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A Restrospective Analysis To Identify An Appropriate Formula For Intraocular Lens Power Calculation In Children

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Abstract: *Intraocular lens power calculation in children is very much different from that of adults. However, various formulae (SRK T, SRK II, Holladay, Hoffer-Q) which are designed for adults eyes are being used for IOL power calculation in children. Hence we made an attempt to determine the appropriate formula for IOL power calculation in children. A retrospective analysis was conducted over a period of two years among 54 children- 34 boys and 20 girls; aged between 4 and 15 years; a total of 80 eyes (26 bilateral cataract and 28 unilateral cataract)- who were operated for congenital and developmental cataract. The predictive error of <0.5D (not significant) with SRK/T, SRK/II, Holladay-1 and Hoffer-Q formulae were 35%, 32.5%, 37.5% and 40% of eyes respectively. With regard to the ratio of eyes showing least APE according to SRK/T, SRK/II, Holladay-1 and Hoffer-Q formulae were 23.7%, 22.5%, 18.7% and 35% eyes respectively, which reveals that Hoffer-Q formula has the maximum predictive ability for IOL power calculation. But, we found that there is no significant difference between SRK/T, SRK/II, Holladay-1, and Hoffer-Q formulae in IOL power calculation. However from among these, Hoffer-Q formula seems to have an edge over others in arriving at best predictive value.*

Keywords: *Intraocular lens power calculation, Predictive error, Absolute Predictive error*

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I.INTRODUCTION

Of the 1.4 million blind children across the globe, 14% are estimated to be suffering from lens-related problems; with proportion varying across different countries.[1-3] Among them, childhood cataract is one of the major avoidable causes of blindness in both developed and developing countries. Hence, the pediatric cataract surgery becomes the essential step in achieving visual rehabilitation in children suffering from congenital and developmental cataracts. However, pediatric cataract eye surgery faces several technical shortcomings: chief among them being rapid growth of eye ball and consequent significant refractive changes in childhood, shorter axial lengths (AL), steeper corneas with higher keratometry (K) values, smaller anterior chamber depths (ACD) and target postoperative refraction in children often being distinct from emmetropia.

Since no accurate formula has emerged for IOL power calculation for children, various IOL formulae designed for adult eyes are being used, which have been showing varying degrees of accuracy in children.[5-10] Hence we made an attempt to assess the alternative best from among the available; SRK/T, SRK/II, Holladay-1 and Hoffer-Q.

II.PATIENTS AND METHODS

This is an institution based retrospective analysis conducted over a period of two years among 54 children- 34 boys and 20 girls; aged between 4 and 15 years; a total of 80 eyes (26 bilateral cataract and 28 unilateral cataract)- who were operated for congenital and developmental cataract. The subjects who underwent uncomplicated surgery accompanied by primary IOL implantation in the capsular bag were considered for the study. However, the other children in whom preoperative readings of AL, K and actual implanted IOL power could not be obtained, IOL was placed in the sulcus, and in whom follow-up refraction was not recorded between 4 and 8 weeks postoperatively were excluded.

Demographic, clinical and investigative data was collected from the records of the patients: date of birth and age, pre operative examination findings of anterior segment and fundus (B-scan wherever necessary), date of surgery, affected eye, K reading (automated keratometry), AL (contact method), calculated IOL power using SRK/T formula and IOL type implanted. Undercorrection was done depending on age at surgery for residual hyperopic error, or with consideration to the refractive status of the other eye. The predicted refractive error for the IOL implanted was noted for SRK/T, SRK/II, Holladay-1 and Hoffer-Q formulae.

The cataract surgeries were performed by a single experienced senior surgeon through a superior limbal section and 2 side ports followed by anterior capsulorrhexis and aspiration of lens material. Manual posterior capsulorrhexis done if needed and IOL (hydrophobic/hydrophilic) was implanted in the bag. The main port was sutured with 10-0 nylon and side ports with 10-0 vicryl. Retinoscopy was used for all patients to determine postoperative refraction with refinement by manifest refraction in older, cooperative children. This measure, obtained between 4 and 8 weeks postoperatively, was recorded and converted into spherical equivalent (spherical equivalent = sphere + cylinder/2).

