International Journal Dental and Medical Sciences Research (IJDMSR)
ISSN: 2393-073X Volume 3, Issue 5 (May- 2019), PP 34-38
www.ijdmsr.com

A Comparative Evaluation of Biometric Values of Laser Interferometry Vs Conventional Ultrasonic Biometry In Undergoing Cataract Surgery

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ABSTRACT
OBJECTIVE: The objective of this study is to investigate the accuracy and visual outcome using different biometric methods for the calculation of intraocular lenses.

MATERIALS AND METHODS: A total of 200 eyes of patients with senile cataract scheduled to undergo cataract surgery at a tertiary care hospital and willing to participate were inducted in the study. IOL power calculations were done by using both IOL- Master (Zeiss IOL Master with Advanced Technology Software Version 5.4). as well as with the ultrasonic biometry and Keratometry. In all eyes, the intraocular lens to be implanted was chosen by means of the SRK/T formula, based on the measurements conducted with our standard method. The achieved postoperative refraction s obtained, at 6 weeks after surgery, by the treating ophthalmologist. The results were compared and analyzed statistically using SPSS17.

Results: We examined 156 out of which 72 female and 84 were male. More than half of the cases (64.5%) had nuclear sclerosis grade 2. Cases with nuclear sclerosis grade 3 were 32.5% and only 3% had nuclear sclerosis grade 1. Values of axial length measured by IOL Master were significantly more than those measured by conventional biometry and the difference was statistically significant in this study. Comparison of axial lengths as well as of the keratometric measurements showed good correspondence between the obtained measurements by both methods, ultrasound biometry yielding significantly ($p < 0.001$) different axial lengths than the IOL-Master, and the B & L yielding significantly ($p < 0.001$) different mean corneal refraction power than the IOL-Master. The accuracy of the refraction obtained postoperatively compared to the preoperative aim was better with IOL master compared to ultrasonic method.
CONCLUSIONS: The predicted systemic differences in measurement results could be verified. Significant improvement in accuracy of our postoperative refraction prediction was achieved using IOL master. The other advantages of the IOL-Master are the substantial gain in time, as well as the fact that performance of the measurements may be delegated. Only shortcoming was to use of IOL master in mature cataract.

Key Words: Cataract, biometry, IOL master, ultrasound biometry

I. INTRODUCTION

Heightened patient expectations for precise postoperative refractive outcome following cataract surgery have spurred the continued improvements in biometry and intraocular lens calculation. In order to meet these expectations, attention to proper patient selection, accurate keratometry, biometry and appropriate intraocular lens (IOL) power formula selection with optimized A constant is required. If this biometric measurement and calculation is inaccurate, the patients may be left with significant refractive error and highly dissatisfied.

Non-contact optical-based devices, such as IOL Master (Zeiss Meditec AG, Germany), compare favourably to conventional ultrasonic biometric and keratometric techniques except in eyes with dense media opacities [1, 2]. Measurements with the IOL Master are affected by the density of cataract due to changes in refractive index, but its accuracy is less affected than conventional ultrasonic biometry[3].

The IOL Master provides an accurate axial length measurement and intraocular lens power calculation based on the third generation formula for IOL Power calculation (SRK/T formula). It is quick, easy to use and provides a non-contact technique with no risk of infection or corneal abrasion[4]. Biometry performed using IOL Master also produces a more predictable refractive outcome than immersion ultrasound[5]. The accuracy of IOL power calculation can be significantly improved using calibrated axial length readings obtained with partial optical coherence interferometry (PCI) which is used in IOL Master[6]. With proper verification of measured data and a suitable IOL calculation formula, good refractive predictability is expected from IOL Master [7].

A recent study concluded that there was a difference in axial length measurement between IOL Master and ultrasonic biometry. A 0.1 mm error in AXL measurement could result in a 0.25 to 0.75 Diopter difference in IOL power calculation that could be clinically significant [8].

Several studies have been conducted to compare the optical biometry versus conventional ultrasonic biometry with regard to the post-operative refractive outcomes. However, not many studies have directly compared the K values, Axial Lengths, Anterior Chamber Depth (ACD) and IOL power calculated using a third generation formula (SRK/T formula) pre-operatively using the optical biometry and conventional ultrasonic biometry.

II. MATERIALS AND METHODS

A total of 200 eyes of patients with senile cataract scheduled to undergo cataract surgery at a tertiary care hospital and willing to participate were inducted in the study. Best corrected visual acuity was estimated and complete ophthalmic examination was done.

