ORIGINAL RESEARCH PAPER

Ophthalmology

COMPARISON OF REFRACTIVE ERROR BY APPLANATION A-SCAN, IMMERSION A- SCAN AND OPTICAL BIOMETER

KEY WORDS: Applanation, axial length, immersion, refractive error, optical biometer

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ABSTRACT

Aim: To compare and assess the accuracy of different techniques of intra-ocular lens power calculation. **Methods:** This was a prospective randomized study done in 90 patients over a period extending from November 2019 - October 2020 in the Upgraded Department of Ophthalmology, Government Medical College Jammu. Intraocular lens power was calculated by measuring axial length by three different techniques and further postoperative refractive error was compared at 4-6 weeks. **Results:** In this study, 43% patients were found to be myopic post-operatively, 10% were emmetropic and 47% patients were hyperopic in Group A, 60% patients were found to be myopic post-operatively, 30% patients were emmetropic and 10% patients were hyperopic in Group B. In Group C, 6.67% patients were found to be myopic post-operatively, 90% patients were emmetropic and 3.33% patients were hyperopic. The postoperative refractive error was found least within the Group C. **Conclusion:** This study concludes that the optical biometry has greater accuracy than ultrasound biometry including applanation and immersion a-scan.

INTRODUCTION

Cataract is clouding of the normally clear transparent lens of the eye, which prevents a clear image from forming on the retina. It is one of the leading causes of preventable blindness in the world today, accounting for 50% of blindness worldwide.The best optical rehabilitation following removal of a cataractous lens is implantation of an intra-ocular lens. The first posterior chamber intra-ocular lens was implanted in a human eye by Sir Harold Ridley at St Thomas Hospital in London on 29 November 1949 which marked the beginning of IOL power calculation. Fyoderv and co-workers first estimated the optical power of an IOL using vergence formulas in 1967. To achieve optimum results, estimation of correct intraocular lens power is necessary.

Ocular biometry involves anatomical measurement of the eye which includes axial length (AL), keratometry & anterior chamber depth (ACD). These biometric measurements are crucial for the selection of the correct IOL power in order to achieve the desired refractive outcome after cataract surgery. Therefore, ocular biometry is an essential step before cataract surgery.

The axial length, one of the variable for the determination of postoperative refraction, is the distance between the anterior surface of the cornea and the fovea and usually measured by a-scan ultrasonography or optical coherence biometry.

Ultrasound biometry involves two types which includes applanation a-scan biometry and immersion a-scan biometry.

Applanation biometry is a procedure in which ultrasound probe comes in direct contact with the cornea under the topical anaesthesia. Immersion a-scan biometry, the other variant of the ultrasound biometry requires placing a saline filled scleral shell between the probe and the eye. A-scan produces one-dimensional images in which echo strengths are displayed as vertical deflections or spikes of varying heights on a displayed screen.

The optical biometer uses the technique of partial coherence interferometry (PCI) which measures the time required for infrared light to travel the retina. The signal is produced by the interference between the light reflected by the tear film and that reflected by the Retinal Pigment Epithelium (RPE).

MATERIALS AND METHODS

This prospective randomized study was conducted over a period extending from November 2019 -October 2020 in the Upgraded Department of Ophthalmology, Government Medical College Jammu (J&K) after taking permission from the Institute Ethic Committee, GMC Jammu.

The study included all patients who attended the OPD of Upgraded Department of Ophthalmology, Government Medical College Jammu (J&K) from November 2019 to October 2020 with Grade 2 and Grade 3 Nuclear sclerosis who subsequently underwent cataract surgery with posterior chamber intra-ocular lens implantation. Written informed consent was taken and patients aged above 40 years and of either sex were included in the study. The patients with Grade 4 cataract, posterior sub-capsular cataract, complicated cataract, prior eye surgeries, corneal scars or corneal diseases, glaucoma, retinal diseases were excluded from this study.

The study was conducted on 90 patients with cataract whose axial length was calculated by all the three techniques viz applanation a-scan, immersion a-scan and optical biometer. After this, the patients were selected randomly for the IOL power to be implanted after cataract surgery.

Measurement of axial length was performed first by optical biometer, then immersion a-scan followed by applanation a-scan. This order was considered necessary to maintain the integrity of the corneal epithelium which may be compromised inadvertently by its contact with the ultrasound probe. Three readings of axial length were taken and then mean of these three values was used as axial length for the calculation of IOL power.

Optical biometry was performed using Topcon's Aladdin HW3.0 . Immersion a-scan was performed using Matrix Immersion A-scan. The technique involves placing a small immersion scleral shell onto the eye between the lids, filling with BSS and immersing the probe into the fluid without contacting the cornea. The keratometry readings obtained with the optical biometer were taken to calculate the IOL power.

