Research Article

Comparative analysis of axial length measurement using partial coherence interferometry and clinical ultrasound

Abstract

Purpose: To determine axial length measurement using partial coherence interferometry based IOL Master and comparing it with contact a-scan ultrasonography.

Methods: Descriptive cross-sectional study was conducted in Madina Teaching Hospital on 60 patients (Male 36, Female 24) with immature cataract and visual acuity ≤6/24 without any other pathology or previous ocular surgery. Axial length was determined first; using non-contact iol master and then by contact a-scan on same individual. Sample was recruited through non-probability convenient sampling from August 2018 to November 2018.

Results: Paired T-test was applied using latest version of SPSS, according to which correlation coefficient was 0.000 and has a significant relation. Pearson correlation ® was 0.733 which stated a positive strength of association. If the selected independent variable (IOL MASTER) increased by 1, the dependent variable (A-Scan) increased by 0.833 according to regression formula. A mean difference of Instruments i.e. IOL MASTER and A-Scan was 2.0333 and 1.9333 respectively, with the Standard Deviation of 0.35415 and the P value of 0.033 according to 5% level of significance.

Conclusion: IOL MASTER shows more reliability and accuracy as compared to A-scan and has less chances of error due to non-indentation method.

Keywords: ascan biometry, contact biometry, IOL master, ultrasonography

Volume 9 Issue 1 - 2019

Fatima Iqbal,[1] Hashim Ali Khan[2]
[1]School of Optometry, The University of Faisalabad, Pakistan
[2]SEHHAT Foundation Hospital, Pakistan

Correspondence: Hashim Ali Khan, OD, FAAO, SEHHAT Foundation Hospital, Danyore, Gilgit, Pakistan, Email drhashmalikhan@yahoo.com

Received: January 10, 2019 | **Published:** January 31, 2019

Introduction

Cataract is defined as the condition of eye dealing with opacification of lens which results in blur vision. Cataract develops with the precipitation of the degraded protein in the crystalline lens and the lens thus loses its transparency. When new cells grow in the peripheral region; the older cells deposit in the center making the lens non-transparent.[1]

The visual damage caused by cataract cannot be recovered by visual aids and refractive surgeries. The cataract can be removed, undergoing the procedure of cataract surgery. There are many techniques being practiced for extraction of cataract including Extra-capsular cataract extraction, Phacoemulsification, Cool micro incision phacoemulsification, Laser cataract surgery (FEMTO-2). In the developing countries, phacoemulsification is the most preferred procedure. The basic principle, it uses is the ultrasonic waves which travel across the opacified lens and disperse the lens which is then easily extracted.[2]

The preoperative assessment of the cataract involves ocular Biometry as major assessment. Ocular Biometry is the term dealing with the relation of biology and mathematics. The term was invented by Whewell in 1800's. Biometric involves the calculation of intraocular lens power and axial length. Biometric calculations can be influenced by the factors such as corneal power, axial length, lens thickness, refractive media status, anterior chamber depth, keratometric readings and IOL power. Biometry has two types; contact ultrasonography based A-scan and non- contact partial coherence based IOL master.

Contact (A-Scan) is used to determine the axial length for calculating IOL power. A-scan uses a single sound beam of approximate frequency of 10MHz's. The beam is projected from the probe tip and measures the interface between the structures. A-scan measurement has some drawbacks. The measurements are affected by corneal indentation, placement of probe, resolution, incorrect sound velocity, off-axis measurement and incorrect measuring distance. These all factors cause incorrect axial length affecting the refractive outcome. An error of 0.1mm in axial length causes 0.25diopters (D) postoperative error and vice versa. Due to errors caused by A-Scan poor handling, the preferred and accurate method is assumed to be the non-contact method.

Non-contact (IOL-Master) is the advanced method which measures the accurate axial length. The IOL - Master uses the principle of the Partial coherent light beam. The light source used in the instrument is infrared light.[4] Infrared is invisible electromagnetic radiation having the wavelength longer than the visible light. IOL-Master has 5times increased accuracy ranging from 0.10mm to 0.02 mm. Michelson inferometry is used to produce interference fringes by splitting the monochromatic beam of light.[5] One ray of the split beam strikes the moveable mirror and the other strikes the fixed mirror. An interference pattern is produced when the beams are reflected back, making a pair of co-axial infrared light of length 130nm.

