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Original Research Article

Comparison of spherical equivalent determined by Sanders-Retzlaff-Kraff-II (SRK-II) formula with target post-operative final refraction in patients undergoing cataract surgery

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A B S T R A C T

Background: The most challenging subject in patient satisfaction after cataract surgery depends upon post-operative refractive outcomes. Accurately predicting post-operative refraction is necessary during the calculation of Intraocular lens (IOL) power. The Sanders-Retzlaff-Kraff (SRK) II formula is one of the few formulae being used for the calculation of IOL power. Our study is to compare the accuracy of the SRK-II formula with targeted final refraction of patients undergoing phacoemulsification.
Materials and Methods: This study was performed on 102 eyes that underwent phacoemulsification. IOL power was calculated using the SRK-II formula. One and a half months after surgery, refraction was performed. Differences between actual post-operative refraction and predicted spherical equivalent was calculated and termed absolute refractive error. Paired t-test was used for comparing actual post-operative refraction and predicted spherical equivalent.
Results: The mean absolute error (MAE) of the SRK-II formula was 0.44 D (diopters) overall. The percentage of eyes within ±0.5 D of the predicted spherical equivalent was 81%. Patients having post-operative refractive error within ±1.0 D for short, average, and long axial length were 88% (P value 0.21), 92% (P value 0.0009), and 91% (P value 0.18) respectively.
Conclusion: We found that the SRK-II formula was accurate and reliable for predicting the post-operative refractive error in eyes with normal axial lengths as the post-operative refraction is near emmetropia and is a good method for IOL power calculation with normal axial lengths.

1. Introduction

The primary reason for preventable blindness worldwide is cataract.[1] Cataract surgery over the years has improved a lot. The most challenging subject in patient satisfaction after cataract surgery depends upon post-operative refractive outcomes. Cataract extraction with Intraocular lens (IOL) implantation is the commonest method of visual rehabilitation in modern times. Therefore, accurately predicting postoperative refraction is necessary during the calculation of IOL power. For the prediction of the IOL power, successive versions of IOL power calculation formulae use different parameters. The Sanders-Retzlaff-Kraff (SRK) formula has emerged as the most used method worldwide. In short and long eyes, the new SRK II formula proposed by Sanders et al. in 1622 has been demonstrated to lower the prediction error of the original SRK formula.[2] Also, by taking precise and trustworthy

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measurements of axial length (AL) and keratometry, more recent biometry devices have improved the findings of IOL power calculations. In this study, we compared postoperative final refraction and spherical equivalent calculated using the SRK-II formula in patients undergoing phacoemulsification cataract surgery.

2. Materials and Methods

This study was performed on 102 eyes that underwent cataract extraction by phacoemulsification with IOL implantation. The study population included patients coming to the outpatient department of ophthalmology for phacoemulsification with IOL implantation.

Informed consent was obtained from all the patients along with permission from the ethical committee. The exclusion criteria for the study are as follows.

1. Patients with a history of previous intraocular surgery.
2. Those who developed intraoperative and postoperative complications.
3. Preexisting ocular diseases that may affect postoperative refraction, for instance, keratoconus, endothelial dystrophy, corneal scarring, macular edema, or retinal detachment
4. Extremes of age (<7 and >70 years).
5. High myopes (> -6 D) and high hypermetropes (> 5 D).[3,4]
6. Astigmatism more than ±1.5 D
7. Extremes of axial length (< 20mm and >26mm)[4–9]

IOL power calculation was done using axial length by ultrasonic A scan method with standard immersion technique and keratometry values were obtained by manual keratometry. IOL power was calculated using the SRK-II formula.[2] One and a half months after surgery, refraction was performed. Differences between actual post-operative refraction and predicted spherical equivalent was calculated and termed as 'Absolute Refractive Error' (ARE), which then was recorded and compared for various axial length.

ARE values were recorded as mean and standard deviation. A paired t-test was used for a parametric comparison of the means. Absolute Refractive Error was evaluated using a two-way analysis of variance (ANOVA). The confidence interval was 95% and $P < 0.05$ was considered statistically significant.

3. Results

The study included 102 eyes of 76 patients (35 males and 41 females). Their age ranges from 39 to 69 years with the mean age being 60 years. The pre-operative mean spherical equivalent was -1.4 D. The mean corneal power was 44.09 D and the mean axial length was 22.88 mm. The mean anterior chamber depth (ACD) and predicted spherical equivalent (PSE) were 2.79 mm and -0.23 D respectively (Table 1).

