Asian J Ophthalmol. 2016;14:185-191

Comparison of accuracy of Partial Coherence Interferometry based Zeiss IOL Master 500 and Immersion Ultrasound (Ocuscan RXP) for intraocular lens power calculation

Vijaya Pai.H[1], Divya Shastri [1], Asha Kamath[2]
[1]Department of Ophthalmology, [2]Department of Community Medicine, Kasturba Medical College, Manipal University, Manipal, India

Abstract

Aim: *To compare accuracy of intraocular lens power (IOL) calculation using Partial coherence Interferometry based Carl Zeiss IOL master 500 and Immersion ultrasound (Alcon Ocuscan RXP).*

Methods: *A prospective randomized study of patients who underwent clear corneal phacoemulsification with foldable (IOL) by a single surgeon, during the period September 2010 to 2012. Group A included those patients in whom IOL power calculation using Immersion ultrasound (Ocuscan RXP) was used. Group B included those patients in whom IOL power calculation using Partial coherence Interferometry based Zeiss IOL master was used. SRK T formula was used to calculate the IOL power in both the groups. Postoperative final refraction was done at 6 weeks. Unaided visual acuity and best corrected visual acuity was assessed. Postoperative refractive error was compared with predicted refractive error with each biometry method. Statistical analysis was done using SPSS 16.5. Continuous variables expressed as mean (standard deviation). $P < 0.05$ was considered significant.*

Results: *There were 50 patients in Group A, 44 patients in Group B. Axial length of the patients varied from 22-26mm in both the groups. The postoperative refraction using Ocuscan, 88% had refractive error ≤± 0.5 D, 94% had ≤±1.00D, and 100% had ≤±2.0D of emmetropia. Using Zeiss IOL Master 72.7% had ≤± 0.5 D, 100% had ≤±1.00D of refractive error. Difference in absolute postoperative refractive error using Ocuscan vs. IOL Master was not statistically significant.*

Conclusion: *In our study both ultrasound Ocuscan and IOL master were accurate in calculating intraocular lens power and achieving postoperative refraction closer to emmetropia.*

Key words: *Intraocular lens power calculation, IOL master, Ultrasound A scan.*

Cataract removal and intraocular lens implantation is one of the most frequent and successful ophthalmic procedure performed today. For a successful refractive outcome, the appropriate intraocular lens power must be selected, accuracy of which is highly dependent on preoperative biometry and keratometry. Newer diagnostic and therapeutic instruments with potentially improved precision, diagnostic capabilities and efficiency and convenience are now available for preoperative biometry. We conducted this study to compare accuracy of intraocular lens power (IOL) calculation using Partial coherence Interferometry based Carl Zeiss IOL master 500 Advanced Technology, Version 7.1.2.0042 and Immersion ultrasound (Alcon Ocuscan RXP)

Correspondence: Vijaya Pai.H, Department of Ophthalmology, Kasturba Medical College, Manipal University, Manipal, India
E-mail: paivijaya@yahoo.co.in

Materials and methods

This was a prospective randomized study of 94 patients who were scheduled for phacoemulsification with implantation of posterior chamber intraocular lens (AcrysofSN60WF/SA60AT) during the period, September 2010 to September 2012. Ethical committee clearance was obtained for the study. For a range of axial length measurements between 22-26mm for power of 80%, a total minimum sample size as determined by statistician was 63 eyes for 5% level of significance. The formula, Hypothesis testing of two means was used to calculate the sample size.

