Benha Journal of Applied Sciences (BJAS) **print : ISSN 2356–9751**
Vol.(4) Issue(2) (2019), xxx-xxx **online : ISSN 2356–976x**
http:// bjas.bu.edu.eg

Comparison of Lenstar Optical Biometry Versus Conventional Ultrasonic Biometry in High Myopic Eyes

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Abstract

High myopia, one of the most prevalent eye diseases worldwide. Accurate preoperative intraocular lens [IOL] power calculation is crucial in achieving satisfactory results. We aimed to compare the Lenstar optical biometry versus conventional ultrasonic biometry in high myopic eyes undergoing cataract surgery concerning the accuracy of IOL power calculation before cataract surgery. This study included 20 high myopic eyes of 20 patients. All patients were subjected to a standardized ophthalmologic examination procedure, optical biometry [Lenstar LS900] and standard A-scan applanation ultrasound biometry [Sonomed]. The Pre operative measurements by the optical and ultrasound biometry; were comparable both devices [P>0.05]. Although not significant, the SRK-T formula predicted the best postoperative refraction with the smallest MAE [0.404 ± 0.22 D in the optical biometry] in comparison to [0.439±0.26 D in the ultrasound biometry. In addition; the Optical biometry showed significantly better accuracy than the ultrasound biometry using the Haigis formula. The SRK-T and Haigis formula showed nearly similar efficacy with the optical biometry, although with the ultrasound biometry, the SRK-T formula showed better performance than the Haigis formula. IOL measurements performed with the optical biometery Lenstar LS900, yielded better IOL power prediction and therefore better refractive outcome in cataract surgery than US biometry in high myopic eyes.

Keywords: High myopia, Optical biometery**,** Ultrasound biometry**.**

1.Introduction

High myopia, one of the most prevalent eye diseases worldwide, has a higher risk of occurrence than other eye diseases. High myopia is associated with the elongation of axial length [AL]. Studies have shown that the incidence and progression of cataract among those with high myopia were significantly higher and faster than those with nonmyopic eyes. At present, patients with high myopia and cataract were often treated with cataract phacoemulsification [1].

The prediction of refractive outcomes after cataract surgery has steadily improved, with more recent intraocular lens [IOL] power formulas generally outperforming those of prior generations. Yet there is still considerable debate about which formula provides the most accurate refractive prediction. Because no single formula has been shown to be highly accurate across a range of eye characteristics, some authors have suggested that cataract surgeons should use different formulas for eyes of varied ocular dimensions [2].

We aimed to compare the Lenstar optical biometry versus conventional ultrasonic biometry in high myopic eyes undergoing cataract surgery concerning the accuracy of IOL power calculation before cataract surgery.

2.Patients and methods

Twenty high myopic eyes with cataract were included in this observational, cross-sectional clinical study. Patients were recruited from patients scheduled for phacoemulsification and IOL implantation attending the Ophthalmology department, Benha University, Egypt.

2.1Inclusion criteria

- Patients with high myopic eyes with spherical equivalent [SE] greater than or equal to −6 D and or AL greater than or equal to 25.0 mm
- Eyes with significant cataract suitable for phacoemulsification and primary in-bag implantation of posterior chamber IOL
- Cataract as the only ophthalmic pathology causing significant visual impairment
- Patient's willingness to comply with scheduled visits and other study procedures.

2.2Exclusion criteria

- Presence of other ophthalmic pathology causing visual impairment, such as amblyopia, glaucoma, optic neuropathy, age-related macular degeneration, macular edema, retinal detachment, proliferative diabetic retinopathy, or ocular inflammation
- Previous intraocular or corneal surgery [including refractive surgery]
- Corneal opacities or irregularities: previous scarring, dystrophy, and ectasia
- Uncontrolled diabetes mellitus with ocular manifestations
- Any neurological condition, which may interfere with performance of required tests.

2.3Surgical exclusion criteria

Patients were excluded from the study when the following complications were encountered during surgery:

- Inability to achieve secure 'in-the-bag' placement of the IOL [i.e., due to posterior capsule rupture, radial tear in capsulorhexis, vitreous loss, or zonular rupture]
- Use of corneal sutures
- Multiple operative procedures at the time of IOL implantation.

The study patients were informed about the purpose of the study and had given an informed consent before inclusion. Data collection was conformed to all local laws and was compliant with the principles of the Declaration of Helsinki. The study was approved by the Ethics Committee of Ophthalmology Department, Benha University.

