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OPTICAL BIOMETRY ASSESSMENT: UNVEILING THE INFLUENCE OF PUPIL DILATATION ON INTRAOCULAR PARAMETERS AND IOL POWER CALCULATION

Ophthalmology

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ABSTRACT

PURPOSE: To determine whether pupil dilatation affects biometric measurement and intraocular lens (IOL) power calculation made using SRK T/2 formula on IOL master (carl Zeiss). **METHODS:**40 eyes of 40 patients evaluated for cataract surgery were prospectively examined using the IOL master before and after pupil dilatation with TROPICAMIDE AND PHENYLEPHRINE (0.01% W/V). The measurements made were: axial length (AL), aqueous chamber depth (ACD), lens thickness (LT), keratometry and pupil diameter (PD). SRK/T formulas were used to calculate IOL power. **RESULTS:** No statistically significant effect of dilatation on AL, LT and keratometry was demonstrated. On the contrary we demonstrated a significant effect on ACD . No effect of dilatation on the PC IOL power calculation using the SRK/ T formula. **CONCLUSION**: Pharmacological dilatation of the pupil significantly affects some intraocular parameters measured by optical biometer.

KEYWORDS

Biometry, cataract, carl Zeiss IOL MASTER, pupil dilatation, IOL

INTRODUCTION:
The precise calculation of intraocular lens (IOL) power is crucial for successful cataract surgery. It is an important step in successful IOL implantation. The refractive power of the pseudophakia is final. Later correction can only be achieved with lens exchange or extraocular aids like glasses or contact lens or corneal refractive surgery. Accurate measurements of parameters like axial length (AL) and corneal power (K) are essential for determining the appropriate IOL power [1]. AL measurements are particularly significant, as even a small error can lead to refractive discrepancies post-surgery [2]. Various methods, such as scan by applanation or immersion, as well as devices like the IOL Master, are used to measure AL accurately [3]. The IOL Master, utilising infrared light, eliminates corneal compression artefacts and provides precise measurements without direct contact with the eye [4]. This technique does not require contact with the globe, so corneal compression artefacts are eliminated. A 1mm error in AL measurement results in a refractive error of approximately 2.36D in 23.5mm eyes.

Corneal power, the second crucial parameter, can be measured using keratometry, corneal topography, or devices like the IOL Master [5]. This device employs automated keratometry to assess corneal curvature and astigmatism. It calculates the total corneal power using a keratometry index, enabling accurate IOL power calculation [6]. Six spots of light are projected onto the cornea in a hexagonal pattern within a 2.5 mm diameter. The position of each pair of reflection spots is detected and measured, and the relative positions are compared to determine corneal curvature and astigmatism as radial measurements. It then converts the radial measurements into diopters (D) using a keratometry index to determine the total corneal power. However, changes in corneal shape due to mydriasis need consideration [6]. With 1.0 D error in corneal power resulting in 1.0 D postoperative refractive error.[2]

IOL master is a combined biometric instrument that measures quickly and precisely parameters of the human eye needed for IOL calculation by a non-contact technique. It also incorporates the software to calculate IOL power from various formulae.

The primary aim of the current study was to evaluate the effect of pupil dilation on the accuracy of IOLMaster measurements on a large, well-defined study group with a carefully powered sample size.

METHODS:
This prospective cohort study was conducted on patients attending the outpatient department at our tertiary care centre. The study protocol was reviewed and approved by the Institutional Review Board.

Exclusion criteria were:
uncorrected visual acuity of worse than 6/60, mydriasis of less than 5.5 mm, acute angle closure suspect, previous ocular surgery or penetrating trauma. Also excluded were patients with physical inability to be positioned at the IOL Master, inability to open the eyelid widely enough so that all measurements could be performed, or inability to fixate due to ocular disease. Patients who had corneal or media opacities other than cataract, and those with active ocular infection, history of contact lens wear, history of mydriatic drug allergy or any macular disease were excluded.

A total of 40 patients met the inclusion criteria and were enrolled. The purpose of the study was explained to every participant and informed consent was obtained.

All patients underwent a visual acuity test as well as a pre-dilation biometric measurement with the IOL Master according to the manufacturer's instructions.

Pupil dilation was achieved with tropicamide 0.5% and phenylephrine 10%. After mydriasis had been attained, the patients underwent a complete ophthalmologic examination, including slit lamp biomicroscopy and intraocular pressure measurement, which was immediately followed by a second biometric measurement with the IOL Master. All the pre- and post-dilated IOL measurements were taken on the same day. The pre-dilation measurements formed the control group and the post-dilation measurements formed the study group. In this way, each eye was its own control and all measurements were paired. The recorded data included demographics, AL, mean K and cylinder. The IOL power required for emmetropia, with a target refraction of -0.5 D, was calculated using the SRK/T formula with an A constant of 119.