Table 1: Pre-operative data

Keratometric reading (D)	
Mean	44.09
SD	1.63
Range	40.13 to 48.25
Axial length measurement (mm)	
Mean	22.88
SD	0.90
Range	20.88 to 25.64
Anterior chamber depth (mm)	
Mean	2.79
SD	0.37
Range	2.23 to 3.79
Predicted spherical equivalent (D)	
Mean	-0.23
SD	0.14
Range	-0.49 to 0

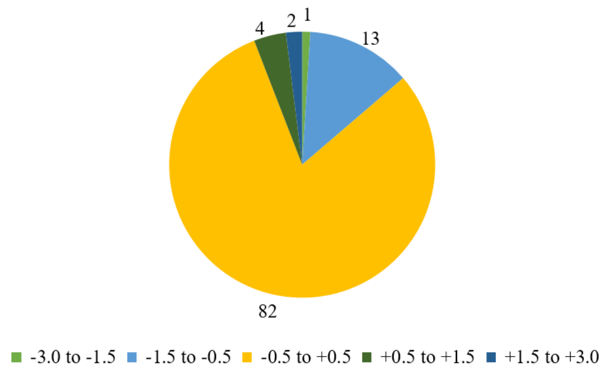

Figure 1: Deviation of refractive outcome from predicted spherical equivalent

The highest number of eyes (82 out of 102) fall between -0.5 and +0.5 D followed by the second highest number of eyes (13 out of 102) falling between -1.5 and -0.5 D.(Figure 1)

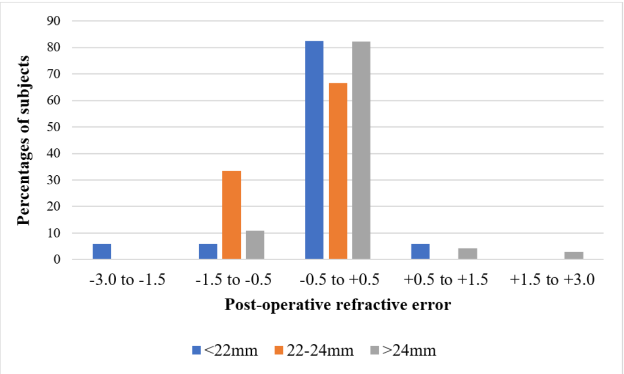

Figure 2: Correlation between Axial length and post-operative spherical refractive error

For most of the eyes, regardless of the axial length, post-operative refractive error falls between -0.5 and +0.5 D.(Figure 2)

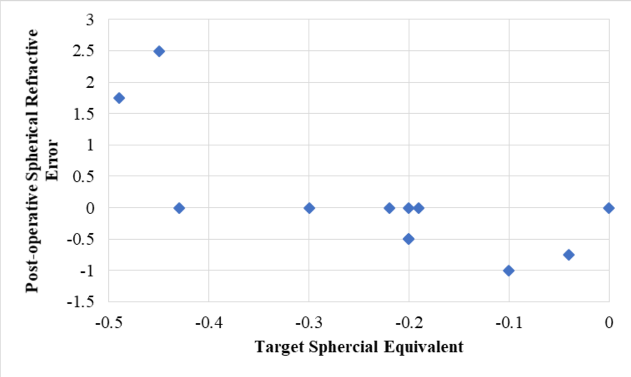

Figure 3: Scatter plot of target vs. actual post-operative spherical refractive error in hypermetropes

Most of the hypermetropic eyes' actual post-operative spherical refractive error falls between 0 and -1D.(Figure 3)

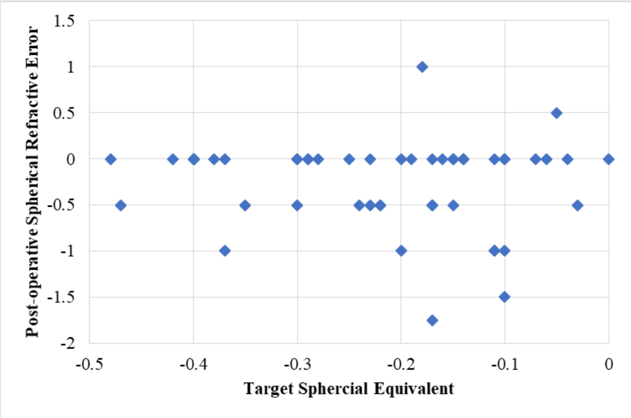

Figure 4: Correlation between target and actual post-operative spherical refractive error in myopes

Most of the myopic eyes' actual post-operative spherical refractive error falls between 0 and -0.5D.(Figure 4)

In our study, 17 out of 102 eyes with short axial length (<22mm) had post-operative refractive error ranging from -1.75D to 0.8 D with mean post-operative refractive error being -0.20 D. Mean absolute error observed was 0.49. The number of eyes having post-operative refractive error within ±0.5 D is 14 (82%) (P value 0.50). The number of eyes having post-operative refractive error within ±1.0 D is 15 (88%) (P value 0.21).

The mean post-operative refractive error was -0.48 D for 12 eyes with long axial length (>24 mm). These eyes had post-operative refractive errors ranging from -1.5D to 0 D. The observed mean absolute error was 0.49 which is similar to short axial length. 8 eyes (66%) had post-operative refractive error within ±0.5 D (P value 0.47). 11 (92%) eyes had refractive error within ±1.0D (P value 0.18).

