

Refractive Status after Phacoemulsification with Biometry Done by Haigis and SRK-T Formulae in Myopic Patients

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Abstract

Background: Optimum refractive outcome is the key indicator for assessing the success of cataract surgery. Accurate biometric calculation of IOL is an important contributor of post-operative refractive status. There are several formulae for calculation of IOL power depending on axial length of eyes. Haigis is the formula of choice for calculating IOL power in myopic patients, whereas, SRK-T is a versatile formula irrespective of axial length. For IOL power calculation by Haigis formula needs expensive instrument. On the other hand, biometry by SRK-T formula can be done by less expensive and easily available instrument. **Objective:** To assess and compare post-operative refractive status after phacoemulsification where biometry done by Haigis and SRK-T formulae. **Methods:** This prospective observational study was conducted over 60 diagnosed patients of cataract with axial length more than 24 mm attending in the cataract clinic of NIO&H for phacoemulsification. Patients were selected based on specific selection criteria. Selected patients underwent detail ophthalmic and systemic examination as well as relevant investigation. Biometric calculation of IOL power was done by a single skilled technician by using Haigis formula (group A) in 30 patients and SRK-T formula (group B) in 30 patients. Visual acuity was assessed by LogMAR unit after 4 weeks of surgery and compared between two groups, p value ≤ 0.05 was considered as significant. **Results:** Mean age of the study subjects were 57.7 ± 6.0 (SD) years in group A and 57.27 ± 5.48 (SD) years in group B. In group A 14(46.7%) were male and 16(53.3%) were female and in group B 16(53.3%) were male and 14(46.7%) were female. Mean axial length was 25.05 ± 0.45 (SD) mm in group A and 24.88 ± 0.32 (SD) mm in group B. Mean IOL power was 18.23 ± 0.76 (SD) diopter in group A and 18.23 ± 0.65 (SD) diopter in group B. Post-operative mean visual acuity was 0.19 ± 0.26 (SD) LogMAR unit in group A and 0.18 ± 0.27 (SD) LogMAR unit in group B. Regarding post-operative refractive status of the study subjects, in group A, out of 30 patients 14(46.7%) were emmetropic, 7(23.3%) were myopic, 5(16.7%) were hypermetropic and the rest 4(13.3%) patients had astigmatism and in group B, out of 30 patients 16(53.3%) were emmetropic, 5(16.7%) were myopic, 4(13.3%) were hypermetropic and the rest 5(16.7%) patients had astigmatism. **Conclusion:** Quantitative assessment and statistical analysis shows there was no significant difference in post-operative refractive status and mean visual acuity between two groups.

Keywords: Biometry, Axial length, Haigis formula, SRK-T formula.

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Introduction

Cataract surgery is the most frequently performed surgical procedure in ophthalmology. In the last five decades, innovations such as ocular biometry, phacoemulsification and intraocular lens (IOL) power prediction formulas have improved considerably the refractive outcome of cataract surgery. Accurate prediction of the postoperative refraction is an important element of patient satisfaction after cataract surgery. Prediction accuracy depends on three factors: accuracy of the biometric data, accuracy of manufactured IOL power quality control and accuracy of the IOL power formulas^{1,2,3}. If these biometric measurements and calculations are inaccurate, the patients may be left with a significant refractive error⁴.

It is well-known that the prediction errors of popular IOL formulas are characterized by their dependence on different axial lengths. Studies based on preoperative and postoperative ultrasound biometry demonstrated that 54% of the errors in predicted refraction after IOL implantation can be attributed to AL measurement errors⁵. Therefore, precise preoperative measurement of AL is the most critical step to improve IOL power prediction⁶. AL measurement and calculation of IOL power by optical biometry is more accurate than that by applanation ultrasound in a normal population^{7,8,9}.

Now-a-days, third generation formulae SRK-T, Hoffer Q; fourth generation formula Holladay 2; fifth generation formula Haigis are the most useful and precise. It is generally accepted that both theoretical and regression IOL formulas perform well for eyes of average axial length (22.0 mm-24.5 mm)¹⁰. There were many studies regarding prediction accuracy of various IOL calculation formulas worldwide. In those studies, it is seen that 100% prediction accuracy is not yet obtained. Besides this, as optical biometry gives the more accurate data than US biometry. It is necessary to see the predictability of SRK-T and Haigis formulae by using the optical biometry.

