Compare the Accuracy of IOL Power Calculations Using Ultrasound Biometry and Partial Coherence Laser Interferometry based Optical Biometry

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Abstract

Aims: To compare the accuracy of IOL power calculations using ultrasound biometry and partial coherence laser interferometry based optical biometry

Material and Methods: All cases of cataract with no other pathology involved presenting to, ophthalmology department at RNT Medical College and Hospital, Udaipur from august 2018 to December 2019.The patients are divided into two group 1st group IOL power calculated by optical biometer and 2nd group IOL power calculated by ultrasound biometry.

Results: Significant p-value (0.01) was observed between Group 1 and Group 2 among pre operative and post-operative VS patients.

Conclusion: optical biometry with the AL scan (Nidek) proved to be slightly more accurate than ultrasound biometry for IOL power calculation.

Keywords: *AL Scan, Ultrasound biometry, IOL*

Introduction

The refractive power of the human eye depends on thepower of the cornea and the lens, the position of the lensand the length of the eye.

Accurate assessment of thesevariables is essential in achieving optimal postoperativerefractive results. If these biometric measurements andcalculations are inaccurate, the patients may be left witha significant refractive error.

Studies conducted byOlsen T[1]showed that imprecision in measurements ofanterior chamber depth (ACD), axial length and cornealpower contribute to 42, 36 and 22%, respectively, of theerror in predicted refraction after implantation of an intraocularlens (IOL).

Biometry is the method of applying mathematics to biology. The term was originally used by Whewell initially in the 1800s for calculating life expectancy. The refractive power of the eye primarily depends upon the cornea, the lens, ocular media, and the axial length of the eye.

When planning for cataract surgery, in order to achieve the desired post-operative refraction, the required power of the intraocular lens implant can be calculated if the corneal refractive power, media type, and axial length are known.[2]

In the late 1990s an alternative to ultrasound biometry was introduced, IOL master (OPTICAL BIOMETRY) was based on the principal of partial coherence interferometry[3]. Ultrasound measurement has always

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had two major limitations. First ultrasound measures the anatomical axial length of the eye from the anterior pole to the posterior pole not the optical axial length along the visual axis. Second problem with ultrasound biometry is that it measures to the front of the retina the internal limiting membrane, but the photoreceptors used for sight are at the back of retina near Bruch's membrane. With the introduction of optical biometry these two problem were addressed. For optical biometry patients fixes on the target light as a result the device actually measures the distance from the corneal vertex to the fovea rather than the anatomical length. Second the optical signal measures to the Bruch's membrane the back of the retina rather than the anterior limiting membrane. The device measures the true distance.

However, there is one limitation to the technology to obtain the measurements a fairly good optical pathway is required. In an eye with grade 4 nuclear sclerotic cataract or a white cataract optical biometry cannot get the reading[4].

Ultrasound axial length measurement have been the gold standard for many years with the introduction of optical biometry, used not only for axial length but anterior chamber depth pachymetry and lens and retinal thickness measurement[5].

This study is being done to compare the clinical accuracy and post - operative refraction between ultrasound and optical biometry.

Materials and Methods

Study subjects:

All cases of cataract with no other pathology involved presenting to, ophthalmology department at RNT Medical College and Hospital, Udaipur from august 2018 to December 2019 was included in study

Exclusion criteria:

1. Patients not willing to participate in the study

2. Ocular pathology involved along with cataract.

3. Patients with mature senile cataract (MSC) andhypermature senile cataract (HMSC)

4. Patients with posterior polar cataract

5. Cataract surgery with intraoperative complication

Study area: Ophthalmology Department in RNT Medical College and Hospital,Udaipur.

Study period: One yearprospectivestudy from August 2018 to December 2019

Methods of collection of data:

Study design: HospitalbasedProspectivestudy.

Sample size: 200

Group 1 – optical biometry

Group 2 - A scan ultrasound

Data collection:

Medical records and case sheets was referred whenever necessary to collect addition information. Patient wasundergo keratometry andA- scan and values was documented IOL power was calculated using SRK T formula. Optical biometry values was measured and values was documented IOL power was calculated using SRK T formula.

