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Accuracy of Biometric Formulae (Hoffer Q and SRK/T) in Hypermetropic Patients undergoing Cataract Surgery by Phacoemulsification

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ABSTRACT

Background: In eyes with significant hyperopia, where attaining precise surgical refractive outcomes may be particularly problematic, the predictive efficiency of the formulas falls.

Aim of work: The goals of this research were: (1) To determine how well the individual can see after having cataract operation in hyperopic persons utilizing the IOL master (Carl Zeiss Meditec, Inc., Dublin, CA, USA) & the Topcon RM-8000B, and (2) To contrast the prediction error of two biometric equations (Hoffer Q and SRK/T).

Methods: Our study was an observational clinical study (analytical cross-sectional). 180 eyes from 180 patients of both sexes with axial length below 22 mm were recognized from individuals performing cataract surgery by phacoemulsification at Ophthalmology Department, Faculty of Medicine, Suez Canal University. A sample of cases was chosen & divided into two groups, each including 90 eyes. One group used Hoffer Q formula (n= 90) and the other group used SRK/T formula (n= 90). Biometry was performed on all participants utilizing the intraocular lens (IOL) master. Each participant had one of their eyes chosen at random. Errors in prediction were computed by comparing preoperative refraction with the refraction measured after surgery utilizing the improved formulae (Hoffer and SRK/T).

Results: Our findings also revealed that the Hoffer Q formula is not with greater precision than SRK/T formula in refractive outcome in hypermetropic patients undergoing cataract surgery as there was no significant variation among them in refractive outcome.

Conclusion: Hoffer Q formula is not superior in terms of accuracy to SRK/T formula in refractive outcome in hypermetropic patients undergoing cataract surgery as there was no significant distinction among them in refractive outcome.

Keywords: Hypermetropia, Hoffer, SRK/T, Cataract.

INTRODUCTION

There is a decrease in the formulas' predictive effectiveness in eyes with substantial hyperopia, when correct operative refractive outcomes can be hard to achieve **(1).**

The Holladay & SRK/T equations indicate a linear connection among axial length (AL) as well as anterior chamber depth, which could not be true in tiny eyes, which is one of the numerous reasons that lead to inferior performance in hyperopia **(2).**

The Hoffer Q, which suggests a correlation among axial length & anterior chamber depth, is thought to be more reliable in very hyperopic individuals. The National Institute for Health and Care Excellence (NICE) has superseded the advice of organizations such the Royal College of Ophthalmologists (RCOphth), it found that people whose AL was less than 22 mm benefited more from the Hoffer Q **(3, 4).**

The purpose of this research was to contrast the prediction inaccuracy of the Hoffer Q along with the SRK/T biometric formulas utilizing the IOL master & the auto refractometer Topcon (RM-8000B) to assess the visual acuity of hyperopic persons following cataract removal.

PATIENTS & METHODS

The research was an observational clinical study (analytical cross-sectional). 180 eyes from 180 patients of both sexes with axial length under 22 mm for cases that need phacoemulsification for cataract removal at

the Ophthalmology Department, Faculty of Medicine, Suez Canal University.

Exclusion criteria:

Patients with corneal abnormalities, history of intraocular inflammation, previous intraocular operation or trauma, preoperative pupil dilatation less than 4 mm, axial length above 22 mm or complications were excluded.

Selected cases were split into two separate groups of 90 eyes in each. One group used Hoffer Q formula (n= 90) and the other group used SRK/T formula (n= 90). All subjects did biometry using IOL master & IOL implantation. Each participant had one of their eyes chosen at random. Errors in prediction were determined by comparing preoperative refraction with the refraction measured after surgery utilizing the improved formulae (Hoffer and SRK/T).

Ethical Approval:

The trial was given approval by the Ethics Board of the Ophthalmology Department of Faculty of Medicine, Suez Canal University (IRB# 6476/17-5-2022). The participants were given all of the relevant details about the examination. A reported consent form was signed by each participant in the

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research. The Code of Ethics of the World Medical Association (Declaration of Helsinki) was followed in this human participant study.

Statistics/data analysis

Mean & standard deviation (SD), median, and range have been employed to describe numerical data. Percentages and frequencies were utilized to represent qualitative data. The Shapiro-Wilk test & The Kolmogorov-Smirnov test were utilized to verify normality of the numerical data. When investigating the connection between qualitative parameters, we employed the Chi-square test (Fisher's exact).

Anova's repeated-measurement test for normally distributed data or Friedman's test for non-normally distributed data was used to compare the mean error between the four types of equations. The 0.05 threshold was chosen as the degree of significance. There were no one-sided exams.

The information was entered into a computer and evaluated statistically with SPSS (Statistical Package for the Social Sciences) version 26. The Shapiro-Wilk test was utilized for checking if the data followed a normal distribution. Statistics were summarized as mean & standard deviation. Parametric and non-parametric quantitative variables were tested for significance utilizing the Student T test to determine distinctions among groups. The variation is statistically significant if the P-value ≤ 0.05.

