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Accuracy of The SRK/T Formula Using Partial Coherence Interferometer, AL-Scan after Phacoemulsification

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ABSTRACT

Purpose: To evaluate the accuracy of SRK/T formula used for IOL power calculation by partial coherence interferometer in patients undergoing phacoemulsification surgery.

Patients and methods: A prospective interventional clinical study included 40 eyes of 34 patients who underwent uncomplicated phacoemulsification with IOL implantation from March 2015 to March 2017. Biometries were measured using ultrasound or AL-scan and intraocular lens power was calculated using the SRK-T formula. Patients were divided into 2 groups based on device used for IOL power calculation: AL-scan or ultrasound ; Axial length: >=25 mm or < 25mm; or lens opacity: Cataractous or clear lens. The mean error (ME) was calculated from the difference between the formula predicted refractive error and the actual post operative refractive error by the end of the followup (3 months postoperative).

Results: Mean axial length measured preoperatively was 27.47 ± 316mm (21.55-34.05) mm. 60 percent of the patients were within 0.5 D of the predicted refractive error and 90 percent were within 1.0 D. There was no statistically significant difference in the overall performance of the SRK/T formula between the mean error when dividing the patients into 2 groups according to: device used for IOL power calculation (P= 0.274); Axial length (P= 0.46); or lens opacity (P= 0.18) in precision of predicting postoperative refraction.

Conclusions : SRK/T formula helps in improvement of the accuracy of IOL power calculation and decreasing the postoperative refractive error. By using SRK/T formula, there was no statistically significant difference between the AL-scan or applanation ultrasound used in biometry.

Keywords: Partial Coherence Interferometer, biometry, AL-scan, Ultrasound, IOL power, SRK/T formula.

INTRODUCTION

Over the years, development of biometry, phacoemulsification, and intraocular lens (IOL) calculation enabled precise prediction of postoperative refraction [(1)].

The parameters needed for accurate IOL calculation including: Axial length (AL), corneal refractive power (K1 and K2), and anterior chamber depth (ACD), must be precisely measured to determine the correct IOL power to achieve the target refraction [(2)].

Intraocular lens (IOL) power calculation formulas have been evolving since 1949 when the first IOL into a human eye was implanted [(2)]. Various theoretical and regression formulas are available for calculation of IOL power. Third- and fourth-generation formulas are now the most preferred formulas. The SRK/T is one of the third-generation formulas that was representing a combination of linear regression method with a theoretical eye model [(3)]. Ultrasound (US) biometry (A-Scan) had been considered the gold standard for axial length and ACD measurement. The partial coherence interferometer (PCI)-based IOLMaster (Carl Zeiss Meditec AG, Jena, Germany) was introduced in 1999 followed by other instruments with continuous modifications in biometry [(4)]. Little is known about the accuracy of the devices for IOL power calculation, with the exception of the IOLMaster , which was the first to be marketed, and the Lenstar LS900 [(5)].

The PCI AL-scan (Nidek, Gamagori, Japan) using PCI and Scheimpflug imaging techniques made it possible to measure axial length, corneal refractive power, anterior chamber depth, central corneal thickness, white-to-white distance, and pupil size in a single sitting based on those values and automatically calculates the appropriate IOL power to be used in cataract surgery by onboard software [(1)]. The purpose of this study is to evaluate the accuracy of SRK/T formula used for IOL power calculation by the PCI AL-scan in patients undergoing phacoemulsification surgery .

PATIENTS AND METHODS

A prospective, comparative study was carried out at Al-Zahraa university hospital from March 2015 to

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March 2017 and included 40 eyes of 34 patients. The study adhered to the tenets of the Declaration of Helsinki and was approved by the ethical board of Al-Azhar university and informed written consent was taken from each participant in the study. Patients scheduled for phacoemulsification, Routine pre-operative ocular examination was done.