Study Analysis

This was a prospective analysis performed on patients undergoing phacoemulsification cataract surgery with IOL implantation. The patients are divided into two group 1^{st}group IOL power calculated by optical biometer, keratometric value in optical biometrygroup was measured by manual keratometry with Bausch & Lomb (B&L) Keratometer and axial length byoptical biometryand 2^{nd} group IOL power calculated by ultrasound biometry used for measuring axial length (AL) and K_1 K_2 measured by B&L keratometer. The postoperative natural visual acuity and refractive error was carried out after 6 weeks of cataract surgery. Spherical equivalent obtained in both cases are studied excluding surgical induced astigmatism. The data was statistically compiled and analysedappropriate statistical tests was applied

Intervention and technique

Patients was asked to sit on the chair and look straight then under local anesthesia containing proparacaine hydrochloride 0.5 percent with a- scan probe, center of cornea was touched to calculate the axial length. Average of thee readings was taken. K1 and k2 values are calculated by keratometry. In optical biometry the patients was asked to sit in front of the instrument and asked to look straight and the readings was taken.

Statistical Analysis

The data was coded and entered into Microsoft Excel spreadsheet. Analysis was done using SPSS version 20 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) Windows software program. Descriptive statistics included computation of percentages, means and standard deviations. The data were checked for normality before statistical analysis using Shapiro–Wilk test. Quantitatively, parameter data were analyzed using t-test while nonparametric data were analyzed using Wilcoxon signed-rank test and Mann–Whitney U-test. Chi-square test and fisher exact test were used for qualitative data whenever two or more than two groups were used to compare. Level of significance was set at $P \leq 0.05$.

Observations

Mean age was 65.91 years in Optical biometry (group 1) and 63.23 years inA-Scan Ultrasound, (group 2)

Group1- Optical biometry were 52 (52%) female and male patients were 48(48%) whereas from Group 2- A-Scan Ultrasound male patients were 37(37%) and female patients were 63(63%).

Left eye patients from Group1- Optical biometry were 46 (46%) and right eye patients were 54(54%) whereas from Group 2-A-Scan Ultrasound LE patients were 41(41%) and RE patients were 59(59%).

24% and 22% sample patients taken under the study were from visual standards 6/60 respectively from Group 1 and Group2 respectively.

Group 1 and Group 2 were further categorized on the basis of NS2, NS3 and NS4 in which maximum patient found with NS 3 (41.9%) grade in both group.

Table 1: Comparison of AL and IOL readings in both the groups

		Mean	Std. Dev	P value
AL	Group 1	22.79	1.08	0.15
	Group 2	23.09	1.04	
IOL	Group 1	21.16	2.95	0.65
	Group 2	20.95	3.53	

Patients categorized on the basis of AL mean was 22.79, 23.09 and standard deviation was 1.08, 1.04 respectively for Group 1- Optical biometry and Group 2- A-Scan Ultrasound respectively. Insignificant calculated p-value (0.15) was observed.

Patients categorized on the basis of IOL mean was 21.16, 20.95 and standard deviation was 2.95, 3.53 respectively for Group 1- Optical biometry and Group 2- A-Scan Ultrasound respectively. Insignificant calculated p-value (0.65) was observed

Table 2: Comparison V.A. Unaided after surgery in both group

			V.A. Unaided					Total
			6/12	6/18	6/24	6/6	6/9	
Groups	Group 1	N	16	2	0	35	47	100
		%	16.0%	2.0%	0.0%	35.0%	47.0%	100.0%
	Group 2	N	31	6	1	26	36	100
		%	31.0%	6.0%	1.0%	26.0%	36.0%	100.0%
Total		N	47	8	1	61	83	200
		%	23.5%	4.0%	0.5%	30.5%	41.5%	100.0%

P value=0.01 (S)

Significant p-value (0.01) was observed between Group 1 and Group 2 among VS patients. Maximum patients were having 6/9 VA, 47% from Group 1 and 36 % were from Group 2.

Table 3: Spherical Refractive error(D)

Groups	Mean	Std. Deviation	P value
Group 1	0.09	0.45	0.74
Group 2	0.11	0.604	

Group 1 have 0.09 Spherical Refractive error(D) and group 2 have 0.11 Spherical Refractive error(D) which showed statistically non-significant result.

Table 4:Spherical RE(D) in Group 1 and 2

		N	Mean	Std. Deviation	P value
Group 1	No correction	52	0.00	0.00	0.02 (S)
	correction	48	0.19	0.64	
Group 2	No correction	47	0.00	0.00	0.02 (S)
	correction	53	0.22	0.81	

Among group 1, no correction have not any Spherical Refractive error(D) and correction have 0.19 Spherical Refractive error(D) which showed statistically significant result.

Among group 2, no correction have not any Spherical Refractive error(D) and correction have 0.22 Spherical Refractive error(D) which showed statistically significant result.