Applanation a-scan biometry was performed using Bausch and Lomb keratometer and Echorule Biomedix A-scan. The corneal curvatural (k) readings were taken with Bausch & Lomb Keratometer. Hand-held transducer probe is used for contact technique of a-scan USG in the Echorule Ultrasonic Biometer.

The IOL power calculation was calculated by using various formulae including the SRK/T formula, the Holladay formula and the Hoffer-Q formula. After the IOL power calculation by all the three techniques of biometry, the patients underwent small incision cataract surgery with posterior chamber intraocular lens implantation. For choosing one of the three IOL powers, the patients were randomly grouped as Group A- patients in whom PCIOL implanted was as per the IOL power calculated by applanation a-scan, Group B- patients in whom PCIOL implanted was as per the IOL power calculated by immersion a-scan, Group C- patients in whom PCIOL implanted was as per the IOL power calculated by optical biometer. The eye was examined at first postoperative day, at 2weeks and 4-6 weeks after the surgery. The postoperative refraction was done at 4-6 weeks after the surgery.

The postoperative visual results were recorded as uncorrected visual acuity (UCVA) and best spectacle corrected visual acuity (BSCVA).

The differences between the refractive results in terms of spherical error were analyzed among the three groups and the observations were compiled and statistically evaluated. For statistical significance, p value of less than 0.05 was considered as significant.

RESULTS

The present study was carried out to compare the accuracy of different techniques of biometry. There was no significant difference between the three groups regarding gender (p=0.821). The study found no significant difference in mean age among the three groups. There was no significant difference between the laterality of the eye operated of study subjects (p=0.956).

The mean pre-operative Va of operated eye (LogMAR) of the study group was 1.32±0.25 (range 0.6-1.77). The mean k1 reading in Group A was 42.78±1.54D and in Group B and C was 43.98±1.76D. There was a statistically significant difference in mean k1 values among the three groups. The mean k2 reading in Group A was 42.38±1.88D and in Group B and C was 45±1.65D each. There was a statistically significant difference between applanation a-scan and optical biometer regarding corneal powers - k1 and k2 (p value<0.0001)

Mean axial length in Group A, Group B and Group C was 22.86±0.85mm, 22.92±0.85mm and 23.1±0.93mm respectively. There was a statistically significant difference between all the three techniques regarding the measured AL (p=0.0004).

The mean IOL power calculated from applanation biometry, immersion and optical biometer was 22.93±1.93D, 20.52±1.87D and 20.74±1.7D respectively. There was a statistically significant difference in estimated IOL power between Group A & Group B and between Group A & Group C but there was no significant difference between Group B & Group C (p<0.0001).

Table 1: Comparison Of IOL Power Calculated Of Between Group A, B And C.

IOL power calculated(D)	Mean ± SD	Median	Range	P value	Test performed
Group A	22.93 ± 1.93	22.71(21.91-23.98)	19.5-29.36	<.0001	Repeated measure ANOVA
Group B	20.52 ± 1.87	20.5(19.1 25-22)	16-24		
Group C	20.74 ± 1.7	20.5(19.6 25-22)	16.5-24.5		

The study found no significant difference in IOL power implanted among the three groups (p=0.413).

At 4-6 weeks post-operatively, refraction of each operated eye was noted. Mean UCVA (LogMAR) measured in Group A was 0.57±0.24, in Group B was 0.35±0.14 and in Group C was 0.22±0.15. The mean difference between all the groups was found statistically significant.

The mean difference in terms of mean BCVA (LogMAR) between Group A & Group B was not statistically significant (p=0.697), but it was significant between Group A & Group C (p=0.0003) and between Group B & Group C (p=0.005).

Table 2: Comparison Of Post Operative Spherical Error Between Group A, B And C.

Post operative spherical error	Group A (n=30)	Group B (n=30)	Group C (n=30)	Total	P value	Test performed
Myopia	13 (43.33 %)	18 (60%)	2 (6.67 %)	33 (36.67 %)	<.0001 A vs B:0.004 A vs C:<.0001 B vs C:<.0001	χ^2test,52.515 A vs B: χ^2 test,10.924 A vs C: χ^2 test,38.533 B vs C: χ^2 test,22.8
Emmetropia	3 (10%)	9 (30%)	27 (90%)	39 (43.33 %)		
Hyperopia	14 (46.67 %)	3 (10%)	1 (3.33 %)	18 (20%)		
Mean ± SD	1.52 ± 1.01	0.35 ± 0.31	0.05 ± 0.19	0.64 ± 0.88	<.0001 A vs B:<.0001 A vs C:<.0001 B vs C:0.153	ANOVA;F value=46.787
Median	1.38 (0.75-2)	0.25 (0-0.5)	0 (0-0)	0.25 (0-0.938)		
Range	0-3.75	0-1.25	0-1	0-3.75		