Using AL, K, and the manufacturer's A constant, expected refraction was calculated with each of the 4 formulae. Prediction error (PE) and absolute prediction error (APE) were calculated for each formula in the following manner:

PE= Predicted refraction - Actual refraction

Absolute PE= | Predicted refraction - Actual refraction |

The formula which gave the best prediction (minimum APE) was assessed. An APE of >0.5D was considered significant.

The data was statistically analyzed by using arithmetic mean, range and standard deviation (SD) techniques. In addition, non-parametric analysis of variance (Friedman Test) was used to find out whether there was a significant difference between absolute PE and mean PE obtained with different formulae. The number of eyes with significant deviation was ascertained apart from noting under-correction or overcorrection by using four different formulae.

III.RESULTS

The mean age of patients was 9.61 years and the range of age being 4-15 years. The average K value (horizontal K+ vertical K/2), mean axial length and mean IOL power implanted were 44.64D, 21.99 mm and 23.59D respectively (Table 1). The predictive error <0.5D (not significant) with SRK/T, SRK/II, Holladay-1 and Hoffer-Q formulae were 35%, 32.5%, 37.5% and 40% of eyes respectively.

TABLE 1: Demographic Data of the Patients

Parameter	Mean±SD	Range
Age (yrs)	9.61±3.506	4-15
Axial length (mm)	21.99±1.545	17.88-27.44
Average K (D)	44.64±1.802	40.625-49
IOL power implanted (D)	23.59±4.486	8-34

To assess the mean PE and APE for the four different formulae, Friedman Test was used in the study and the results were formed into subgroups.

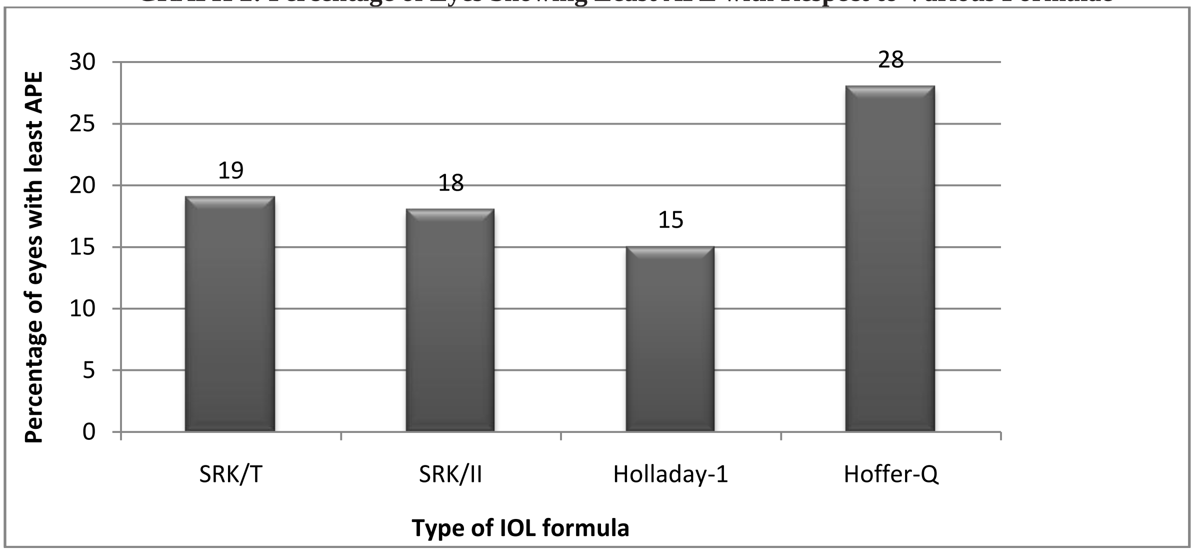
TABLE 2: Mean PE and APE with Each Formula in 80 Eyes