RESULTS

All demographic data were summarized in table (1). The expected error by the 2 formulae were calculated in our study and it was -0.0097 ± 0.112 by Hoffer Q, while was 0.0180 ± 0.115 by SRK/T (Table 2). When comparing them there was no significant variance. The mean error (ME) after 4 weeks follow up was 0.30 ± 0.57D in group A used Hoffer Q and it was 0.32 ± 0.49 D in group B used SRK/T. There was no statistically significant variance amongst the 2 formulae (Table 3). The mean error after 6 weeks follow up was 0.27 ± 0.78 D in group A used Hoffer Q and it was 0.28 ± 0.74 D in a group B used SRK/T.

There was no significant variation among the two formulae (Table 4). Our findings also revealed that the Hoffer Q formula was not more accurate than SRK/T formula in refractive outcome in hypermetropic patients undergoing cataract surgery as there was no significant distinction among them in refractive outcome. The mean error difference was 0.28 ± 0.79 D in the group used Hoffer Q & it was 0.27 ± 0.73 D in a group used SRK/T (Tables 5-12).

Table (1): Demographic Data of each group

Variable		Group A	Group B
Sex	Male	55	58
	Female	35	32
Eyes	Right	49	42
	Left	41	48
Axial length	21mm-21.9mm	52	49
	20mm-20.9mm	32	33
	19.5-19.9mm	6	8

Table (2): Mean predicted error by both groups

Variable	Group A	Group B	P value
Expected, mean ± SD	-0.0097 ± 0.112	0.0180 ± 0.115	0.351

Student t test, *p is significant at below 0.05

Table (3): Absolute error after 4 weeks among both groups

Variable	Group A	Group B	P value
Absolute error, mean ± SD	0.30 ± 0.57	0.32 ± 0.49	0.904

Table (4): Absolute error after 6 weeks among both groups

Variable	Group A	Group B	P value
Absolute error, mean ± SD	0.27 ± 0.78	0.28 ± 0.74	0.932

Table (5): Difference error among expected & after 6 weeks among both groups

Variable	Group A	Group B	P value
Difference error, mean ± SD	0.28 ± 0.79	0.27 ± 0.73	0.956

Table (6): Anterior chamber depth (ACD) among both groups

	Group A	Group B	P value
ACD, mean ± SD	2.67 ± 0.328	2.63 ± 0.351	0.431

Table (7): K2 (steep) among both groups

	Group A	Group B	P value
K2 (steep), mean ± SD	44.76 ± 1.54	45.13 ± 1.42	0.123

Table (8): K1 (flat) among both groups

	Group A	Group B	P value
K1 (flat), mean ± SD	42.73 ± 1.62	43.15 ± 1.7	0.149

Table (9): CYL among both formulae

	Group A	Group B	P value
CYL , mean ± SD	-0.98 ± 1.4	-0.95 ± 1.53	0.893

Table (10): Mean absolute error according to axial length (AL) categories after 4 weeks among both formulae.

	Group A	Group B	P value
21mm-21.9mm, mean ± SD	0.303 ± 0.529	0.348 ± 0.446	0.461
20mm-20.9mm, mean ± SD	0.071 ± 0.427	0.031 ± 0.335	0.485
19.5-19.9mm, mean ± SD	0.713 ± 0.467	0.805 ± 0.475	0.192

Table (11): Mean absolute error according to axial length (AL) categories after 6 weeks among both formulae.

	Group A	Group B	P value
21mm-21.9mm, mean ± SD	0.313 ± 0.798	0.471 ± 0.679	0.154
20mm-20.9mm, mean ± SD	0.008 ± 0.655	-0.121 ± 0.593	0.168
19.5-19.9mm, mean ± SD	1.08 ± 0.438	1.06 ± 0.562	0.791

Table (12): Correlation between mean absolute error and other reading among both formulae.

MAE	Group A		Group B	
	r	p	r	P
AL	.215	.119	.233	.107
ACD	**-.463**	**.005**	**-.387**	**.014**
K2	.132	.579	.221	.397
K1	.167	.213	.154	.118
CYL	.292	.178	.214	.265

DISCUSSION

Cataracts are the major cause of blindness, responsible for over eighteen million cases of bilateral blindness globally [(5)].

According to **Roh *et al.*** [(6)] the selection of an accurate biometry & an acceptable intraocular lens power (IOLp) formula when performing cataract surgical treatment is particularly crucial for the postoperative patient's level of satisfaction.