Inclusion criteria were, patients with cataract of any type or with clear lens, normal anterior and posterior segment; uneventful surgery with "in the bag" monofocal IOL implantation in all patients. Patients with history of intraocular operation, inflammation, retinopathy, severe corneal degeneration, corneal opacity, vitreous pathology, developmental and acquired macular diseases were excluded. Biometry by AL-scan (Nidek Co. Ltd., Gamagori, Japan) used in 25 eyes. Axial length, anterior chamber depth, and corneal refractive power were measured by the AL-scan. In 15 eyes; the applanation ultrasound (Mentor ^{R} Advent ^{TM} A/B System) was used to obtain anterior chamber depth and axial length. Corneal refractive power was measured by handheld automated keratometer (KM-500, NIDEK, Aichi, Japan). Calculation of the IOL power to be implanted was done using SRK/T formula. and the A-constant was maintained at 118. The predicted refraction value targeted myopia; (-0.5 to -1). All patients underwent uneventful phacoemulsification surgery with a standard technique. An incision and side-port paracentesis were made. Ophthalmic Viscoelastic Device (OVD) was injected into the anterior chamber and a Continuous Curvilinear Capsulorrhexis (CCC) was created. Hydrodissection was done with Balanced Salt Solution (BSS). This was followed by phacoemulsification, aspiration of cortex and implantation of the foldable posterior chamber IOL using the recommended injector system or implantation of PMMA 5mm IOL after enlarging the wound to 5.5 mm. The OVD was subsequently removed and surgical wounds were hydrated with no sutures in 3.2 mm wound or were applied or closed by one stitch for the 5.5 mm incision. All wounds were checked for leakage. Subconjuctival gentamycin and dexamethasone injections were given at the end of surgery. All the patients were examined at 1 day, 1 week, 1 month and 3 months postoperatively and the stitch removed when indicated. The actual postoperative spherical equivalence (SE) was recorded 3 months following the surgery. The mean numeric error (MNE) is calculated as: formula predicted postoperative refraction – actual postoperative refractive error by the end of follow up. The absolute value of MNE is the MAE.

Statistical analysis was performed using Statistical Package for the Social Sciences software (SPSS 11.01) with A p-value of less than 0.05 indicated statistical significance. Comparison between each two groups was analyzed by using the t-test.

RESULTS

A total of 34 patients and 40 eyes were included in this study. The mean age was 43.7 (23-63) years. 26 were cataractous and phacoemulsification was done for refractive purpose in 14 eyes (Myopic anisometropia or bilateral high myopia not met the criteria for LASIK). The mean AL, mean K reading are shown in Table (1)

Table 1: Demographic data of 40 eyes underwent phacoemulsification surgery with in-the-bag placement of IOL implant.

	Range	**Mean ± SD**
Age (years)	23 - 63	43.7 ± 12.03
Axial length (mm)	21.55 - 34.05	27.47 ± 316
Keratometry (KV)	40.75 - 47.75	44.59 ± 1.9
Keratometry (KH)	41.21 - 46.94	44.09 ± 1.54

The mean numeric error (MNE) (actual postoperative refractive error minus refractive target) ranged from −1.38 D to +1.34 D. The mean error was -0.08 ± 0.61 D. The majority of patients (90%) were within 1 D of the predicted refractive error (Table 2)

Table 2: Difference between the actual and predicted refractive errors and variance of outcome of spherical equivalence.

Difference Between actual and predicted refraction (D)	**No. (%)**
Within ± 0.25 D of predicted refractive error	14 (35%)
Within ± 0.5 D of predicted refractive error	24 (60%)
Within ± 1.0 D of predicted refractive error	36 (90%)
Within ± 1.5 D of predicted refractive error	40 (100%)

Post operative MNE in the AL-scan group was not statistically significant different from that of ultrasound group; P= 0.274, also there was no statistically significant difference when dividing the patients according to AL (Long AL >=25 mm, medium AL <25mm); P= 0.46, or according to lens opacity either clear or cataractous lens; P= 0.18 (Table 3).

Table 3. Refractive results: comparison each 2 groups.