Table 5: Comparison of postoperative visual acuity after spherical correction in both the groups

		6/12	6/18	6/24	6/6	6/9	Total
Group 1	No.	3	0	0	74	23	100
	%	3%	0.0%	0.0%	74%	23%	100%
Group 2	No.	3	0	0	66	31	100
	%	3%	0.0%	0.0%	66%	31%	100%
Total	N	6	0	0	140	54	200
	%	3%	0.0%	0.0%	70%	27%	100%

P value =0.56

Significant p-value (0.01) was observed between Group 1 and Group 2 among VS patients. Maximum patients were having 6/6 VA, 74% from Group 1 and 66 % were from Group 2.

Discussion

In our study it is found maximum number of patient having cataract at age of more than 60 years. It is similar to study done in south India by Singh S et al[6] in 2019, they reported that the prevalence of cataract in population more than equal to 60 years in south India in both urban and rural population

In our study it is found that prevalence of cataract in female is more than male. It is similar to study done by PK Nirmalan et al[7] found that prevalence of cataract significantly lower in male.

SimilarlyVashistP et al[8] concluded that prevalence of cataract increases with age and was higher in women than in men.

Optical biometry offers many distinct advantages compared to US-guided biometry. It is a non-contact approach with likely accuracy and reproducibility in the context of non-severe pathology. When limitations such as dense media opacity, high axial myopia, and/or poor fixation prevent use of optical biometry, US-guided biometry becomes a useful alternative method, as it can be used in cases with significant media opacity[9,10]

In our study we have compared optical biometry (non contact) and A scan(contact method) to assists the better visual outcome in patients with cataract of various grades. This study compares the refractive outcome post surgery between the ultrasound A scan and the optical biometry.

Similarly, there were no statistically significant differences in AL measurements and IOL power calculation between the two groups.

We know from previous studies that optical biometry measurements are most reliable[11].

The results from this study help to determine that in such cases, optical biometry (IOL Master in particular) may still be utilized or, at the very least, clinically relevant when making IOL selections for a specific refractive target.

Even in cases where high-quality data is available, our results and literature also suggest that there is still room for improvement in order to achieve more precise postoperative refractive results. It is therefore still important to any discussion of cataract surgery that there may be a role for spectacles after surgery despite the array of treatments, technologies and formulae.

A recent study in 2017 reported 49% of patients were still spectacle-dependent for distance after cataract extraction with IOL implant using the most advanced technologies to target emmetropia. In addition, there was a strong correlation between the use of spectacles post-operatively and surgeons' advice to obtain them for optimal refractive outcome.[12]

Precise and accurate biometric data is a fundamental requirement for successful refractive outcomes with cataract surgery. However, pathology often highlights technological related limitations where data of lower quality is the best available. Newer modalities including those utilizing Swept source-based technologies are being integrated to overcome the technological limitations of prior generation biometry.[13]

In our study we found that Optical biometry done in group 1 showed better visual outcome postoperatively than compared with ultrasound A scan in group 2.This is comparable to Kiss B et al[14] study, 6 (95.7% using PCI technique) and Rose LT et al[15] study(100% in PCI group and 71.42% in US group).

Sang woo moon et al[16] in their study showed the difference is not statistically significant intraocular lens calculation done by AL scan were nearly same in predicting postoperative optical refraction compare to those of applanation ultrasound.

Raymond S et al[17] in their prospective double-blind randomised clinical study demonstrated no clinical advantage of PCI technology over conventional aplanation US for IOL power calculation.

Also, Moeini et al[18] in their study show that was no significant difference in IOL power calculation.

Other authors demonstrate that results with optical biometry are more precise and have more predictable refractive outcome than the conventional ultrasound biometry[19,20]

It is generally accepted that the optical biometry offers superior reproducibility of axial length measurement in comparison with applanation ultrasound biometry.

In generally is agreed that the accurate biometry is the most important factor in achieving a successful refractive outcome after IOL implantation.

However, optical biometry is limited by its inability to measure AXL in dense ocular media, nonoptimal fixation as in cases of age-related macular degeneration and in patients with mobility problems in which ultrasound biometry still has a role.

Currently optical biometry is the most widely used technique for biometry. If measurement using ultrasound biometry is done correctly, results of both methods correspond significantly and the methods are mutually replaceable

Our results showed that optical biometry with the AL SCAN (NIDEK CO. LTD) proved to be slightly more accurate than ultrasound biometry for IOL power calculation. We did not evaluated for different types of cataract.

Conclusion

In conclusion, the optical biometer is quick and easy to use and provides a noncontact technique with no risk of infection or corneal abrasion and most accepted by patients. It allows accurate AXL measurement and determination of IOL power for cataract surgery.