Material and methods

Descriptive Cross Sectional Study was conducted at Ophthalmology Department of Madina Teaching Hospital, Faisalabad from August 2018 to November 2018. 60 patients were recruited through non probability convenient sampling method. Study involved individuals with immature cataract reporting outpatient department with visual acuity ≤6/24 and of age group 40-80years with either gender. Any subject having any systemic, ocular disease and surgery were excluded.

All patients of cataract were categorized by using Ophthalmoscope and Slit lamp, and immature cataract patients were added in our study after consent according to declaration of Helsinki. Visual acuity was measured using snellen chart at a distance of 6 meters. Torch examination was done for external examination of adnexa and for internal eye examination and ruling out any other ocular pathology Ophthalmoscopy and Slit Lamp were used. Axial length was measured first using non-contact partial coherence based zeiss 500 IOLMaster and then on same individuals again axial length was obtained using ultrasound based contact a-scan. All measurements were taken thrice in order to avoid error. Comparison was performed for AL (axial length) using SPSS latest version.

Results

Among the total population, age of 50 % subjects was 40-50years, 28.3% in 51-60years and 16.7% respectively in 61-70years, out of which 60% were males and 40% were females (Figure 1).

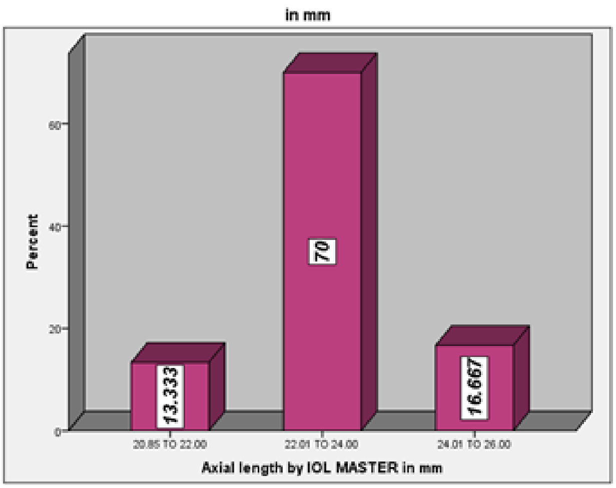

Figure 1 Axial length by IOL master.

Figure 1 shows axial length measured by IOL MASTER was categorized as 20.85 to 22.00mm, 22.01 to 24.00mm, 24.01 to 26.00mm with following percentages; 13.3 %, 70.0 % and 16.7 %.

Figure 2 shows axial length measured by A-Scan by categorizing sample data in 3 sets, i.e. 20.95 to 22.50, 22.51 to 24.50 and 24.51 to 26.50 and their resultant percentages were 15.0 %, 76.7% and 8.3%.

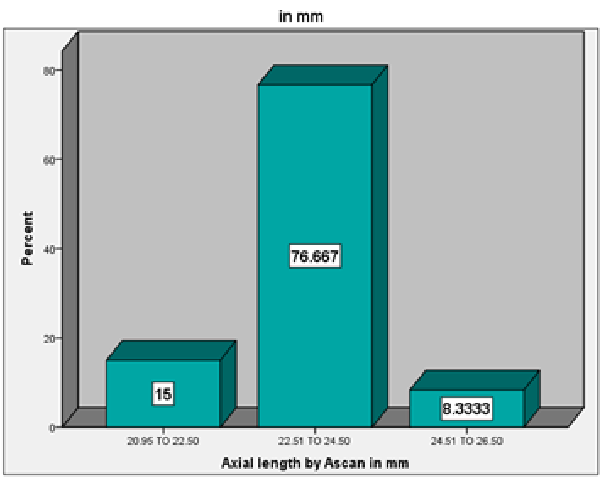

Figure 2 Axial lengths by Ascan in mm.

Figure 3 shows the difference between both instrument readings were compared with the values ranging from 0.01 to 0.08, 0.09 to 0.19 and >0.20mm. According to which 53.3%, 35.0% and 11.7% difference lies in both instruments axial lengths. There is a significant difference between both instruments and is proved by paired sample t-test with a significance value of 0.03 at the level of 5% of confidence interval.