Selected patients were then subjected to biometry. Biometric parameters ($K_{horizontal}$, $K_{vertical}$, axial length of the eyeball, anterior chamber depth) and IOL power using SRK/T formula were then performed. All eyes underwent estimation of these parameters with the non-contact IOL master (Zeiss IOL Master with Advanced Technology Software Version 5.4). The estimations were subsequently repeated with Bausch & Lomb keratometer and ultrasonic A-scan biometry using Appascan AME – 01A – Scan. The power chosen was the emmetropic power.

Eyes were subjected to phacoemulsification surgery under peribulbar anaesthesia with implantation of standard foldable intra- ocular lens. The power of IOL implanted was the one derived by IOL master. Foldable PCIOL of Bausch & Lomb (Akreos Adapt-AO) was implanted**.** Wound was closed with corneal hydration. Consecutive cataract patients who underwent surgery by the same surgeon using the same surgical technique were taken up for study.

Selected cases were followed up and glasses were prescribed at the end of 6^{th} post-operative week based on refraction and auto-refractometer readings.

The final refractive error was tallied with the IOL powers derived at pre-operatively by manual method (Group A) and IOL master (Group B). Patients requiring no spherical correction or those requiring ± 0.5DS of correction for a best corrected visual acuity of 6/9 or better were considered to be emmetropic. The differences were tabulated and subjected to statistical analysis using Microsoft excel software and SSPS version 11.0.1. A p value of < 0.05 was taken as significant.

Following eyes were excluded from the study:

1. Eyes with poor fixation secondary to macular or retinal disorders
2. Eyes with anterior segment disorders like tear film abnormalities, corneal pathologies and mature cataracts.
3. Eyes which have had intra- operative or post- operative complications and when sutures have been applied after phacoemulsification surgery.

III. RESULTS

More than half of the cases (64.5%) had nuclear sclerosis grade 2. Cases with nuclear sclerosis grade 3 were 32.5% and only 3% had nuclear sclerosis grade 1.

There is a notable difference between the $K_{horizontal}$ and $K_{Vertical}$ (D) values, axial length and anterior chamber depth (ACD) as measured by conventional keratometry and IOL Master with the difference being statistically significant [Table 1, Chart 1].

Values of three out of the four parameters were higher when measured by the IOL Master than the values measured by Conventional Biometry. Since the conventional biometry recorded higher $K_{horizontal}$ values and lower values of $K_{vertical}$ and vice versa for IOL Master, the effect of the variability of K-readings on IOL power calculation was neutralised. The average K reading was 44.42mm by conventional biometry and 44.09mm by IOL master. SRK/T formula was used to calculate the IOL power which did not take into account the anterior chamber depth for IOL power calculation, therefore the effect of anterior chamber depth on IOL power calculation could not be deduced. So, effectively, the only variation is the axial length values as measured by both the methods that affected the calculation of IOL power. This implies that the essential difference between the conventional biometry and IOL is the measurement of axial length.

In 25% of cases there was no requirement of spherical correction for emmetropic visual acuity at 6th post-operative week. A refractive error of ±0.5D was taken as emmetropia. The number of cases that corrected to 6/9 or better with ±0.5D was 46%. With implantation of IOL of power as calculated by IOL Master, a total of 71% cases achieved emmetropia at 6 weeks post-operatively.

With IOL Master, 90% of the patients had post- operative refractive error of less than ±1.0D; had IOL implantation been done with aid of US Biometry, only 55% would have had post- operative correction of less than ±1.0D. 45% would have had post- operative refractive correction exceeding ±1.5D.

IV. DISCUSSION

The postoperative outcome and patient satisfaction following cataract surgery is largely dependent upon accuracy of preoperative biometry[9].

The IOL Master is a new technique for ocular biometry in clinical practice. It provides an alternative to ultrasound, the conventional method of measuring axial length. The accuracy, precision and repeatability of the IOL Master have been the focus of various studies[10].

Values of axial length measured by IOL Master were significantly more than those measured by conventional biometry and the difference was statistically significant in this study.

The percentage of eyes with a difference in the IOL powers calculated by the IOL Master and conventional biometry was 78% in the zero spherical correction sub-group and 80.4% in ±0.5D sub-group, which is significant. The commonest difference in the IOL powers between the two groups was ±1.5D in the zero spherical sub-group (22%) and ±1.0D in ±0.5D sub group (23.9%). This means that at least $^{1}/_{5}^{th}$ of the cases had a difference of 1.0 – 1.5D when the power was calculated by conventional biometry compared to that by calculated by IOL Master [Table 2].