All the patients above the age of 40 years who were to undergo cataract surgery were screened for inclusion in the study. Those with any ocular condition which prevented good visual outcome like macular pathology, , patients with astigmatism of more than 1D, corneal scars, previous ocular surgery, complicated cataract due to uveitis, trauma & silicone oil, ocular conditions in which partial coherence interferometry was not able to calculate IOL power, intraoperative complications like posterior capsular tear were excluded from the study. Axial length measurements between 22-26 mm were included in the study. In all the patients IOL power calculation was done using both partial coherence interferometry and immersion A-scan. Both the partial coherence interferometry and immersion A-scan axial length was measured by the same ophthalmologist. For immersion A scan keratometry value from automated keratometry was used. IOL power was calculated using SRK /T formula. Post-operative refractive error was aimed within +/-0.5D of emmetropia. The patients were alternatively allotted to Group A (immersion A-scan), Group B (partial coherence interferometry) for choosing the IOL. In 29 eyes partial coherence interferometry was not able to calculate the axial length and was not included in the study. All the patients underwent phacoemulsification through temporal clear corneal incision with a 2.8 mm keratome by a single surgeon under local anesthesia. The IOL was implanted in the capsular bag. Postoperative final refraction was done at 6 weeks. Unaided visual acuity and best corrected visual acuity was assessed. The postoperative refractive error was compared with the predicted refractive error in each biometry method. Statistical analysis was done using SPSS 16.5. Continuous variables expressed as mean (standard deviation). $P < 0.05$ was considered significant.

Results

A total of 94 eyes were included in the study. Group A (immersion A-scan group) had 50 eyes and Group B (partial coherence interferometry) had 44 eyes because 6 patients in Group B cataract surgery got postponed due to coexisting medical problems. The age of the patients ranged from 45 to 87 years. The mean age was 66.83 years with a standard deviation of 8.955 years. Mean age of patients in group A was 65.66 years with a standard deviation of 9.4 years and in group B 68.16years with a standard deviation of 8.32 years. 54% of the patients were males and rest females.

IOL power calculated was in the range of 16.5D to 27.5D in Group A and in Group B the range was from 19 D to 24 D. (Table 1).

Table 1: Range of intraocular lens power in both the groups.

IOL power (Diopter)	Minimum	Maximum	Mean	SD
Group A (Immersion A scan)	16.5 D	27.5D	21.52D	2.10
Group B (partial coherence interferometry)	19D	24D	21.59D	1.27

Postoperatively refractive error was calculated in spherical equivalent. Numerical error was defined as the difference between spherical equivalent and the predicted error. Absolute error was defined as absolute difference between spherical equivalent and the predicted error (Table 2).Group A showed higher positive skewness for both numerical and absolute error as against group B (Table 2). Comparison of the skewness coefficients between the two groups demonstrated a statistically significant difference for both the numerical (z= 2.338, p= 0.01) and absolute error (z=6.269, p<0.001).

Table 2: Comparison between Immersion A scan and Partial coherence Interferometry in terms of numerical error and absolute error.

	Group (A) Immersion A-scan	*Group (B)* Partial coherence interferometry	p- value
Numerical error(Median)	0.09	-0.105	0.132
Range	(-1.03, 1.90)	(-0.75, 0.87)	
Interquartile range	(-0.17, 0.34)	(-0.33, 0.30)	
Skewness coefficient + standard error of skewness	1.148+0.337	0.338+0.357	<0.0001
Absolute error(Median)	0.26	0.2975	0.363
Range	(0.01, 1.90)	(0.01, 0.90)	
Interquartile range	(0.13, 0.42)	(0.14, 0.54)	
Skewness coefficient+ standard error of skewness	2.729+0.337	0.557+0.357	<0.0001

As the data did not follow a normal distribution, a non-parametric test (Mann Whitney -U test) was used for comparison between the groups. P value obtained was (0.256) not statistically significant. In group A 88% of the patients had post op refractive error ≤±0.5 D, 94% had residual refractive error ≤± 1.0 D. In group B 72.7% had residual refractive error of ≤±0.5 D, and no patient had refractive error greater than 1D (Table 3). In our study immersion A scan showed hyperopic shift in (58%) and partial coherence interferometry showed a hyperopic shift in (43.2%).

Table 3: Group wise percentage of eyes that were within ≤±0.5 D, ≤±1.0D, ≤±2.0D of emmetropia.