Name of formula	Mean PE	Standard Deviation	Median	Lower 95% Confidence interval for mean	Higher 95% Confidence interval for mean
Mean PE					
SRK/T	-0.18	1.18	-0.225	-0.44	0.08
SRK/ II	-0.45	1.49	-0.43	-0.78	-0.12
Holladay-1	-0.02	1.13	-0.04	-0.28	0.23
Hoffer-Q	-0.01	1.16	-2.48	-0.26	0.25
Mean APE					
SRK/T	0.93	0.74	0.76	0.76628	1.09585
SRK/ II	1.191	0.98	1.01	0.97900	1.41763
Holladay-1	0.88	0.71	0.76	0.72352	1.04035
Hoffer-Q	0.92	0.71	0.88	0.75838	1.07274

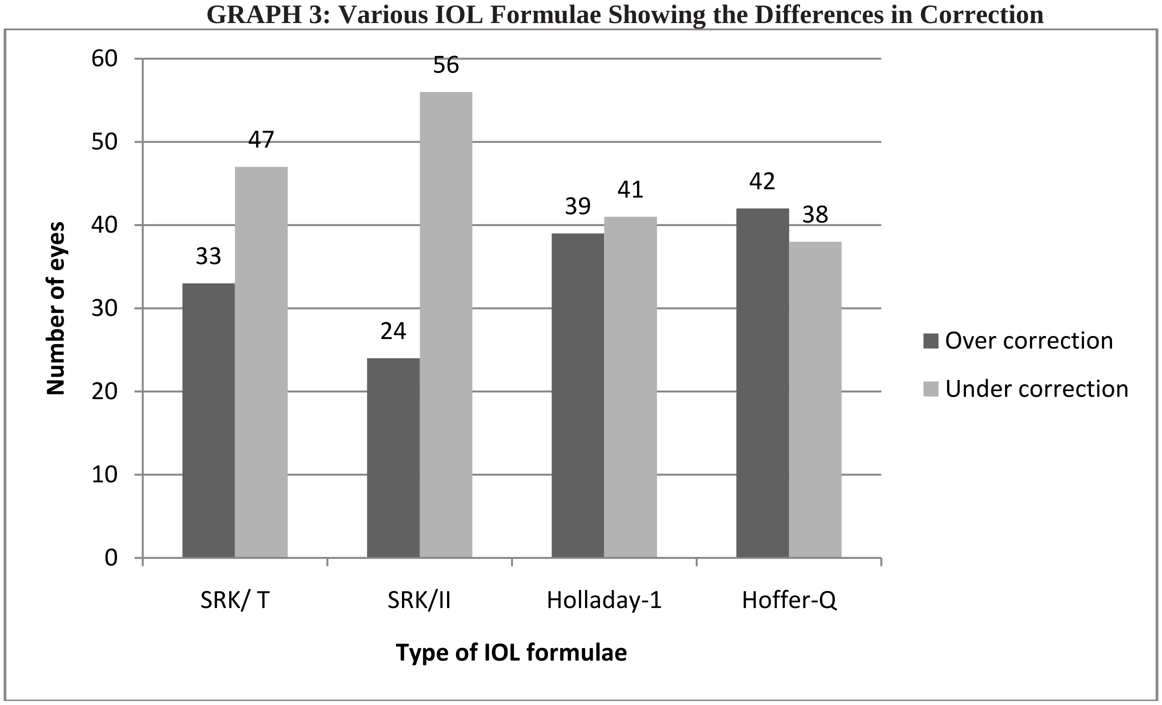
One way Anova test (Friedman Test) revealed no significant difference in the mean PE obtained (P<0.093824) but revealed statistically significant difference in the APE obtained (P=0.046064) at five per cent confidence level.