This must be because the IOL master utilises a non-touch technique and in the conventional method a certain amount of pressure gets applied, resulting in calculation of a shorter axial length. The relatively similar differences are seen in ACD measurements; suggesting that the main reason for the shorter axial length is indentation of the cornea caused by direct contact [11,12]. This leads to the assumption that Ultrasonic examination is more dependent upon the operator.

In only 37.3% of the eyes the IOL powers calculated by the Conventional method was such that post-operatively the patients would have required ±0.5D or less of spherical correction to achieve 6/9 or better vision as compared to 71% of eyes who had achieved the same with IOL Master. The findings of this study are in corroboration with various studies which have shown the IOL Master to be ten times more precise as brought out by O. Findl *et al*[13].

In conclusion, the IOL Master has simplified the process of ocular biometry. It is quick, easy to use and provides a non-contact technique without need of topical anesthesia. Thus, in addition to providing comfort to the patient, there is no risk of pre- operative infection or corneal abrasion. It allows accurate axial length measurement and determination of IOL power for cataract surgery because it measures the ocular axial length along the visual axis, as the patient fixates at the measurement beam. During ultrasound biometry a misalignment between the measured axis and the visual axis and indentation by the operator may result in erroneous axial length measurements.

Financial interest: None
Conflicts of interest: None

Chart 1:

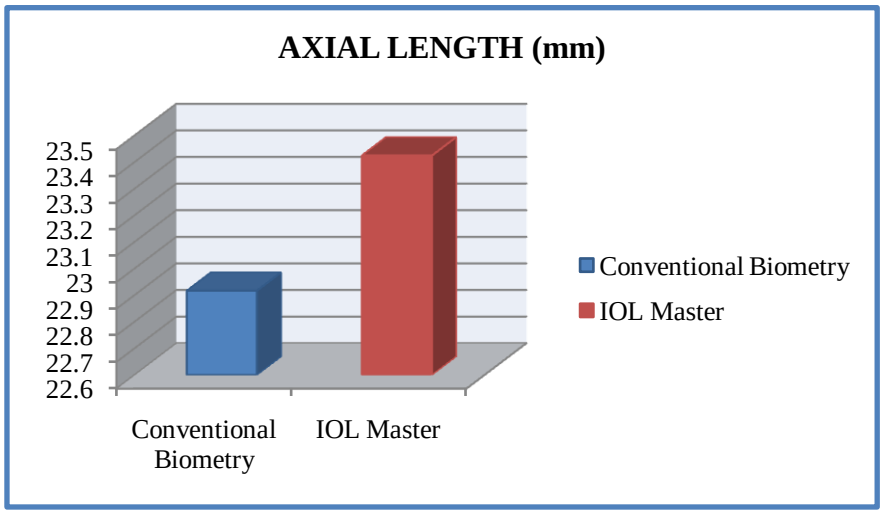

Table 1:

	Conventional Biometry (A)	IOL Master (B)	Statistical significance of difference between the means
$K_{horizontal}$ (D)	45.14	43.55	Significant
$K_{vertical}$ (D)	43.70	44.68	Significant
Axial length (mm)	22.92	23.43	Significant
Anterior Chamber Depth (mm)	2.80	3.05	Significant

Table 2:

Post- operative Correction (at 06 weeks)	**IOL Master**	**Conventional Biometry (Ultrasound)**	
		Difference of IOL power from that measured by IOL Master	Number of cases
No spherical correction (A sub group)	50 (25%)	No difference $\pm$ 0.5D $\pm$ 1D $\pm$ 1.5D $\geq$ 2D	11 6 9 11 13
±0.5 D Correction (B sub group)	92 (46%)	No difference $\pm$ 0.5D $\pm$ 1D $\pm$ 1.5D $\geq$ 2D	18 18 22 14 20
±0.75D Correction (C sub-group)	48 (24%)	No difference $\pm$ 0.5D $\pm$ 1D $\pm$ 1.5D $\geq$ 2D	13 6 10 7 12
Greater than ±1.0D Correction (D sub-group)	10 (5%)	No difference $\pm$ 1.5D $\geq$ 2D	3 2 5
No spherical correction or ± 0.5D correction (A+B)	50 + 92 = 142 (71%)	No difference $\geq$0.5D	11 + 18 = 29 (20.4%) 6 + 18 = 24 (16.9%) 20.4+16.9= 37.3%

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