	≤±0.5 D	≤±1.0D	≤±2.0D
Group (A) (Immersion A scan)	88.0%	94%	100%
Group(B) Partial coherence interferometry	72.7%	100%	100%

Table 4: Showing the results of previous studies and the present study

Study	Formula	≤±1D (US))	≤≤±1D (IOLM)	±2D (US)	≤±2D (US)	SS
Drexler[1] (US&PCI)	SRKII	73%	85%	96.4%	100%	PCI>US
MS Rajan[2] (US&PCI)	SRK/T	80%	87%			Nil
H Eleftheriadis[5] (US&PCI)	Holladay 1	93%	96%			PCI>US
Haigis [9] (US&PCI)	Haigis	86.7%	84.7%	99%	99%	Nil
Loreto[2] (US&PCI)	SRK/T	79%	81%	98%	100%	PCI>US
Present study (US&PCI)	SRK/T	94%	100%	100%	100%	Nil

US- ultrasound, PCI- Partial coherence interferometry, SS-statistical significance

Discussion

The refractive outcomes following phacoemulsification cataract surgery is dependent on a number of factors. They include axial length measurement, keratometry, anterior chamber depth, IOL power formula and quality of IOL. Since predictability of refractive outcomes is based on accuracy of preoperative biometry, the methods used in biometry continue to evolve.

The main limitation with the A scan ultrasound is the poor image resolution

due to use of a relatively long, low resolution wavelength (10MHZ) to measure a relatively short distance.

The newer partial coherence interferometry advanced technology software upgrade (version 5) is designed to enhance signal to noise ratio in order to improve measurement of axial length in eyes with media opacity[7].

In the present study we included patients with age>40 years. However studies done by Loreto T Rose[1], MS Rajan[2], Wolfgang Haigis[9], and Drexler[10] did not have a criteria for age. In the Study by Eleftheriadis[5] they included patients with only age related cataract. Those eyes whose axial length could not be measured with partial coherence interferometry due to dense media opacity were excluded to prevent any bias in refractive error calculation which could affect the postoperative refractive outcome. MS Rajan[2], Eleftheriadis[5] had similar exclusion criteria whereas Loreto T Rose[1], Drexler[10] did not have any exclusion criteria; hence there was a possibility of bias in the final refractive outcomes obtained. In our study in 29 eyes partial coherence interferometry was not able to calculate axial length and was not included in the study. In MS Rajan[2] study failure rate was 8% with partial coherence interferometry. Loreto T Rose[1] did not have any failure rate with partial coherence interferometry. Previous reports have demonstrated a failure rate with partial coherence interferometry which varied from 5 to 15%.[1,2,3,4,6,7,8,9]

In our study the desired postoperative refractive error was aimed at ±0.5D. However this was not done in other studies. In our study all the surgeries were performed by a single surgeon in a standardized manner. Previous studies done by Loreto T Rose[1], MS Rajan[2] Eleftheriadis[5], Drexler[10] were also done in a similar manner. However in the study by Wolfgang Haigis[9] three surgeons performed the surgery and the surgical technique was not standardized. Hence this could have accounted for an error in the final refractive outcome.

In our study Group A showed higher positive skewness for both numerical and absolute error as against group B. Though the axial length was comparable in both the groups the range of IOL power in Group A was +16. 5 D to 27D, where as in Group B the range of IOL implanted, was +19 D to +24 D. We believe the keratometry difference may be responsible for this difference in the IOL range and the skewness of the numerical and absolute error. However we did not analyse the keratometry values separately. In the study by Elftheriadis[5] distribution of the absolute error did not follow the normal distribution.

In the present study postoperative refraction using immersion scan, residual refractive error was ≤± 0.5 D in 88%, ≤±1.00D in 94%, ≤±2.0D in 100%.Using partial coherence interferometry 72.7% were ≤± 0.5 D, 100% were within ≤±1.00D and 100% were ≤±2.0D of emmetropia. This showed that optical biometry was clinically superior to ultrasound to achieve a refractive error closer to emmetropia. Loreto TRose[1] Eleftheriadis[5], Drexler[10] found partial coherence interferometry to be superior to immersion A scan whereas MS Rajan[2], Haigis[9] did not find such difference. Table 4 shows the results of these studies and our study.

