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Predictive Ability of SRK-T and SRK-II Formulae for Aspheric and Non-Aspheric Intraocular Lenses: A Comparative Analysis

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Abstract: *To determine the difference between the predictive ability of SRK-T and SRK-II formulae in IOL power calculation for aspheric and non aspheric IOL types, retrospective analysis of case sheets of 70 patients who underwent phacoemulsification at a tertiary care centre was done. Pre-operative measurements of axial length, keratometry and IOL power calculation with optimised A constant, done by a single operating surgeon manually, was used in this assessment. All patients underwent phacoemulsification with intraocular lens (IOL) implantation into the bag done by a single experienced surgeon. Aspheric IOL was implanted in 35 patients and non-aspheric IOL in rest of the 35 patients. Post operative refraction was done at 4-6 weeks and the spherical equivalent obtained was compared with the predictive error noted preoperatively using the SRK-T and SRK-II formulae. Using SRK-T formula the absolute error was <0.5D in 51.4% and 45.8% eyes in aspheric and non-aspheric groups respectively. It was <1.0D in 82.85% and 85.71% eyes in aspheric and non-aspheric groups respectively. Using SRK-II formula the absolute error was <0.5D in 40.0% and 42.8% eyes in aspheric and non-aspheric cases respectively. It was <1.0D in 74.28% and 80.0% eyes in aspheric and non-aspheric groups respectively. No significant difference was observed between the predictive ability of SRK-T and SRK-II formulae for aspheric and non aspheric IOLs.*
Keywords: *Absolute error, Aspheric IOL, Non-aspheric IOL, SRK-T formula, SRK-II formula.*

I. Introduction

Intraocular lens (IOL) power calculation formulae that attempts to provide a predictable refractive outcome based on preoperative measurements have evolved over the past 30years [1]. The aim of an accurate power calculation is to provide an IOL that fits the specific need and desire of the individual patients. Use of more precise mathematical formulae to perform the appropriate calculations improved the accuracy levels significantly [2, 3].

The most recent formulae, third and fourth generation, are found to be the most useful and precise in IOL power calculation [4-8]. Accuracy of these formulae for IOL power calculation vary with anterior chamber depth, axial length (AL) and corneal curvature. The SRK-T formula uses the axial length, average keratometry and optimised A-constant (which varies with IOL design and the manufacturer) to calculate the IOL power[4,5,7,9]. Over the years, surgeons discovered that the SRK formula is best used in medium sized eyes (axial length between 22.0 and 24.50mm). A subsequent formula, the SRK-II was developed for use in long and short eyes.

Prediction accuracy of IOL power calculation depends on three factors, viz., accuracy of the biometric data, accuracy of the manufactured IOL power, quality of the IOL and accuracy of the IOL formula used. Several previous published studies reported that the prediction accuracy varied between 80 and 90 per cent, depending on the AL and the IOL power calculation formula [1-4, 10-11].

In recent years there has been an increasing trend in the use of IOL from non-aspheric to aspheric models that help in the reduction of amount of spherical aberration in the eye, thus allowing higher contrast and acuity. The optics of these aspheric IOLs are conical in shape with improved optical properties leading to less pseudo accommodation, thus increasing the influence of defocus. Therefore it is mandatory to predict the aspheric IOL power as precisely as possible [12-14]. Therefore, in the present study we made an attempt to analyse the difference in predictive ability of SRK-T and SRK-II formulae for IOL power calculation of aspheric IOLs in comparison with non aspheric IOLS.

II. Methodology

In the present study, retrospective analysis of case sheets of 70 patients (70 eyes) who underwent phacoemulsification at a tertiary care centre, aged between 35-80 years, was done. However, it is essential to note, all consecutive cases of phacoemulsification were included in the study. At the same time, patients who underwent combined procedures, capsule rupture, and failure to place the lens in the bag or any other intra operative and postoperative complications were excluded from the study.

Pre operative measurements of axial length, keratometry and IOL power calculation with optimised A constant was done in all 70 cases by the single operating surgeon manually. The predictive error with SRK/T and SRK-II formulae was noted.

All patients underwent phacoemulsification with intraocular lens implantation performed by a single experienced surgeon. The surgeon does approximately 1000 phacoemulsification cases per year and neither her technique nor abilities changed over the study period. Phacoemulsification was done with a temporal clear corneal incision, 2 side ports and 5-6mm of capsulorhexis with into the bag intraocular lens implantation. The incisions were not sutured in any of the cases. Among the 70 patients, aspheric IOLs were implanted in 35 patients (group-1) and non-aspheric IOLs in the rest 35 patients (group-2).