All the patients subjected to History taking and Ocular Examination; Anterior Segment examination including Ocular motility and orbit examination, slit lamp biomicroscopy, eye lid, conjunctiva, drainage system, cornea and crystalline Lens examination and applanation tonometry and posterior Segment examination.

The pre-operative evaluation; all patients were subjected to a standardized ophthalmologic examination procedure comprising Snellen visual acuity test, dilated pupil ophthalmoscopy at the slitlamp, optical biometry [Lenstar LS900, Haag-Streit Koeniz, Switzerland] and standard A-scan applanation ultrasound biometry [Sonomed, PACSCAN 300A, USA].

Axial length and IOL power calculation were obtained with the LS900 biometer, followed by ultrasound biometry on the same day, consecutively by the same investigator. 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. Optical biometry was performed with the patient seated at the LS900 biometer and asked to fixate on the fixation target. Standard A-scan applanation ultrasound biometry was performed after instillation of one drop of surface anesthetic [benoxinate hydrochloride 0.4%] on the lower conjunctiva.

2.4 Preoperative measurements and postoperative outcomes

Axial length, average keratometry-readings [K], anterior chamber depth [ACD], implanted IOL power, actual postoperative spherical equivalent [SE[, mean absolute error [MAE] of Haigis and MEA of SRK‑T.

2.5 Lens Opacities Classification System

Type and severity of cataract were evaluated using LOCS III grading system, evaluating the opacity of the lens with respect to nuclear colour [NC, score 0 to 6], nuclear opalescence [NO, score 0 to 6], cortical cataract [C, score 0 to 5] and posterior subcapsular [P, score 0 to 5] cataract [Chylack et al. 1993]. Each parameter was assessed subjectively at the slitlamp by one examiner and documented in the case report forms.

2.6 Keratometry

Keratometry-readings [K] was obtained by an automated eratometer [Nidek Co. Ltd] and used by the A-scan ultrasound in IOL power calculation.

2.7 Biometry

Standard A-scan applanation ultrasound biometry [Sonomed, PACSCAN 300A]

Five AL measurements were obtained by applanation ultrasonography and a mean of at least three valid measurements were used as the AL. In SO-filled eyes, the velocity of the beam was changed to 980 m/s to eliminate the magnified AL induced by the presence of SO. Measurements were taken with the patient sitting upright and the transducer held so that the ultrasound beam was perpendicular to the globe. This position helps in keeping any fluid downwards and silicone in touch with the central retina so that no pocket of fluid can affect the measurement taken.

2.8 The optical biometry [Lenstar 900]

The length measurements were performed using optical coherence technology with a super luminescent diode as light source. Measurement of axial length along the visual optical axis is performed while the device controls the stable fixation. Four complete measurements were performed in each eye and analysed with the LS900 device.

2.9 Statistical analysis

Data were collected and entered to the computer using SPSS [Statistical Package for Social Science] program for statistical analysis [Chicago,Inc, Illinose, program for statistical analysis] version 18. Data were entered as numerical or categorical, as appropriate. Quantitative data were shown as mean, SD, and range. Qualitative data were expressed as frequency and percent. Chi- square test was used to measure association between qualitative variables. Student t- test and Mann Whitney U test were done to compare means and SD of 2 sets of quantitative data as appropriate. Paired sample t- test was done to assess the follow up of 2 sets of quantitative data. The results of comparing the correlation between two continuous variables were indicated by the correlation coefficient [r] using correlation analysis. P [probability] value will be considered to be of statistical significance if it is less than 0.05.

3.Results

This study included 20 high myopic eyes of 20 patients, of which 15 [75%] females and 5 [25%] males. Thirteen [65%] eyes were left sided and 7 [35%] eyes were right sided. The mean age of was 46.8 ±11.3 years [range, 28 to 72 years].

Mean k1 reading of the patient was [43.14±2.07] Diopter with minimum k 37.07 D and maximum k 46.65 D. Mean k2 reading of the patient was [45.22±3.76] Diopter with minimum k 38.26 D and maximum k 53.58 D.

Preoperative measurements of the Optical biometry [Lenstar LS900]; The mean AL was 28.75 ± 1.69 mm [range, 26.34 to 32.43 mm]. The mean ACD was 3.59 ± 0.3 mm [range,3.01 to 4.32 mm]. The largest spherical equivilant was in the SRK-T formula [-0.571 ± 0.32 D], the followed by those of the Haigis formula [-0.497 ± 0.32 D].