With the above view, the aim of this study was to evaluate the role of both Haigis and SRK-T formulae on post-operative refractive outcome in patients with myopia (axial length ≥ 24 mm).

This study might give a guideline to reach the target refraction after cataract surgery and also to create an interest among researchers to study on this subject.

Material and methods

This prospective observational study was carried out over a period of 6 months among patients who were admitted for cataract surgery in National Institute of Ophthalmology & Hospital, Sher-E-Bangla Nagar, Dhaka. For convenience of the study as myopic patient fulfilling the criteria is less in number as well as short duration of study 60 eyes of 60 patients (30 in each group) were selected purposively for the study.

All patients above 50 years of age having

myopia (axial length 24mm or more) with age related cataract attending in OPD of Cataract Dept. of National Institute of Ophthalmology & Hospital were included in this study.

Patients suffering from intraocular diseases other than cataract, having history of trauma or other ocular surgery, taking any oral medication that may influence refractive status, enrolled in other study group were excluded from this study.

Patients were divided into two groups according to the formula used for IOL power calculation preoperatively namely SRK-T and Haigis groups. Each group was included with 30 eyes. All patients included in the study signed a pre-designed consent form prior to undergoing intervention after oral explanation about the nature, purpose and procedure of the study. Eyes with pathology or operative complications affecting the refractive results and those with missing data were excluded. All demographic data (i.e. history, examination and investigations) of the patients were filled out by the investigator in a pre-designed data collection form. The axial length, keratometry value and anterior chamber depth were measured by using IOL Master equipped with software containing Haigis & SRK-T formulae. The target refraction was Plano (predicted post-operative refraction was Plano). All examinations were performed by the same examiner.

The power of implanted IOL and the predicted post-operative spherical equivalent were determined using SRK-T and Haigis formulae. Only the signal-to-noise (SNR) value more than 2.5 was recorded. IOL types used in this study were Alcon (USA).

All the patients were reviewed after one week and four weeks after surgery. Visual acuity with pinhole improvement, slit lamp examination, tonometry and funduscopy were noted in each case. Refraction at the fourth post-operative week was considered as a stabilized refractive status. The final spectacle correction was given according to autorefractometer and retinoscopy findings.

Ethical clearance was taken from Ethical Review Committee (ERC) of NIO&H.

Data collected for different variables were presented in tables/diagrams. Data was analyzed using SPSS version 20. The postoperative

refraction was reduced to a spherical equivalent. Predictive accuracy of each formula was analyzed by comparing the observed and predicted post-operative spherical equivalent. Independent 't' test was done for comparison of mean and standard deviation of continuous/

numerical variables. The Chi-square test and Fisher Exact test were used for statistical analysis of quantitative data. A "p" value of <0.05 was considered as statistically significant.

Results

Table I: Age distribution of the study subjects (n=60)

Age group (in years)	Group A	Group B	p value
45-54	8 (26.7%)	7 (23.3%)	0.476 ^a
55-64	17 (56.7%)	21 (70.0%)	
65 and above	5 (16.7%)	2 (6.7%)	
Mean ±SD	57.7±6.0	57.27±5.48	0.541 ^b

a=Fisher Exact test, b=Independent Sample t test

In group A, out of 30 patients 17 (56.7%) patients were 55-64 years age group and while in group B, 21 (70.0%) patients were 55-64 years age group. The mean age difference between two groups was not significant statistically (table I).

Table II: Gender distribution of the study subjects (n=60)

Gender	Group A	Group B	p value
Male	14 (46.7%)	16 (53.3%)	0.606 ^a
Female	16 (53.3%)	14 (46.7%)	

a=Chi-square test

In group A, 14 (46.7%) patients were male while in group B, 16 (53.3%) patients were male (table II).

Table III: Axial length distribution of the study subjects (n=60)

Axial Length (in mm)	Group A	Group B	p value
24.0-24.50	3 (10%)	3 (10%)	0.222 ^a
24.51-25.0	14 (46.7%)	21 (70%)	
25.01-25.50	9 (30%)	5 (16.7%)	
25.51-26.0	4 (13.3%)	1 (3.3%)	
Mean ±SD	25.05 (±0.45)	24.88 (±0.32)	0.276 ^b

a=Fisher Exact test, b=Independent Sample t test

In group A, the mean axial length was 25.05±0.45 mm while in group B, the mean axial length was 24.88±0.32 mm. The mean difference of axial length between two groups was not significant statistically (table III).