Patients were examined on day one, after one week and after four to six weeks of surgery. During each visit, assessment of best-corrected visual acuity, slit lamp examination of the anterior segment, intraocular pressure measurement and fundus examination was done. Post operative refraction was done during 4-6 weeks visit using automated refractometry and the spherical equivalent obtained was compared with the predictive error noted preoperatively using the SRK-T and SRK-II formulae for the two groups.

III. Results

Of the 35 patients in whom aspheric IOL was implanted, 19 were males and 18 were females with ages ranging from 37 to 75 years with a mean age of 59.05+/-8.45yrs. The right eye was operated in 17 patients and the left eye in 18 patients. The axial length varied between 21.4mm and 24.34mm with a mean of 23.11+/-1.59mm. The mean IOL power implanted was 20.8+/-1.74D (ranging from 16.5 to 24D). The mean predicted refraction obtained with SRK-T and SRK-II formulae were -0.370+/-0.329D and -0.197+/-0.14D respectively. Post-operatively, the mean spherical component of the refractive error was -0.053D, mean cylindrical component was -1.25D and mean spherical equivalent (SE) was -0.722+/-0.630D (Table-1).

Table-1: Details of Mean Age, Axial Length, IOL Power Implanted and Post-op SE

Results	Aspheric IOL	Non-aspheric IOL
Mean age (yrs)	59.05+/-8.45	57.62+/-8.87
Mean axial length (mm)	23.11+/-1.59	22.87+/-0.486
Mean IOL power implanted (D)	20.8+/-1.74	20.87+/-1.59
Post-op mean SE (D)	0.722+/-0.630	-0.107+/-1.12

The mean absolute errors (difference between the predicted refractive error and the spherical equivalent obtained post operatively) recorded using SRK-T and SRK-II formulae were 0.65 and 0.66D respectively. The absolute error recorded using SRK-T and SRK-II formulae was <0.5D in 51.4% and 40% eyes respectively (P-Value=0.16), it was <1.0D in 82.85% and 74.28% of eyes respectively (P-Value=0.24) and the difference between these two formulae was not significant (Table-2).

Of the 35 patients in whom non-aspheric IOL was implanted, 21 were males and 14 were females with ages ranging from 39 to 80 years, with a mean age of 57.62+/-8.87yrs. The right eye was operated in 23 patients and the left eye in 12 patients. The axial length varied between 21.93mm and 23.96mm, with a mean of 22.87+/-0.486mm. The mean IOL power implanted was 20.87+/-1.59D (ranging from 17.5 to 24D). The mean predicted refraction noted was -0.170+/-0.139D with SRK-T formula and -0.316+/-0.295D with SRK-II formula. The mean postoperative spherical component of the refractive error was 0.385D and mean cylindrical component was -0.99D. The mean postoperative spherical equivalent obtained was -0.107+/-1.12D (Table-1).

The mean absolute errors noted using SRK-T and SRK-II formulae were 0.66D and 0.76D respectively. The absolute error recorded using SRK-T and SRK-II formulae was <0.5D in 45.8% and 42.8% eyes respectively (P-Value=0.18), it was <1.0D in 85.71% and 80% of eyes respectively (P-Value=1.39) and the difference between these two formulae was not significant (Table-2).

Table-2: Details of Absolute Predictive Error obtained with SRK-T and SRK-II formulae

Formula	Absolute Predictive Error	Group 1 (% of eyes)	Group 2 (% of eyes)
SRK-T	<0.5D	51.4	45.8
	<1.0D	82.85	85.71
SRK-II	<0.5D	40	42.8
	<1.0D	74.28	80

Using SRK-T formula the absolute error was <0.5D in 51.4% and 45.8% eyes in groups-1 and 2 respectively. It was <1.0D in 82.85% and 85.71% eyes in group-1 and 2 respectively (Table-2). The difference of absolute error between these two groups was not significant (<0.5D: P value = 0.4; <1.0D: P value = 0.62). Using SRK-II formula the absolute error was <0.5D in 40.0% and 42.8% eyes in groups-1 and 2 respectively. It was <1.0D in 74.28% and 80.0% eyes in group-1 and 2 respectively. The difference of absolute error between the two groups was not statistically significant (<0.5D: P value = 0.73; <1.0D: P value = 0.39).