Studies done by Loreto TRose[1], MS Rajan[2], Eleftheriadis[5]; Drexler[10] compared applanation ultrasound with partial coherence interferometry. A study done by

LoretoT Rose[1] showed a 35% improvement in absolute postoperative refractive error with partial coherence interferometry compared to applanation ultrasound which was statistically significant. MS Rajan[2] study showed that using mean absolute error there was no statistically significant difference between partial coherence interferometry and ultrasound. This was in concordance with present study.

In the study done by Eleftheriadis[5] retrospective optimization of surgeon factor was done. Mean absolute error of optimized partial coherence interferometry was significantly smaller than that of the optimized ultrasound. With partial coherence interferometry there was an improvement in refractive outcome by 39%. Using ultrasound, postoperative refractive error in 93% were within ≤±1.0D of emmetropia and using partial coherence interferometry 96%were within ≤±1.0D of emmetropia. We did not find such difference between the two groups. Optimization of the surgeon factor was not done in our study.

MS Rajan[2] also demonstrated that eyes that underwent partial coherence laser interferometry had increased tendency for hyperopic shift (65%) when compared to the eyes in ultrasound group (50%). He suggested that this was probably because axial length measured with partial coherence laser interferometry is 100um longer than applanation ultrasound. However this was not seen in the present study. In our study immersion A scan showed hyperopic shift in (58%) and partial coherence interferometry showed a hyperopic shift in (43.2%).

Conclusion

In the present study immersion scan group, 88% of the patients had post op refraction of ≤± 0.5 D, 94%of the patients had refractive correction ≤±1.00D. Using partial coherence interferometry 72.7% of patients had postop refractive error ≤± 0.5 D, 100% were within ≤±1.00D. Differences in absolute postoperative refractive error using immersion scan vs. partial coherence interferometry was not statistically significant. This study showed that both the machines were accurate in calculating intraocular lens power and achieving postoperative refraction with values closer to emmetropia.

References

1. Rose LT, Moshegov CN. Comparison of the Zeiss IOL Master and applanation A –scan ultrasound: biometry for Intraocular lens calculation.Clin Experimental Ophthalmol .2003Apr; 31(2): 121-4.
2. Rajan MS, Keilhorn I, Bell JA. Partial coherence laser interferometry vs. conventional ultrasound biometry in intraocular lens power calculations. Eye (Lond).2002 Sep; 16(5):552-6.
3. Lam AK, ChanR, Pang PC.The repeatability and accuracy of axial length and anterior chamber depth measurement from the IOL master. Ophthalmic Physiol Opt .2001 Nov; 21(6):477-83.
4. Sheng H, Bottjer CA, Bullimore MA. Ocular component measurement using Zeiss IOL Master. Optom Vis Sci. 2004 Jan; 81(1):27-34.
5. EleftheriadiasH. IOL Master biometry: refractive results of 100 Consecutive cases.Br J Ophthalmol.2003 Aug;8(8):960-3
6. Freeman G,Pseudovs K.The impact of cataract severity on measurement acquisition with IOL Master.ActaOphthalmol Scand. 2005Aug; 83(4): 439-42.
7. Lee AC, Qazi MA, PeposeJS.Biometry and intraocular lens power calculation. Curr Opin Ophthalmol.2008, Jan; 19 (1):13-7.

8. PrinzA, NeumayerT.BuehlW, KissB, SacuS, DrexlerW, FindlO. Influence of severity of nuclear cataract on optical biometry.J Cataract Refract Surg.2006 Jul; 32(7):1161-5.
9. Haigis W, Lege B, Miller N ,SchneiderB.Comparison of immersion ultrasound biometry and partial coherence interferometry for intraocular lens calculation according to Haigis. Graefe's Arch Clin Exp Ophthalmol .2000 Sep; 238(9):765-73.
10. DrexlerW, FindlO, MenapaceR, Rainer G, Vass C, Hitzeberger CK, Fercher AF.Partial Coherence interferometry: a novel approach to biometry in cataract surgery. Am J Ophthalmol 1998Oct; 126(4):524-34.
11. Roger.F.Steinert: Cataractsurgery: Published by Elsevier health sciences: 2010; 3rd edition; 33-55.