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STUDY AND COMPARE POST-OPERATIVE REFRACTIVE OUTCOME OF PATIENTS UNDERGOING CATARACT SURGERY WITH IOL CALCULATION BY BARRETT UNIVERSAL II AND SRK-T FORMULAE

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ABSTRACT **Background-** Modern cataract surgery is gradually becoming both a rehabilitative and a refractive procedure. An accurate biometry and appropriate intraocular lens power calculation formula selection in cataract surgery is very important for post-operative patient satisfaction. By customizing the IOL power during cataract surgery we can provide patients best refractive outcomes even in high myopes & hypermetropes. **Methodology-** The study was undertaken in the department of ophthalmology, VMMC & Safdarjung Hospital,New Delhi. A total of 60 eyes of patients who had immature senile cataract and were due for undergoing phacoemulsification surgery were enrolled for the study. Patients were divided in two groups with 30 patients each. All the patients were examined before the surgery and on day1,week1 and week 6 after the surgery. At each followup VA, IOP, slit-lamp examination and refraction(except on day1) was done. **Result-** Our study comprised of 60 patients (30 patients in each group) who are above 40 years of age, with mean age 56±10.38 years (range from 40-78 years) in group-1 and 59±9.52 years(range from 42-74 years) in group-2. The mean pre-operative visual acuity was 0.86±0.23(LogMAR) in group-1and0.93±0.26 (LogMAR) ingroup-2. The mean IOL power used in surgery was 21.07±1.79.in most of the eyes that there was a difference of IOL power of ±0.50D, when IOL power was calculated by both the Barrett Universal II and SRK-T formulas. **Conclusion-** The Barrett Universal II formula shows more accuracy in prediction of actual post-operative refraction than SRK-T formula.

KEYWORDS : IOL, Barrett universal II, SRK-T, cataract, phacoemulsification

INTRODUCTION

Modern cataract surgery is gradually becoming both a rehabilitative and a refractive procedure. An accurate biometry and appropriate intraocular lens power calculation formula selection in cataract surgery is very important for postoperative patient satisfaction. The introduction of optical coherence interferometry has increased the accuracy of biometry[1]. Phacoemulsification was first introduced by Charles C Kelman in 1967. Phacoemulsification is a technique of lens removal that uses an ultrasonically-driven tip to fragment the nucleus of the cataract and aspirate the lens. By customizing the IOL power during cataract surgery we can provide patients best refractive outcomes even in high myopes & hypermetropes. A state of emmetropia occurs when the image of a distant object is focused on the retina without the aid of adjunctive spectacles correction. Various formulas have been developed over the last two to three decades to calculate the power of IOL required to achieve emmetropia postoperatively. These formulas are classified into theoretical formulae based on geometric optical principles (optical model of eye)[2] and empirical or regression formulae based on empirical data analysis of eyes with IOL implantation[3,4]. The regression formulas worked well in axial length between 22-24.5mm[5].

As theoretical formulas, are based on physiologic optics, they may be more accurate than regression formulas when applied to long and short eyes. In the derivation of SRK-T formula, Retzlaff, Sanders and Kraff merged the theoretical and regression approaches. The SRK-T formula had a non-linear theoretical equation as its foundation which is optimized by empirical regression methodology .The postoperative anterior chamber depth prediction, retinal thickness and corneal refractive index were systematically and interactively optimize during repeating rounds of analysis in the data set up to derive the SRK-T formula. This formula was found to be more accurate in extremely long eyes with axial length more than28mm[6].

The Barrett Universal formula was published in 1993 by Dr. Graham D. Barrett[7].The formula was an enhancement of a previous IOL power formula developed for hydrogel IOLs[8]. It was a thick lens formula based on Gaussian optical principles. This formula had IOL's thickness, refractive index and location of principle planes of refraction as relevant variables. This formula had the universal description because it can be used for all IOL types as well as for all axial length ranges. This formula contains expression for the first and second principle plane of refraction. The location of the second principle plane from a relatively fixed anatomical reference plane, such as the plane of the iris in the pseudophakic eye, is primarily determined by the characteristics of IOL that can be described as a lens factor. This formula is found to be accurate in the entire range of axial lengths in the study of 100 eyes in the same article by Barrett[7]. Further an update of Barrett Universal formula was introduced in 2010 by Graham D.Barrett[9]. In this update (Barrett Universal II), the effective lens position (ELP) also depends on anatomical factors such as axial length, keratometry, optical anterior chamber depth(ACD), lens thickness (LT) and horizontal white to white (WTW). A crucial difference in the Universal formula compared with other formulas is that it recognizes, in the presence of a negative power IOLs. This formula does not require 'A' constant modifications or unusual A-constants in highly myopic patients with low or negative power IOLs.

