differences were observed in measurements for AL, K1, K2 and mean K after pupillary dilation (p>0.05), while ACD significantly increased post-dilation (Table 1).

Mean change in lens power was not significant (Table 2).

Hypermetropic eyes were defined as AL <22.5mm, and emmetropic eyes had AL range 22.5-24.5mm. Myopic eye was defined as AL >24.5mm. No significant changes were observed in IOL power post-dilation for any AL group using all 3 formulae (Table 3).

Of the 276 studied eyes in the current sample, 193(70%), 165(60%) and 158(57%) eyes had no change in the calculated IOL before and after dilation using SRK/T, Holladay and Hoffer Q formulae, respectively. In the remaining cases where IOL measurements were different pre-dilation and post-dilation, the change was within 0.5 deviation (D) in 71(27.5%) eyes when SRK/T formula was used. It was within 1D and >1D in 6(2.2%) cases each. Using Holladay and Hoffer Q, the difference in lens power was within 0.5D in 97(35%) and 96(34.8%) eyes. The difference was within 1D in 8(2.9%) eyes when Holladay formula was used, and in 15(5.4%) eyes with Hoffer Q. The change was >1D in only 6(2.2%) eyes with both formulae (Table 4).

Table-1: Mean difference between IOLMaster readings pre- and post-dilation.

Reading	Mean±SD	*p* value
AL, mm	0.01341±0.222	0.410
K1 (horizontal)	0.0032±1.351	0.968
K2 ((vertical)	0.0042±0.425	0.869
Km	0.00371±1.0	0.931
ACD, mm	0.05442± 0.2216	0.00

ACD: Anterior chamber depth; AL: Axial length; CV: Coefficient of variation; K: Keratometry; Km: Mean keratometry; Only ACD had a significant variation.

Table-2: Mean difference in IOL power calculation using all three formulae (pre- and post-dilation).

Formula	Mean±SD	*p* value
SRK/T	0.0631	0.442
Holladay	-0.0471	0.257
Hoffer Q	-0.00545	0.942

IOL: Intraocular lens; SRK/T: Sanders/Retzlaff/Kraff Theoretical.

Table-3: Stratification of eyes based on axial length.

Classification	Axial length	Number of eyes in each group
Hypermetropic	<22.5mm	27
Emmetropic	22.5-24.5mm	183
Myopic	24.5mm	66

Table-4: Data summary.

Formula	N1 (%)	N2 (%)	N3 (%)	N4 (%)
SRK/T	193 (70)	71 (27.5)	6 (2.2)	6 (2.2)
Holladay	165 (60)	97 (35)	8 (2.9)	6 (2.2)
Hoffer Q	158 (57)	96 (34.8)	15 (5.4)	6 (2.2)

N1: Number of cases in which no change in intraocular lens (IOL) power was observed pre- and post-dilation; N2: Number of cases in which the change was within 0.5 devaition (D); N3: Number of cases in which the change was within 1D; N4: Number of cases in which the change was >1D; SRK/T: Sanders/Retzlaff/Kraff Theoretical.

Discussion

There was a significant change in ACD with cycloplegia, while the remaining measures, including IOL power, did not exhibit any statistically significant change in the current study.

Previous studies evaluating the effect of pupil dilation have reported similar outcomes. AL has been found to remain unaffected in all the reported studies.[4,5] K measurements, in the form of K2 and mean K significantly varied with mydriasis in only one study.[5] Despite changes in K readings, the study[5] did not observe significant changes in IOL power. Prospective studies[6,7] observed significantly increased ACD post-cycloplegia, a finding that was also observed in the current study. The device used by Villalobos et al[20] was an optical low-coherence reflectometry (OLCR) optical biometer, instead of the gold standard partial coherence-based biometry device. Deepening of the ACD could partly be explained by the lens flattening and moving more posteriorly with accommodative paralysis.

With respect to IOL power, significant differences in lens power have been reported only with the Haigis formula[21] which is a fourth-generation formula that calculates effective lens position, taking into account the ACD. However, till date no significant differences in lens power have been observed when using the SRK/T and Holladay

formulae as the prediction models.

The current study's findings related to pre- and post-dilation measurements using SRK/T, Holladay and Hoffer Q formulae were similar to results reported earlier.[4]

Although SRK/T has been previously analysed, to the best of our knowledge, this is the first study evaluating Holladay and Hoffer Q in an Asian sample.

The current study, however, has limitations. Even though AKUH caters to an ethnically diverse group of patients, the study was only done at a single centre. Multi-centre studies involving subjects from different ethnicities and countries would strengthen the findings. Besides, the study did not include the Haigis formula to predict IOL power calculation which also takes into account the ACD while making calculations.

Conclusion

There were no significant changes in AL, K measurements and IOL power calculations post-mydriasis in all three prediction models. However, there was a significant difference in ACD readings. The clinical significance of this difference, however, is debatable and, in the light of the results of other studies conducted earlier, it is perhaps non-significant.

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