Table IV: IOL power distribution of the study subjects

IOL power (in D)	Group A	Group B	p value
17.0-18.0	07(23.3%)	07(23.3%)	0.952 ^a
18.0-19.0	16(53.3%)	15(50%)	
19.0+	07(23.3%)	08(26.7%)	
Mean \pm SD	18.23(\pm 0.76)	18.23 (\pm 0.65)	0.848 ^b

a=Chi-square test, b=Independent Sample t test

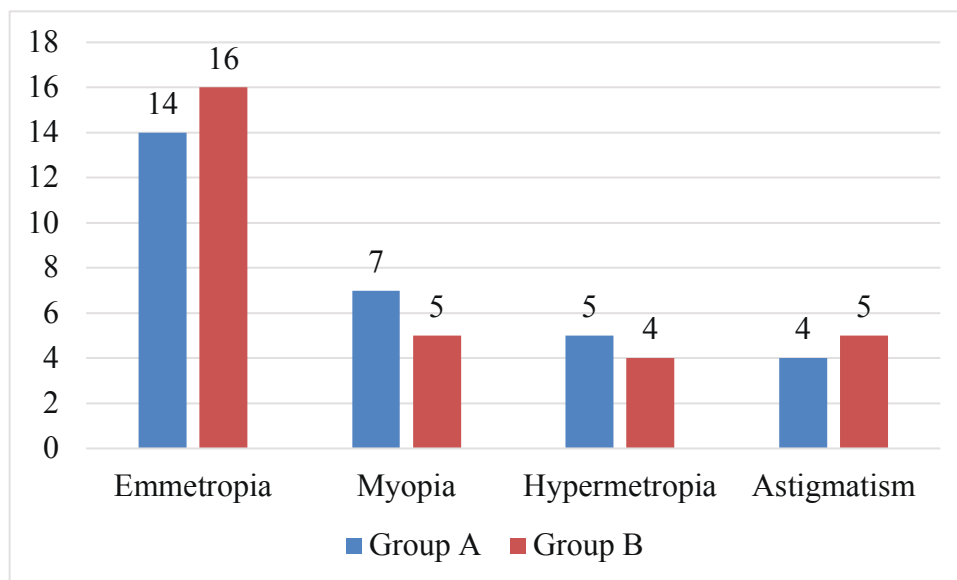
In group A, out of 30 patients 16(53.3%) patients were 18-19 D group and in group B, 15(50%) patients were 18-19 D group. The mean difference of IOL power between two groups was not significant statistically (table IV).

Table V: Distribution of post-operative visual acuity of study subjects

Visual acuity (in LogMAR)	Group A	Group B	p value
0.0-0.2	25(83.3%)	25(83.3%)	0.952 ^a
0.3-0.5 D	2(6.7%)	1(3.3%)	
0.6-1.0	3(10%)	4(13.3%)	
Mean \pm SD	0.19 (\pm 0.26)	0.18 (\pm 0.26)	0.772 ^b

a=Fisher Exact test, b=Independent Sample t test

Most of the patients in both groups (83.3%) had visual acuity from 0.0-0.2. The mean visual acuity in group A and B were 0.19 \pm 0.26 and 0.18 \pm 0.26 respectively. The mean difference of post-operative visual acuity between two groups was not significant statistically (table V).

**Figure I:** Bar diagram showing post-refractive status of the study subjects

In group A, 14 (46.7%) patients were emmetropic while in group B, 16 (53.3%) patients were emmetropic. The difference of post-operative refractive status between two groups was not significant statistically (Figure I).

Discussion

Visual outcome after cataract surgery depends on various factors, one of the most important of which is accurate biometric calculation of IOL power to be implanted. There are various formulae for calculation of IOL power. Choice of formula depends on the axial length of the eye. For eyes with long axial length Haigis formula is preferred, which needs non-contact partial coherence interferometry method for measurement of length, on the other hand SRK-T is a versatile formula where axial length can be calculated by ultrasound A-scan which is much less expensive than partial interferometry method. In this study, selected patients were grouped into group A (IOL power calculated by Haigis formula) and group B (IOL power calculated by SRK-T formula) and their refractive outcome was compared in 60 patients with axial length more than 24mm after phacoemulsification done by a single competent surgeon in a common set-up where IOL power was calculated by using Haigis in 30 patients and SRK-T formula in 30 patients.