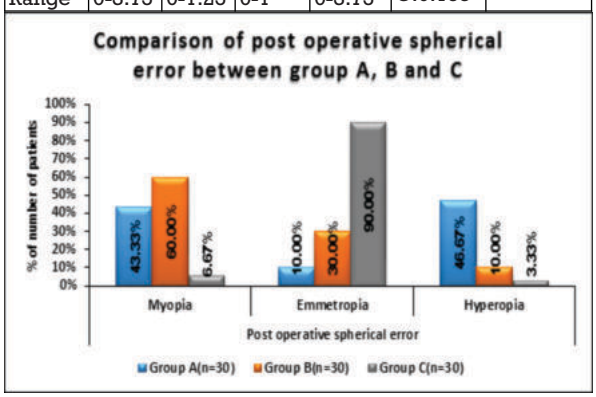

Figure 1: *Comparison Of Post Operative Spherical Error Between Group A, B And C.*

The mean post-operative spherical error in Group A was 1.52±1.01. The mean post-operative spherical error in Group B was 0.35±0.31 and the mean post-operative spherical error in Group C was 0.05±0.19. The mean difference between all the three Groups in terms of post-operative refractive error was statistically significant and the range was found to be least in Group C (0-1), followed by Group B (0-1.25) and maximum in Group A (0-3.75).

DISCUSSION

The precision of IOL calculation is influenced by several factors including the corneal curvature, axial length & the IOL type. The three groups in this study did not differ significantly in terms of age, sex, laterality and preoperative visual acuity. All the patients of the study were older than 48 years. Accurate biometric data are essential for achieving good surgical outcomes and patient satisfaction after cataract and refractive surgery. The mean K reading values found in the present study are in conformity to the value given by various authors.

The axial length with applanation a-scan in Group A ranged from 20.99-24.6mm with mean AL of 22.86±0.85mm. The axial length in Group B as measured with immersion a-scan ranged from 21.5-24.9mm with a mean AL of 22.92±0.85mm. The mean AL with immersion & contact technique in a study done by ***Ademola- Popoola DS et al*** (2015) were 26.60±1.36mm and 23.46mm. Their study found statistically significant difference between the AL measured by the two techniques. ***Shammas*** (1984) revealed that the axial length measurements obtained with the contact technique were shorter compared to the immersion technique by an average of 0.24mm.

In present study, there was a statistically significant difference between the AL measured by the contact and immersion technique. The mean AL with optical biometer in our study was comparable to the mean AL found in study done by ***Nakhli FR***. In another study done by ***Gaballa SH et al,*** the mean AL measured by IOL-M was higher (26.18±2.92mm) that with A-Scan (26.02±2.99mm) with a mean difference of 0.2±0.44mm (p=0.07).

This study found significant difference between IOL power calculated from applanation technique versus immersion technique and applanation technique versus optical biometer. There was no difference between the mean IOL power calculated from immersion technique & optical biometer.

The study done by ***Gaballa SH et al*** (2017) found a statistically significant difference between the IOL power calculated from a-scan biometery and IOL-master.

Many workers have tailored IOL power by measuring corneal curvature and AL of eye & reported their postoperative results. However, very few clinical studies are available in literature comparing the postoperative refraction results obtained with three techniques of biometry including applanation a-scan, immersion a-scan & optical biometer.

In the present study, there was no statistically significant difference between Group A and Group B regarding BSCVA but there was a statistically significant difference between Group A and Group C and between Group B and Group C.

In this study, myopia was seen among 43% of patients in Group A, 60% in Group B and 6.7% in Group C. Hypermetropia was seen among 14% in Group A, 10% in Group B & 3% in Group C. In a study by ***Gaballa SH et al*** (2017), postoperative BCVA was 6/9 or better in 80% of the eyes, 6/12 in 12.5% of the eyes & 6/18 in 7.5% of the eyes. They found no statistically significant difference between the a-scan and IOL-M methods when comparing the predicted IOL power to the postoperative spherical equivalent.

CONCLUSION

This study showed that the patients who received IOL power calculated by optical biometer achieved better UCVA than those who received the IOL power calculated by the other two methods. However, this study is limited by the relatively small number of patients and short duration of follow-up and this study may be a seedbed for future research.

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Conflict Of Interest: Nil

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