The number of eyes showing least APE according to SRK/T, SRK/II, Holladay-1 and Hoffer-Q formulae were 19, 18, 15 and 28 eyes respectively, and the same was presented in Graph-1; which reveals that Hoffer-Q formula has the maximum predictive ability for IOL power calculation.

GRAPH 2: Percentage of Eyes Showing Least APE with Respect to Various Formulae



GRAPH 3: Various IOL Formulae Showing the Differences in Correction



When the amount of diversity of correction was calculated in 80 eyes, the results arrived from four formulae varied significantly. The SRK/T (33 vs 47) and SRK/II (24 vs 56) revealed a distinctly more number of eyes of under correction as compared to over correction. In the case of Holladay-1 (39 vs 41) formula under correction was only marginally higher as compared to over correction. In contrast to the above three formulae Hoffer-Q (42 vs 38) formula showed more of overcorrection than under correction. Graph-2 helps in clear understanding of the variation in the results.

IV.DISCUSSION

The placement of an IOL in children undergoing cataract surgery is gaining wider acceptance.[4-6] In addition, with improved surgical equipment and techniques, the acceptable age for IOL implantation is becoming progressively younger.[4] With the trend toward implanting IOLs in infants with shorter AL values and higher K values, there is a need to understand the accuracy and the difference between prediction formulae at lower extremes of ALs and at the higher extremes of K values for calculation of IOL power. In the present study, we evaluated four IOL calculation formulae - SRK/T, SRK/II, Holladay-1 and Hoffer-Q.

The predictive error of less than 0.5D with SRK/T, SRK/II, Holladay-1 and Hoffer-Q formulae were 35%, 32.5%, 37.5% and 40% respectively, which means Hoffer-Q formula has the maximum predictive ability. Similar results were found in Nihalani et al[7] study in which Hoffer-Q formula gave the best prediction value. But in another study done by Vasavada et al[8] they found that the least PE was with SRK/T formula followed by Holladay 2. This might be because Hoffer-Q is best for IOL power calculation in smaller eyes and in our study 44 out of 80 eyes had axial length <22mm.

The mean prediction error (PE) was assessed in all eyes in accordance to various formulae using Friedman test and tabulated in subgroups (Table 2). There was no significant difference in the mean PE between the four formulae by One way Anova test (P<0.093824). In the study done by Neely et al[7], they also reported that among the formulae tested, that is, SRK/T, SRK/II, Holladay-1, and Hoffer-Q, there was no significant difference.

The number of eyes showing least APE according to SRK/T, SRK/II, Holladay-1 and Hoffer-Q were 19, 18, 15 and 28 eyes respectively. Least APE was found in maximum number of eyes when Hoffer-Q formula was used and in minimum number of eyes when Holladay-1 formula was used, thus pointing towards the more efficacious adoptability of Hoffer-Q.

When the amount of diversity of correction was calculated by using the four IOL formulae, it was observed that overcorrection and under-correction differed substantially i.e., SRK/T (33 vs 47), SRK/II (24 vs 56), Holladay-1 (39 vs 41) and Hoffer-Q (42 vs 38).(Graph 3) When all the four IOL formulae were compared for the amount of diversity in correction, it was observed there is more likelihood of overcorrection by Hoffer-Q formula, while all the other formulae showed more likely an undercorrection. Similar results were found in Nihalani et al[7] study.

Limitations of the study are small sample size, use of manual method for measurement of axial length.

V.CONCLUSIONS

The IOL power calculation continues to be a herculean task for a pediatric ophthalmologist inspite of numerous formulae being available for power calculation. In the present study we found that there is no significant difference between SRK/T, SRK/II, Holladay-1, and Hoffer-Q formulae in IOL power calculation. But from among these, Hoffer-Q formula seems to have an edge over others in arriving at best predictive value. However, more comprehensive studies seem necessary with a larger sample size and use of automated measurements to prove the same.

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