Preoperative measurements of the ultrasound biometry [Sonomed, PACSCAN 300A]; The mean AL was 28.74 ± 1.7 mm [range, 26.23 to 32.38 mm]. The mean ACD was 3.51 ± 0.31mm [range,2.97 to 4.24 mm]. The mean ACD was 3.59 ± 0.3 mm [range,3.01 to 4.32 mm]. The largest spherical equivilant was in the SRK-T formula [-0.536 ± 0.35 D], followed by those of the Haigis formula [-0.354 ± 0.24 D].

On Comparison of the Pre operative measurements of the optical and ultrasound biometry; Our results revealed that there was no statistical significant difference between both devices concerning the pre-operative measurements [P>0.05].

The mean power of implanted IOL was 5.4±5.15 D [range, -2to 14 D]. The mean actual postop.refraction was -0.975± 0.21 [range from -1.25 to -0.5 D].

Of the preoperative measurements, the K reading was the significant risk factor determining the post-operative SE, there was a significant negative correlation between the K readings and the SE [r = -0.519, P = 0.019] for K1 and [r = -0.609, P = 0.004] for K2, while the other parameters showed no significant correlation.

There was significant post-operative improvement in the visual acuity [P <0.0001], with the mean improvement of the visual acuity of the patient was 0.55 ± 0.15.

On Comparing the MAE of the optical and ultrasound biometry,

Our study showed that the SRK-T formula predicted the best postoperative refraction with the smallest MAE in the optical and the ultrasound biometry, followed by those of the Haigis formula. In addition the MAE of the Haigis formula was significantly lower in the Optical biometry than the ultrasound biometry [P <0.05] Table (1).

On comparing the efficacy of each formula within the optical biometry the SRK-T and Haigis formula were comparable [P> 0.05] Table (2). While within the ultrasound biometry, the SRK-T was significantly better than the Haigis formula [P< 0.05] Table (3).

The proportion of MAE ≤ 0.5 D by SKR-T formula was equal by the optical and ultrasound biometry [65%]. While by the Haigis formula 65% of the cases was ≤ 0.5 D by the optical biometry in comparison to 45% by the ultrasound biometry.

On assessing the probable sources of error of different formulas in the optical and ultrasound biometry, we found a significant positive correlation between the AL and MAE by the SRK-T formula in the optical biometry [r = 0.561, P = 0.01]. while in the ultrasound biometry, there was a significant positive correlation between the AL and the MAE [r = 0.732, P = <0.0001] and a significant negative correlation between the IOL power and the MAE[r = -0.491, P = 0.028] by the SRK-T formula, and a significant negative correlation between the ACD and the MAE[r = -0.645, P = 0.002] by the Haigis formula.

Table (1) Comparison of the MAE of the optical and ultrasound biometry.

	Optical biometry N=20	**Ultrasound biometry N=20**	**Mannwhitney U test**	**P-value**
	Mean±SD [range]	**Mean±SD [range]**		
MAE SRK-T	0.404±0.22 [-0.82 - -0.05]	0.439±0.26 [-0.85 – 0.05]	0.602	0.277
MAE HAIGIS	0.477±0.27 [-0.91 - 0.05]	0.621±0.20 [-1.1 - -0.35]	3.22	0.002*

Table (2) The MAE of the different formulas of the optical biometry.

Optical biometry	**SRK-T N=20**	**HAIGIS N=20**	**Mannwhitney U test**	**P-value**
	Mean±SD [range]	**Mean±SD [range]**		
MAE	0.404±0.22 [-0.82 - -0.05]	0.477±0.27 [-0.91 - 0.05]	1.028	0.304

Table (3) The MAE of the different formulas of the ultrasound biometry.

Ultrasound biometry	**SRK-T N=20**	**HAIGIS N=20**	**Mannwhitney U test**	**P-value**
	Mean±SD [range]	**Mean±SD [range]**		
MAE	0.439±0.26 [-0.85 – 0.05]	0.621±0.20 [-1.1 - -0.35]	4.58	0.001*

4.Discussion

With the improvement in surgical techniques and biometry devices, cataract surgery is now considered a form of refractive surgery. Accurate preoperative intraocular lens [IOL] power calculation is crucial in achieving satisfactory results [3].