IV. Discussion

In the present analysis we studied the predictive ability of SRK-T and SRK-II formulae for aspheric and non aspheric IOLs. A comparative analysis of our results and results obtained in other studies reveals certain important findings, some of which concurred with our study whereas some varied.

Hoffer *et al* [1] published a series of 450 cases that were operated by a single surgeon, measurements done by a single technician and in whom single type of IOL (non aspheric) has been implanted. For SRK-T and SRK-II, an error of SD 0.5D was present in 62% and 57% of eyes respectively and for errors of SD 1.0D the results were 92%% and 88%, that is SRK-T performed marginally better than SRK-II. In the present study also, in non-aspheric group SRK-T formula (<0.5D in 45.8%, <1.0D in 85.71%) performed marginally better than SRK-II (<0.5D in 42.8%, <1.0D in 80%) but the difference between them is not found to be not statistically significant.

Retzlaff *et al* [5] used an unselected data set of 1677 cases to compare the predictive ability of SRK-T, Holladay, SRK-II, Hoffer and Binkhorst II formulae. In this study for errors of <0.5D, the percentages of eyes achieved were statistically similar for SRK-T (50%) and SRK-II (48%) and the difference between them was not statistically significant. Similarly in the current study, in both the groups of IOLs, with <0.5D error no significant difference was found between the predictive ability of SRK-T and SRK-II formulae.

For errors <1.0D the outcomes were 80% and 77% eyes, for which SRK-II was significantly worse than SRK-T. But in the current study in both the group of IOLs for errors <1.0D also, no significant difference was found between the predictive ability of two formulae. The difference in the results their study and ours could be because of significant difference in sample size between the two, involvement of multiple technicians in pre-operative measurements and multiple surgeons in the former as compared to single surgeon performing pre-operative measurements and surgeries in our study. It is important to recall the observation of Retzlaff *et al* in this context that ‘it appears that there is more variability in the level of error between surgeons than there is between formulae’.

Sanders *et al* [15] used a data set of 990 unselected cases from multiple surgeons and seven IOL styles to compare SRK-T, Holladay, SRK-II, Hoffer and Binkhorst II formulae. The results were that the percentage of cases that achieved a spherical error of <0.5D were 30%, 30%, 29%, 28%, and 29% respectively and error of <1.0D were 81%, 81%, 79%, 77%, and 77% cases respectively. By using chi-square and Yates’s correction authors found that there were no significant differences between formulae used to find out the errors of <0.5D. Only significant difference for errors <1.0D are that SRK-T and Holladay was better than Hoffer and Binkhorst (81% *v* 77%, p=0.03), and the SRK-II formula was not significantly different from SRK-T or the Holladay formulae. Similarly in our study in the aspheric IOL group, the absolute error using SRK/T and SRK-II formulae was <0.5 D in 51% and 40% cases respectively (P value=0.16) and <1.0 D in 83% and 74% cases respectively (P Value=0.24), and the P Values between the two formulae were found to be not significant statistically. In the case of non-aspheric IOL group, the absolute error using SRK/T and SRK-II formulae was <0.5 D in 45.8% and 43% cases respectively (P value=0.18) and <1.0 D in 86% and 80% cases respectively (P Value=1.39), and the P Values between the two formulae were found to be not significant statistically.

Peter C. Hoffmann *et al* [16] studied the IOL calculation for aspheric intraocular lenses in which they got a mean absolute error of 0.43D using SRK-T formula. In our study the mean absolute error obtained was 0.65D for the aspheric IOL group. In their study they used IOL master for the measurements whereas in our study manual measurements were used, which could be the source of this difference.

V. Conclusions

Many studies were done previously to assess the predictability of absolute error of various theoretical and regression formulae and also on different types of IOLs, but comparative studies for the aspheric and non-aspheric type of IOLs were not done. In the present analysis we compared the accuracy of SRK-T and SRK-II formulae for aspheric and non aspheric IOLs. We observed that there was no significant difference between the two formulae in both the groups of IOLs.

However limitations of the present study include a small sample size and manual measurements, where human error is possible. Hence further studies are needed in this aspect with a larger sample size and with automated measurements (IOL master and ray tracing) to confirm these results.

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