Sample size (n) was determined based on the maximal difference between pre- and post-dilation AL that had no clinical significance, and thus would not change the IOL calculation using the SRK/T formula.

RESULT:
The study included 40 patients, with a mean age of 52.39 years. The demographic data of patients are shown in Table 1.

TABLE 1: DEMOGRAPHIC DATA OF THE PATIENTS

DEMOGRAPHIC DATA OF THE PATIENTS:		
SEX	MALE (60%)	FEMALE (40%)
MEASURED EYE	RIGHT EYE (48%)	LEFT EYE (52%)

While there were no significant differences in AL or keratometry readings between pre- and post-dilation measurements, ACD

significantly increased post-dilation. The main outcomes were AL, keratometry reading (steepest K and flattest K), ACD, and IOL power pre dilatation and post-dilatation, are presented in Table 2.

TABLE 2: THE MAIN OUTCOME OF THE STUDY

THE MAIN OUTCOME OF THE STUDY:					
Measurement	Mean ± SD Pre-dilatation	Mean ± SD Post dilatation	Mean difference	95 % CI	p value
Axial length (mm)	23.37 ± 1.12	23.37 ± 1.12	0.0032	0.0003, 0.0069	0.0715
Flattest K (D) (K1)	44.05 ±1.53	44.03 ±1.54	0.0171	-0.0072 0.0413	0.1677
Steepest K (D) (K2)	45.03 ± 1.6	45.03 ±1.59	-0.0073	-0.233 0.2184	0.9495
Anterior chamber depth (mm)	3.15 ±0.37	3.27 ±0.37	-0.1185	-0.1362 -0.1007	0.05

DISCUSSION:

Pupil dilation before biometry is standard practice in cataract surgery preparation, but it can pose challenges in accurate measurements, particularly fixation issues [3]. Technical problems may arise in establishing fixation in patients with dilated pupils, possibly even more so in the presence of bilateral cataracts, leading to difficulty in measuring accurate parameters through the visual axis.

AL measurement with the IOLMaster is dependent on the refractive indices of the ocular media. The measurement of AL by the IOL Master may be affected by mydriasis due to accommodation changes. It has been shown that the eye elongates during accommodation. Use of 1% tropicamide results in maximum residual accommodation of 1.3 D. The mean difference in AL measurements between dilated and undilated pupils was only 0.03 mm (SD 0.14) and this was also not statistically significant. When the estimated target refractive error in dilated and undilated pupils was compared with actual postoperative mean spherical equivalent, there was no significant difference in the two groups. Accommodation may have some effect on corneal shape as well. However, the variance in the indices is so small that its influence on the measured AL is negligible.) Although AL measurement is the most influential parameter measured for IOL power calculation, this increased precision has not always been reflected in better refractive outcomes, as discussed by Olsen.29 It is possible that the larger errors in postoperative ACD estimation and refraction overshadow the relatively smaller error in AL. (2)

Pupil size is the source of error in IOL powering. However, when there is no spherical aberration, pupil size has no effect on refraction. The pseudophakic eye is free of spherical aberration; aspherical power calculation in combination with measurement of the pupil is needed to understand the true impact of this source of error. From a practical standpoint, if spherical aberration is present, refraction will depend on the pupil size induced by the light level of the environment; for example, night myopia can occur. (2)

The next largest error sources from keratometry. Measurement of anterior curvature is probably as precise as it can be using keratometers. Topographers could be used to measure the anterior corneal surface asphericity and take that into account in the power calculation. Instruments such as the Penta Cam (Oculus) or Orb scan (Bausch & Lomb) could be used to measure corneal posterior curvature and asphericity as well as thickness. By application of aspherical ray-tracing calculations, the errors resulting from these parameters could be reduced provided that the measurements are sufficiently accurate. the anterior and posterior corneal shapes change as a result of mydriasis, and that changes in corneal refractive power occur as well. Despite the possible theoretical changes in parameters, the results of the current study showed no statistically significant difference in pre- and post-dilation AL (0.005, P =0 .474) or K (0.001, P =0.933) measurements

The remaining sources of error are so small that they can be neglected. Of them, the refractive indices of the ocular media cannot be measured in the living eye. Corneal thickness and posterior surface asphericity could be measured, and there is no harm in including them in the power calculation. Astigmatism and higher-order aberrations exist in the cornea. Cornea, pupil, lens, and fovea are not perfectly aligned with each other. Finally, there is chromatic aberration. The study found minimal impact of pupil dilation on AL and corneal power measurements, indicating the reliability of the IOL Master in such conditions [3] The our study concludes that pupil dilation does not significantly affect IOLMaster measurements of AL, corneal power, or corresponding theoretical IOL power, as calculated by the SRK/T formula.

Declaration of Patient consent:

We certify that we have obtained all appropriate patient consent forms. In the form the patient has given his/her consent for his/her images and other clinical information to be reported in the journal. The patient understands that his/her name and initials will not be published and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

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