Our results showed that optical biometry with the AL scan (Nidek) proved to be slightly more accurate than ultrasound biometry for IOL power calculation.

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Conflict of Interest – Nil

References

1. Olsen T. Calculation of intraocular lens power: a review. Acta Ophthalmol Scand 2007; 85:472–485. Good summary of factors involved in the calculation of intraocular power
2. Astbury N. and Ramamurthy B., How to avoid mistakes in biometry, Community Eye Health. 2006 Dec; 19(60): 70–71.
3. Drexler W, Findl O, Menapace R, et al. Partial coherence interferometry: a novel approach to biometry in cataract surgery. Am J Ophthalmol. 1998; 126(4): 524-534
4. Zaldivar R, Shultz MC, Davidorf JM, Holladay JT. Intraocular lens power calculations in patients with extreme myopia. J Cataract Refract Surg. 2000; 26(5): 668-674.
5. Sahin A, Hamrah P. Clinically relevant biometry. Curr Opin Ophthalmol. 2012;23:47–53
6. Singh S, Pardhan S, Kulothungan V, Swaminathan G, Ravichandran JS, Ganesan S, Sharma T, Raman R. The prevalence and risk factors for cataract in rural and urban India. Indian J Ophthalmol [serial online] 2019 [cited 2020 Jan 1];67:477-83. Available from: http://www.ijo.in/text.asp?2019/67/4/477/254705

7. Nirmalan PK, Robin AL, Katz J, Tielsch JM, Thulasiraj RD, Krishnadas R, et al. Risk factors for age related cataract in a rural population of southern India: The Aravind Comprehensive Eye Study. Br J Ophthalmol 2004;88:989-94
8. Vashist P, Talwar B, Gogoi M, Maraini G, Camparini M, Ravindran RD, et al. Prevalence of cataract in an older population in India: The India study of age-related eye disease. Ophthalmology 2011;118:272-8
9. Bhatt AB, Schefler AC, Feuer WJ, Yoo SH, Murray TG. Comparison of predictions made by the intraocular lens master and ultrasound biometry. Arch Ophthalmol. 2008;126(7):929–933
10. Goebels SC, Seitz B, Langenbucher A. Comparison of the new biometer OA-1000 with IOLMaster and Tomey AL-3000. Curr Eye Res. 2013;38(9):910–916.
11. Verhulst E, Vrijghem JC. Accuracy of intraocular lens power calculations using the Zeiss IOL master. A prospective study. Bull Soc Belge Ophtalmol. 2001;281(281):61–65
12. Farhoudi DB, Behndig A, Montan P, Lundström M, Zetterström C, Kugelberg M. Spectacle use after routine cataract surgery: a study from the Swedish National Cataract Register. Acta Ophthalmol. 2018;96(3):283–287
13. Srivannaboon S, Chirapapaisan C, Nantasri P, Chongchareon M, Chonpimai P. Agreement of IOL power and axial length obtained by IOLMaster 500 vs IOLMaster with Sonolink connection. Graefes Arch Clin Exp Ophthalmol 2013; 251: 1145-9.
14. Kiss B, Findl O, Menapace R, et al. Refractive outcome of cataract surgery using partial coherence interferometry and ultrasound biometry: clinical feasibility study of a commercial prototype II. J Cataract Refract Surg 2002; 28:230–234.
15. Rose LT, Moshegov CN. Comparison of the Zeiss IOLMaster and applanation A-scan ultrasound: biometry for intraocular lens calculation. Clin Exp Ophthalmol. 2003;31(2):121–124.
16. Moon SW, Lim SH, Ho Lee Y. Accuracy of biometry for intraocular lens implantation using the new partial coherence interferometer. Korean J Ophthalmol 2014;28(6) ; 444-450.
17. Raymond S, Favilla I, Santamarial L. Comparing Ultrasound Biometry with Partial Coherence Interferometry for Intraocular Lens Power Calculations: A Randomized Study. Invest Ophthalmol Vis Sci, 2009; 50:2547-2552.
18. Moeini H, Eslami F, Rismanchian A, Akhlaghi M, Najafianjazi A. Sci. 2008;13(2):43-7.
19. Hsieh YT, Wang IJ.Intraocular lens power measured by partial coherence interferometry.Optom Vis Sci. 2012;89(12):1697-701.
20. Landers J, Goggin M. Comparison of refractive outcomes using immersion ultrasound biometry and IOLMaster biometry.Clin Exp Ophthalmol. 2009;37(6):566-9.