The Pre operative measurements by the optical and ultrasound biometry; AL, ACD, SE by both the SRK-T and Haigis formulas, were nearly comparable by both devices [P>0.05].

Wang et al., 2016 assessed the AL for 49 high myopic eyes with the Lenstar LS 900 [ver. 2.1.1, Haag-Streit AG, Koeniz, Switzerland], and A-scan ultrasound biometry device [UltraScan, Alcon, USA]. AL for Lentestar was 26.74±2.04 mm and AL for US biometry was 26.49±1.98 mm. The Mean interdevice differences [Ultrasound-Lenstar] in IOL power calculation based on SRK II formula was -0.63±0.33 D [P <0.0001] [4].

On comparing the efficacy of the optical and ultrasound biometry; although not significant, the SRK-T formula predicted the best postoperative refraction with the smallest MAE [0.404 ± 0.22 D in the optical biometry] in comparison to [0.439±0.26 D in the ultrasound biometry. In addition; the Optical biometry showed significantly better accuracy than the ultrasound biometry using the Haigis formula, MAE [0.477 ± 0.27 D in the optical biometry] and [0.621±0.20 D in the ultrasound biometry].

The accuracy of biometric measurements is higher for optical methods than for ultrasonic methods. In ultrasound biometry [UB], there are more operator-dependent factors that are not present with optical methods. The development of optical devices indicates that UB will be used only given specific indications [5].

UB remains the preferred method for IOL calculation in dense cataracts. Applanation ultrasound remains a common method to measure AL worldwide, especially in developing countries due to familiarity with the technique and cost. Another advantage of the applanation method is the faster measurements in the hands of a skilled operator [6].

One of the most important sources of refractive surprise in UB is the pressure on the cornea during measurement that may result in shorter AL measurements. Even when a single doctor takes all the measurements, its result is myopic shift [7].

Optical biometry is the most commonly used method for IOL calculation; it uses keratometry measurements and thus obviates the need for a second instrument. The advantages of OB over applanation are the lack of risk of trauma or infection, increased patient comfort and improved accuracy and repeatability of measurements [8].

Several studies evaluated the accuracy of various IOL power calculation formulae used optical and ultrasound biometry data obtained from assessments of eyes with long AL with different results.

In our study; the SRK-T and Haigis formula showed nearly similar efficacy with the optical biometry [0.404±0.22, 0.477±0.27 respectively], although with the ultrasound biometry, the SRK-T formula showed better performance than the Haigis formula [0.439±0.26, 0.621±0.20 respectively].

Zhou et al., 2019 studied the accuracy of the refractive prediction determined by intraocular lens power calculation formulas in high myopia using the LENSTAR LS900 and agreed with our results that the SRK/T and Haigis formulas arrived at similar MAE, [SRK/T 0.46±0.39, Haigis 0.45±0.38] [9].

Variations in keratometers, ultrasound machine settings and surgical techniques [such as the creation of the capsulorrhexis] can all have an impact on the refractive outcome.

The MAE value of SRK/T formula was positively correlated with AL in both the optical and ultrasound biometry, while the MAE of the Haigis formula not correlated with the AL. Therefore, in clinical treatment, we can measure the AL of the patient's eye preoperatively by appropriate prediction formula to reduce the refractive error absolute value and improve the clinical treatment effect of patients with high myopia.

In agreement with our results, Zhou et al., 2019 stated that AL measuring affecting the prediction error in IOL calculations. In his study, the accuracy of each formula under different ALs was analyzed. His study showed that the MAE of SRK/T formula was less when the AL was between 24.5 and 30 mm in comparison to that calculated by Haigis formula; while when the AL was greater than 30 mm, the MAE of Haigis formula was less [9].

With the ultrasound biometry, the ACD negatively correlated with the MAE [$r = -0.645$, $P = 0.002$] by the Haigis formula.

Olsen, 2007 on studying the effect of ACD on the choice of IOL calculation formula, he concluded that; the reported contribution to error from ACD, AL, and corneal power is 42, 36, and 22%, respectively. Therefore, one of the main causes of residual refractive error with IOL formulas is neglecting the role of the ACD [10].

5.Conclusion

IOL measurements performed with the optical biometery Lenstar LS900, yielded better IOL power prediction and therefore better refractive outcome in cataract surgery than US biometry in high myopic eyes. The SRK-T formula showed better performance than the Haigis formula.

6.References

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