73 eyes with a normal axial length between 22 and 24 mm had a mean post-operative refractive error of -0.16 D. The post-operative refractive error in these eyes ranged from -1.5 D to 2.5 D. The observed mean absolute error was 0.42, which is slightly less in comparison to short and long axial length. The post-operative refractive error of 61 eyes (84%) was within ±0.5 D (P value 0.09). 67 eyes (92%) had it within ± 1.0 D (P value 0.0009).

4. Discussion

Axial length and anterior chamber depth are the two parameters most frequently employed in formulas to calculate IOL power. Every 1 mm inaccuracy in axial length measurements results in a 2.5 to 3.0 diopter error. If the contact technique is used instead of the immersion technique for ultrasonic biometry, the cornea is compressed, which could lead to inaccurate measurements.[10,11] To minimize such error we have used immersion technique for axial length calculation in our study.

The use of various IOLs and procedures carried out by numerous surgeons may diminish the reliability of research. To negate the effect of variability caused due to such parameters, in our study we have included cases of single-type IOL and all the measurements were carried out by the single surgeon.

IOL calculation formulae work best with eyes that have a normal axial length. However, it has never been easy to anticipate correct biometry at axial length extremes. This paper also reviews the SRK-II formula's predictive powers at various axial length.

Hoffer et al[12] published a study of 450 eyes that were operated by a single surgeon, and in whom a single type of IOL has been used for IOL implantation. For the SRK-II formula, the percentage of the eyes with post-operative refractive error within ±0.5 D and ±1.0 D was 57% and 88% respectively. Sanders et al[13] used a data set of 990 eyes operated by various surgeons using seven different types of IOL to compare SRK-T, Holladay, SRK-II, Hoffer, and Binkhorst II formulae. The results obtained by the SRK-II formula were showing that the percentage of eyes achieving the spherical error of < ± 0.5D was 29% and the error of < ±1.0D was 79%. Retzlaff et al[14] used a data set of 1677 eyes to compare the ability of SRK-T, Holladay, SRK-II, Hoffer, and Binkhorst II formulae in IOL power calculation. In above study for post-operative refractive errors of <0.5D, the percentage of eyes achieved was 48%. In our study 81% of the eyes had post-operative refractive error within ±0.5 D and 91% of the eyes had post-operative refractive error within ±1.0 D.

Mohindar et al[15] studied 400 eyes that underwent cataract extraction with IOL implantation to compare the predictive accuracy of various IOL power calculation formulae. The sample comprised 65 short eyes (axial length <22 mm), 283 eyes of average axial length (22-24.49 mm), and 52 long eyes (>24.5 mm). The number of eyes with post-operative refractive errors within ±1.0 D were 79%, 77%, and 83% for short, average, and long axial lengths respectively. SRK II formula performed equally for short and average axial lengths. Whereas, it performed better for long axial lengths in this study. Another study[16] by the Ophthalmic Department of Żeromski Specialist Hospital in Cracow about the accuracy of IOL power calculation formulae for eyes of axial length more than 24.5 mm showed that the performance of SRK II formula in long axial length is poor. Out of 61 eyes, only 5 achieved emmetropic visual acuity after implantation of IOL with power calculation by SRK II formula. In our study of 102 eyes, the number of eyes with short, normal, and long axial length were 17, 73, and 12 respectively. The number of eyes with post-operative refractive error within ±1.0 D was 88%, 92%, and 91% respectively.

In the study conducted by Mohindar et al,[15] p values for eyes achieving post-operative refraction within ±1.0 D for short, average, and long axial lengths were 0.45, 0.43, and 0.18 respectively, making the formula performing better for long axial length than those for short and average axial length. Whereas in our study, p-value for eyes with normal axial length achieving post-operative refraction within ±1.0 D is obtained 0.0009 which is statistically significant indicating that the SRK-II formula performs fairly well for normal axial lengths. For short and long axial length p value observed is 0.21 and 0.18 respectively, making the SRK-II formula inaccurate for short and long axial lengths.

5. Conclusion

We found that the SRK-II formula was accurate and reliable for predicting the post-operative refractive error in eyes with normal axial lengths. The mean absolute error (MAE) of the SRK-II formula was 0.44 D overall and 0.41 D for normal axial length. The percentages of eyes within ±0.5 D and ±1.0 D of the predicted spherical equivalent were 81% and 91%, respectively.

SRK-II formula is a valid and practical method for predicting the post-operative spherical equivalent in patients undergoing cataract surgery in normal AL of the eye. SRK-II formula with axial length measurement by immersion method is equally good for IOL power calculation as the post-operative refraction is near emmetropia and SRK-II is a good method for IOL power calculation in phacoemulsification especially in normal axial length.

6. Limitations

1. Relatively small sample size.
2. Only one formula SRK-II was used.
3. IOL master was not used for IOL power calculation.

7. Source of Funding

None.

8. Conflict of Interest

None.

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