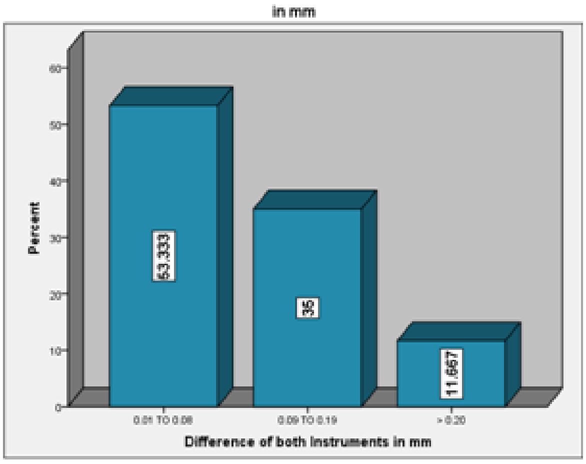

Figure 3 Difference of both instruments in mm.

Discussion

A research was conducted by Saliva et al. in which 10high hyperopic patients underwent cataract surgery. Preoperative keratometric readings were taken. Patients' Biometry was done by IOL Master; surgical technique used was phacoemulsification and foldable lens implantation. Postoperative refraction was performed 40days after surgery. Results showed the mean axial length between IOL MASTER and immersion A-scan ultrasound Biometry was 0.027mm and between IOL MASTER and contact A-scan ultrasound Biometry was 0.05mm.[6] Axial length measured by IOL Master was long and when K-readings were measured by manual Keratometer it was 45.64D and for IOL Master (Zeiss) it was 45.91 D. Mean postop refraction after 40days of surgery was evaluated and i.e. +0.25D in the selected sample. Compared to the postoperative refraction at week 6, the calculated refractive values were higher in Contact A-scan (+0.53D) and lower in two measuring devices: IOL MASTER -2.36D and A-scan: -0.28D.

Another study was conducted in which the refractive outcomes of 155 eyes of 120 patients using the IOL Master were analyzed for phacoemulsification. After analyzing the IOL constants, the prediction error formula, i.e. PE=achieved spherical equivalent - calculated spherical equivalent, was calculated for each eye and then their relation to the axial length of the eye with and without the optical transformation. A keratometry measurement was done by the standard auto keratometer.[7] This was validated in a second group of 90 eyes. According to the results, PE of all but the Haggis triple optimized formula was found to be positively correlated to the axial length. The optical and keratometric alteration statistically significantly reduced this correlation, leading to fewer PE at all axial lengths. PE per millimeter axial length was 0.06D/mm (SRK-T), 0.16D/mm (Hoofer-Q), 0.14D/mm (Holladay I), 0.11D/mm (Haigis single) and -0.02 D/mm (Haigis triple). Following transformation, the best case prediction error was reduced to -0.01D/mm (SRK-T), 0.08D/mm (Hoffer-Q), 0.01D/mm (Holladay I), 0.01D/mm (Haigis single) and -0.01D/mm (Haigis triple). According to results, by changing the

IOL Master measurement into the optical axial length while making amendments in keratometry measurement improved the predictability of outcomes at extreme axial lengths without further modification to the standard IOL formulae.[8]

There was another study conducted by Kunavisarut et al.[9] which showed similar results, i.e. Pearson's correlation® for IOL MASTER was 0.966 and for A-Scan was 0.410, which meant that IOL MASTER is a more reliable instrument as compared to A-Scan. Research was performed on Silicon filled eyes, pre and post refraction were also compared and sample technique they selected were non-randomized with a sample size of 34 eyes (22 males and 12 females) with the age group of 15 to 73years.[9]

Study discussed by Packer et al.[10] elaborates similar results. In this study correlation coefficient of IOL MASTER and Immersion ultrasonography was highly correlated, i.e. 0.996 which is approx. to 1. Which showed the efficiency of IOL MASTER is 4 times higher than A-scan. The sample size was 50 patients who were having cataract and according to analysis, 92% of eyes were within 0.5 diopters of Emmetropia based on immersion axial length measurements.[10]