As there is paucity of the studies, the above research was conducted to study and compare the post-operative refractive outcome of patients undergoing cataract surgery with IOL calculation by Barrett Universal II and SRK-T formulae.

MATERIALS AND METHODS

Location-

The study was conducted at Tertiary Eye Hospital (VMMC & Safdarjung Hospital, New Delhi) in the department of ophthalmology,

Study design-Randomized interventional study.

Inclusion criteria-

Patients with Immature senile cataract of grade1 2&3 (LOCSIII), age 40-80 years and willing to give written informed consent for participation.

Exclusion criteria-

Patients with associated glaucoma, Non-correctable retinal and corneal problems affecting vision, History of trauma, steroid induced cataract, Intraoperative and postoperative complications, Systemic diseases like diabetic maculopathy, unwilling to give informed consent.

Sample size- 60 eyes with 30 each, randomized into two groups
Group1- IOL power calculation by using Barrett Universal II.
Group2- IOL power calculation by using SRK-T.

Data analysis-

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Normality of data was tested by Kolmogorov- Smirnov test. If the normality was rejected then non parametric test was used.

Statistical tests were applied as follows-

1. Quantitative variables were compared using Independent t test/Mann-Whitney Test (when the data sets were not normally distributed) between the two groups.
2. Qualitative variables were correlated using Chi-Square test.

A p value of <0.05 was considered statistically significant. The data was entered in MS EXCEL spreadsheet and analysis was done using

Statistical Package for Social Science(SPSS) version 21.0.

Ethical considerations-
All the required ethical clearance was obtained from the Institutional Ethics Committee of V.M.M.C and Safdarjung hospital before starting the study.

Valid informed consent was obtained from every participant. Approval number: IEC/VMMC/SJH/Thesis/October/2017-138

Preliminary screening assessment& examination was done. Once patients were selected, baseline assessment was done including best corrected visual acuity, refraction, IOP, anterior segment evaluation with slitlamp bio microscopy, fundus examination by direct and indirect ophthalmoscopy, keratometry, axiallength, ACD and WTW measurement by IOLMASTER, IOL Power calculation by two formulae: Barrett Universal II and SRK-T. Other routine investigations were done including blood sugar (fasting and PP). Patients were then randomly divided into two groups.
Group1-IOL power calculation by using Barrett Universal II.
Group2- IOL power calculation by using SRK-T.

All patients under went phacoemulsification by temporal clear corneal incision. The same procedure i.e. phacoemulsification was done for cataract extraction along with foldable PCIOL implantation. The patients were then reviewed at post-operative day 1, week 1, week 6.The postoperative refraction was compared with the preoperative predicted refractive error inboth the groups to decipher if the formulae are different and if the difference is occurring by chance (null=0).

RESULT
Table. 1: Age wise distribution:

Age	GroupI	GroupII	Total	Pvalue
40 –50years	13(43.33%)	9(30.00%)	22(36.67%)	0.597
51-60years	7(23.33%)	8(26.67%)	15(25.00%)	
61-70years	7(23.33%)	11(36.67%)	18(30.00%)	
71-80years	3(10.00%)	2(6.67%)	5(8.33%)	
Total	30 (100%)	30 (100%)	60 (100%)	

The number of patients in age group 40-50 were 22 (36.67%), 51-60 were 15 (25.00%), 61-70 were 18(30.00%) and in age group 71-80 were 5(8.33%). The mean age for the study sample population in group1 was 56±10.38 years (range from 40-78 years). The mean age for the study sample population in group 2 was 59±9.52 years (range from42-74years).

Table.2: Pre-operative visual acuity of entire study population

Statistical parameter	Visual acuity (LogMAR)
Mean± Standard deviation	0.89±0.25
Median	1
Range	0.30-1.48

The mean pre-operative visual acuity of the study population was 0.89 ± 0.25 Log MAR units (range:0.30—1.48).

Table.3: Comparison of post-operative Visual Acuity and post-operative refractiveerror in Group 1&2.

Group	Parameters	Mean±SD	P Value
1	UCVA at 6 weeks(LogMAR)	0.06±0.03	0.0023
2		0.16±0.11	
1	BCVA at 6weeks (LogMAR)	0.04±0.08	0.18
2		0.05±0.09	
1	Refractive error(D)	-0.12±0.45	0.011
2		-0.47±0.63	

The mean uncorrected visual acuity (UCVA) and the mean best corrected visual acuity (BCVA) at 6 weeks was 0.16±0.11 LogMAR units and 0.05±0.09 LogMAR units respectively.