In this study, the mean age of study population was 57.7 ± 6.0 (SD) years in group A and 57.27 ± 5.48 (SD) years in group B. The mean age difference between two groups was not significant statistically. Study done by Rascevskis et al., 2016¹¹ showed that the mean age of the study participants was 74.44 ± 6.32 (SD) years. There is difference in mean age between these two studies may be due to differences in life expectancy of the places of the study.

In this study, among the study participants, 14(46.7%) were male and 16(53.3%) were female in group A and in group B, 16(53.3%) were male and 14(46.7%) were female. Study done by Rascevskis et al., 2016¹¹ showed that 11(44%) were male and 14(56%) were female. This finding is competent with the existing study.

In this study, the mean axial length of study population was 25.05 ± 0.45 mm (SD) in group A and 24.88 ± 0.32 mm (SD) in group B. The mean difference of axial length between two groups was not significant statistically. Study done by Rascevskis et al., 2016¹¹ showed that the mean axial length of the study participants was

23.51 ± 1.19 mm (SD). There is difference in mean axial length between these two studies because in the study done by Rascevskis et al., 2016¹¹ the patients were selected irrespective of axial length. But in this study, only myopic patients having axial length ≥ 24 mm were selected.

In this study, the mean IOL power of study population was 18.23 ± 0.76 D (SD) in group A and 18.23 ± 0.65 D (SD) in group B. The mean difference of IOL power between two groups was not significant statistically. Study done by Rascevskis et al., 2016¹¹ showed that the mean IOL power of the study participants was 20.8 ± 3.49 D (SD). IOL power depends on average keratometric reading and axial length of the individual. The difference in mean IOL power in these two studies is due to difference in the mean axial length.

In this study, the mean post-operative visual acuity of study population was 0.19 ± 0.26 LogMAR unit (SD) in group A and 0.18 ± 0.26 LogMAR unit (SD) in group B. The mean difference of post-operative visual acuity between two groups was not significant statistically. Study done by Dalto et al., 2017¹² showed that mean refractive status was 0.24 ± 0.09 (SD) D in Haigis formula and 0.27 ± 0.09 (SD) D in SRK-T formula. There is difference in refractive outcome between these two studies due to that in the later study, the cataract surgery was done with an intentional myopic overcorrection.

In this study, regarding post-operative refractive status, in group A, out of 30 patients 14(46.7%) were emmetropic, 7(23.3%) were myopic, 5(16.7%) were hypermetropic and the rest 4(13.3%) patients had astigmatism and in group B, out of 30 patients 16(53.3%) were emmetropic, 5(16.7%) were myopic, 4(13.3%) were hypermetropic & the rest 5(16.7%) patients had astigmatism. The difference of post-operative refractive status between two groups was not significant statistically.

As discussed earlier that accurate biometric calculation of IOL power is a key determinant of post-operative visual outcome, and choice of exact applicable formula individual condition is mandatory for satisfactory refractive status. Apart from this, experienced surgeon and skilled

technician also contributes in the optimum surgical outcome. SRK-T is a versatile formula for all patient irrespective of axial length. The choice of formula for myopic eye is Haigis formula. Although, Haigis formula can calculate pre-operative anterior chamber depth in addition to keratometry and axial length, it contributes less in post-operative refractive outcome.

Limitations of the study

Correlation between axial length and IOL power was not calculated. Moreover, this study was done over a small number of purposively selected population. Other factors contributing to post-operative visual outcome (e.g. keratometric reading, co-existing retinal diseases associated with myopia) was not considered.

Conclusion

Quantitative analysis of the study findings shows that, there is no statistically significant difference in post-operative refractive status and mean post-operative visual acuity in

homogenous population in myopic eyes (axial length ≥ 24 mm) where biometry done by Haigis or SRK-T formula.

Recommendations

Further study should be done over large number of randomly selected population (to avoid bias) in multiple centers to draw a universal conclusion about the efficacy of the two formulae. Other factors (associated with myopia) influencing post-operative visual outcome should be taken into accounts. Long term follow-up should be done to assess and compare final visual outcome.

Conflict of interest: There is no conflict of interest to declare.

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