Prospective study was conducted by Nakhli[11] which has almost similar results to ours. In selecting study cataract patients were selected with the sample size of 68 patients. Samples were tested by IOL MASTER and A-Scan. Comparison, correlation and repeatability of axial length readings were taken with both devices and were analyzed. Results were analyzed and regression formula is used for calculations with the P value <0.001 and difference of both instruments was P=0.031. Results showed that there was strong repetition, i.e. 99.4% and compliance was r =0.987. Which meant that the difference in axial length measurements was present' and is mostly due to hyperopia eyes in both instruments.[11]

Study done by (Goel, et al, 2004), had almost the same results as our study when t-test was applied by different groups of biometrics (expert, intermediate and novice) providing a P value of <0.001.[12] The sample size of this study was 39 patients and each group of biometric user was compared with expert group. The result of this study reveals that using IOL MASTER, readings were more accurate and same in each group of biometrics as compared to A-Scan.[13]

Conclusion

We conducted research on the Estimation of mean axial lengths by IOL MASTER (Non-Contact) and A-Scan (Contact) methods. Our aim of this study was to check the reliability of instruments and to avoid post-operative refractive outcome by taking accurate axial length readings by following instruments. According to our results both instruments are significant and have positive correlation with each other and strong strength of association and both instruments can show great results if worked well because both have the same direction of work. From statistical analyses, we compute that IOL MASTER is a more reliable instrument when compared to A-Scan, as IOL MASTER is non-contact method and there is no indentation of the cornea, which can cause changes in axial length, as in A-Scan which is contact method.

Acknowledgments

None.

Conflicts of interest

Author declare their in no conflicts of interest towards the manuscript.

References

1. Awasthi N, Guo S, Wagner BJ. Posterior capsular opacification. *Arch Ophthalmol*. 2009;127(4):555–562.
2. Epitropoulos A. Axial length measurement acquisition rates of two optical Biometers in cataractous eyes. *Clin Ophthalmol*. 2014;(8):1369–1376.
3. Bai QH, Wang JL, Wang QQ, et al. The measurement of anterior chamber depth and axial length with the IOL Master compared with contact ultrasonic axial scan. *Int J Ophthalmol*. 2008;1(2):151–154.
4. Rajan MS, Keilhorn I, Bell JA. Partial coherence laser interferometry vs conventional ultrasound Biometry in intraocular lens power calculations. *Eye (Lond)*. 2002;16(5):552–556.
5. Khan JH. Research Methodology. New Delhi: SB Nangia; 2008.
6. Sheng H, Bottjer CA, Bullimore MA. Ocular component measurement using the Zeiss IOL Master. *Optom Vis Sci*. 2004;81(1):27–34.
7. Kothari CR. Research Methodology. Methods and techniques. 2nd ed. New Delhi, India: New Age International Ltd; 1985.
8. Hoffer KJ, Shammas HJ, Savini G. Comparison of 2 laser instruments for measuring axial length. *J Cataract Refract Surg*. 36(4):644–648.
9. Kyselova Z. Different experimental approaches in modelling cataractogenesis: An overview of Selenite-induced nuclear cataract in rats. *Interdiscip Toxicol*. 2010;3(1):3–14.
10. Packer M, Fine IH, Hoffman RS, et al. Immersion A-scan compared with partial coherence interferometry. *J Cataract Refract Surg*. 2002;28(2):239–242.
11. Nakhli FR. Comparison of optical Biometry and applanation ultrasound measurements of the axial length of the eye. *Saudi J Ophthalmol*. 2014;28(4):287–291.
12. Goyal R, North RV, Morgan JE. Comparison of laser interferometry and ultrasound A-scan in the measurement of axial length. *Acta Ophthalmol Scand*. 2003;81(4):331–335.
13. Stenström S. Studies on the variation and co-variation of the optical elements of the human eye. *Am J Optom Arch Am Acad Optom*. 1948;25(10):496–504.

Citation: Iqbal F, Khan HA. Comparative analysis of axial length measurement using partial coherence interferometry and clinical ultrasound. *Adv Ophthalmol Vis Syst*. 2019;9(1):11–13. DOI: 10.15406/aovs.2019.09.00334