Regarding the findings of **Norrby** [(7)], inadequate preoperative assessment of axial length (AL) or keratometry accounts for 43% and 67%, correspondingly, of major unanticipated changes in the individual's refractive status. An error of one mm in measuring axial length leading to an error of about 2.88 D in postoperative refractive error or 3.00-3.50 D in calculating intraocular lens power (depending on axial length of the eye), as well as an error of 1 D in keratometric reading (K) consequences in an error of approximately 0.9-1.00 D in calculating intraocular lens power**.**

Formulas from the 3rd & 4th generations are currently the most popular. One of the third-generation formulae is the SRK/T (T for theoretical) that represents a hybrid of the linear regression technique with a theoretical eye model. The A-constant is employed in conjunction with the retinal thickness & corneal refractive index to get the anterior chamber depth. Manufacturers may give the anterior chamber depth constant for SRK/T, or it may be derived from the SRK-II A-constant utilizing the following formula. Anterior chamber depth (ACD = (0.62467× A) −68.747) [(8)]**.**

Kane and Melles [(9)] cleared that there are several reasons for poor performance in hyperopia, but one possible issue is that tiny eyes do not have the linear connection of AL & ACD that is assumed by the Holladay and SRK/T formulas. Both the Haigis formula, which incorporates anterior chamber depth into the formula to enhance the accuracy of postoperative ELP, & the Hoffer Q, which assumes a tangential connection among axial length also anterior chamber depth, have been considered as potentially more accurate in high hyperopia [(9)]**.**

The Hoffer Q & Haigis equations are more effective (in addition by implication, should be used) for those with an anterior segment length of under twenty-two millimeters, in accordance with guidelines of the Royal College of Ophthalmologists, which have since been replaced by the NICE [(4)]**.**

Our research aimed to evaluate the prediction accuracy of the Hoffer Q & SRK/T biometric equations utilizing the IOL master & the auto refractometer Topcon (RM-8000B) to determine the refractive results of cataract operation in hyperopic individuals. The expected error by the 2 formulae were calculated in our study and it was -0.0097 ± 0.112 by Hoffer Q while was 0.0180 ± 0.115 by SRK/T. When comparing them there was no variation that could be considered statistically significant. The mean error (ME) after 4 weeks follow up was 0.30 ± 0.57 D in group A used Hoffer Q and it was 0.32 ± 0.49 D in group B used SRK/T. The two formulas weren't distinct in a way that could be considered statistically significant from one another. The mean error after 6 weeks follow up was 0.27 ± 0.78 D in group A used Hoffer Q and it was 0.28 ± 0.74 D in group B used SRK/T. There was no statistically variance amongst the two formulae. Our findings also revealed that the Hoffer Q formula is not more accurate than SRK/T formula in refractive outcome in hypermetropic cases undergoing cataract surgery as there was no significant alteration amongst them in refractive outcome. The mean error change was 0.28 ± 0.79 D in the group used Hoffer Q & it was 0.27 ± 0.73 D in the group used SRK/T.

Several biometric formula accuracy studies were conducted utilizing hyperopic eyes. In accordance with their findings, Hoffer Q appears to be the most reliable of the existing formulas [1, 2, 10, 11].

It can be challenging to select the correct lens for eyes that have a short axial length. In spite of the fact that Hoffer's conclusions lacked statistical significance. Hoffer initially described the Hoffer Q formula in order to get more predictable outcomes about the effects of the refractive index. It was found that Hoffer Q had superior MAE and ME when compared to SRK/T after an explicit comparison among the two was done [10].

Aristodemou *et al.* initiated that Hoffer Q to be the most exact formula in the largest study of refractive outcomes in small eyes. This research consisted of 457 eyes with AL 22 mm that received the SofPort IOL. Hoffer Q had the lowest MAE of any formula for eyes with an axial length of 20 to 20.99 mm, whereas Hoffer Q had MAEs ranging from 21.50 to 21.99 mm. Intriguingly, the formulas that were compared in this study yielded the same percentage of results within 1 D for groups 21.50–21.99 mm in diameter. Hoffer Q outperformed SRK/T for AL 21.00–21.49 mm by 88% versus 85% [11].

The variations among studies may be attributable to the various IOL types employed and the potential influence of a 'lens effect'. In this research, foldable intraocular lenses (acrylic UV lens) were utilized. Statistical analysis varies among investigations as well. MAE and ME are computed identically across all experiments. Nevertheless, distinct statistical tests have been utilized for various data sets.

CONCLUSION

Since there was no statistically distinction in refractive result among the Hoffer Q formula also the SRK/T formula, we concluded that the Hoffer Q method is not more accurate than the SRK/T formula in hypermetropic individuals undergoing cataract surgery. We advocate individual auditing to take into consideration local biometry and individual IOL choice due to the wide range of reported refractive outcomes in the literature. When counseling patients on their risk of refractive surprise, both the Hoffer Q formula as well as the SRK/T formula should be taken into account. Intraoperative aberrometry presents a promising avenue toward improved lens selection in the future. The predictive error of additional biometric equations should also be investigated, and investigations of the refractive results of cataract operation in hyperopic cases should be conducted.

DECLARATIONS

- **Consent for publication:** I attest that all authors have agreed to submit the work.
- **Availability of data and material:** Available
- **Competing interests:** None
- **Funding:** No fund
- **Conflicts of interest:** no conflicts of interest.

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