		Mean numerical error (MNE) (D)	P-Value
Biometry Method Used	AL- scan	-0.158 ± 0.58	P= 0.274
	applanation ultrasound	0.06 ± 0.63	
Axial Length	>=25 mm	-0.11 ± 0.67	P= 0.46
	< 25mm	0.18 ± 0.35	
Lens Opacity	Cataract	-0.17 ± 0.56	P= 0.18
	Clear lens	0.10 ± 0.67	

DISCUSSION

Accurate biometric data are essential for achieving good surgical outcomes and patient satisfaction after cataract and refractive surgery. Third- generation formulas such as the Holladay 1, the Hoffer Q, and the SRK/T; fourth-generation formulas such as the Holladay 2, the Haigis, and the Olsen; and newer formulas are the most commonly used in all eyes [3]. Different studies to evaluate the predictive accuracy of various IOL power calculation formulas; Wang et al. [6] showed similar performance of the Haigis, Hoffer Q, Holladay1, and SRK/T in medium eye length, in another study SRK/T and Haigis performed equally well and outperformed the Hoffer Q and Holladay 1 in 34 eyes between 25 and 28mm [7]. A study consisting of more than 300 long eyes, demonstrated the performance of the SRK/T better than the Holladay 1 and Hoffer Q for AL more than 27mm [8].

In this study by using the SRK/T formula, the mean numeric error ranged from −1.38 D to +1.34 D. The mean error was -0.08 ± 0.61 D. The majority of patients (90%) were within 1 D of the predicted refractive error (Table 2). These results were similar to the study done by **Karabela *et al.*** [3] with a prediction accuracy of 38.66% for refractive errors of 0.25D, 69.51% for refractive errors of 0.50D, and 93.87% for refractive errors of 1.00D. **Lagrasta *et al.*** [9] showed a prediction accuracy of 55% for refractive error within 0.50D, and 91% for refractive error within 1.00D using SRK/T formula with US biometry in 33 eyes of 33 patients with medium ALs (22.2–24.5 mm).

Among the factors needed for accurate IOL calculation, **Olsen** [10] reported that axial length plays a main role in determining postoperative refraction and is responsible for 54% of the actual refractive error. AL error of 100 μm translates to a postoperative refraction error of 0.28 D. US biometry (A-Scan) had been considered the gold standard for axial length and ACD measurement. Many studies have reported the accuracy of the PCI biometer when compared with traditional ultrasound biometry [11,12]. Conversely, there are studies reporting similar precision between those two methods [1,13]. This study also has shown no significant difference in MAE when biometry was done by AL-scan or ultrasound. **Rajan *et al.*** [14] conducted a prospective study in 100 patients and found that 87% of patients were within 1.00D in their PCI group as compared to 80% in the US group (P 0.24).

To compare precision in predicting postoperative refraction by the axial length, we divided the patients into two groups based on axial length above and below 25 mm. Analysis performed by these groups revealed no significant difference in precision between the two groups (P= 0.46). **Hoffer** [15] examined the mean absolute error in 317 eyes using the SRK/T, Holladay I, Holladay II, and Hoffer-Q formulas and he found that the SRK/T formula showed a trend toward the lowest mean absolute error in medium long (24.5–26.0 mm) and very long (>26.0 mm) eyes. Also **El-Nafees *et al.*** [16] reported that the ME was 0.17 D for eyes using SRK/T with ALs greater than 25 mm. Another study reported that the majority of eyes (94.74 %) for short ALs < 22.0 mm and (70.97 %) for long ALs ≥24.6 mm were within ±1 D of the predicted refractive error by using SRK/T formula [17].

For comparison of refractive outcome between cataractous lens and that of clear lens, we did not found statistically significant difference between both groups. This in contrary to other study in which biometry prediction was more accurate in refractive

lens exchange group than cataract group (0.17 ± 0.27 D versus 0.40 ± 0.58 D; $p < 0.001$) [18].

In the current study, SRK/T formula works well accurately, and IOL calculations made with the AL-scan were nearly similar in predicting postoperative refraction compared to that of using the applanation ultrasound, although applanation ultrasound was preserved when measurements by AL-scan biometry was inadequate due to dense ocular media as in dense posterior capsular opacity or poor fixation. Also SRK/T formula is precise in predicting postoperative refraction in different axial lengths.

CONCLUSION

SRK/T formula helps in improvement of the accuracy of IOL power calculation and decreasing the post operative refractive error. By using SRK/T formula, there was no statistically significant difference between the AL-scan or applanation ultrasound used in biometry.

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Conflicts of interest

There are no conflicts of interest.

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