Interpretation for table 3: (p value <0.05 statistically significant)
Group 1 and group 2 show significant differences in UCVA and refractive Error at 6 weeks post operation.

Table.4: Comparison of Biometry data of the study population in group1 &2.

Group	Parameters	PValue
1	AL(mm)	0.464
2		
1	KM(D)	K1=0.982
2		K2=0.822
1	IOL Power used(D)	0.879
2		
1	ACD(mm)	0.371
2		
1	WTW(mm)	0.430
2		

Interpretation for table 4: (p value >0.05 statistically not significant)
There was no statisctically significant difference in the biometry data of the study population between group 1 and group 2

Table.5: Predicted error (absolute value) in Dioptres(D) and prediction error (absolute value) in Dioptres (D) in group1&2.

	Group 1	Group 2	Pvalue
Predictederror (absolutevalue)			0.019
Sample size	30	30	
Mean± SD	0.15± 0.2	0.08± 0.07	
Median	0.1	0.06	
Min-Max	0-1.04	0-0.34	
Interquartile Range	0.0400- 0.160	0.0300- 0.100	
Prediction error1wk(absolutevalue)			0.030
Sample size	30	30	
Mean± SD	0.59± 0.35	0.77± 0.51	
Median	0.57	0.64	
Min-Max	0.04-1.24	0.08-2.23	
Interquartile Range	0.320- 0.850	0.400- 0.990	
Prediction error6wk(absolutevalue)			0.001
Sample size	30	30	
Mean± SD	0.33± 0.27	0.6± 0.48	
Median	0.22	0.48	
Min-Max	0-0.99	0.08-1.88	
Inter quartile Range	0.0900- 0.520	0.260- 0.740	

Interpretation for table 5: (p value <0.05 statistically significant)
There are statistically significant differences in predicted error (in dioptres D) between group 1 and group 2 at both 1 week and 6 weeks

Table.6: Prediction error of post-operative refraction of study population at 6weeks

Formula	Mean numerical error±SD(D)	Mean absolute error±SD(D)	Median absolute error(D)	Range(D)
BUF II	-0.22±0.37	0.33±0.27	0.22	-0.99-0.59
SRK-T	-0.44±0.63	0.6±0.48	0.48	-1.85-1.88

Interpretation for table 6:There were statistically significant differences between the mean absolute errors of post-operative refraction given by two formulas.

Table.7: Comparison of mean absolute prediction errors obtained by the two IOL power calculation formulas

Formulas compared	P- value
Group-1(BUFII)	0.001
Group-2(SRK-T)	

Interpretation for table 7:the comparison of mean absolute prediction errors between two iol power calculation formulas, Group-1(BUFII) and Group-2(SRK-T) reveals a statistically significant difference with a p value of 0.001.

The mean absolute error is used as a marker of accuracy. In the study sample population, the Barrett Universal II formula gave the lower mean absolute error (0.33±0.27D) and median absolute error (0.22D) in comparison with SRK-T formula (mean absolute error 0.6±0.48Dand median absolute error 0.48D) in predicted post-operative refraction. On analysis of study population, there is statistically significant difference between two groups (P value of 0.001).This implies that Barrett UniversalII formula is more accurate in prediction of actual post operative refraction than SRK-T formula.

DISCUSSION

The above study comprised of 60 patients (30 patients in each group) who are above 40 years ofage, with mean age 56±10.38 years (range from 40-78 years) in group-1 and 59±9.52 years(range from 42-74 years) in group-2. The mean pre-operative visual acuity was 0.86±0.23(LogMAR) in group-1 and 0.93±0.26(LogMAR) in group-2 and this difference was statistically not significant (P value=0.274). The mean axial length of study population was 23.21±0.82 mm (range from 21.61 to 24.85 mm) and mean keratometry K1 was 43.83±1.71D (range from 40.61 to 47.87 D) and K2 was 44.71±1.73 D (range from 41.77 to 48.21 D). There was statistically insignificant difference in Biometry data of the study population in group 1 & 2. The predicted error of Barrett UniversalII formula was calculated from the online calculator of Barrett Universal II formula with biometry measurements from IOL master 500 which takes 2 to 3 minutes for calculation. The predicted error of SRK-T was obtained from IOL master500. It was seen in most of the eyes that there was a difference of IOL powerof±0.50D, when IOL power was calculated by both the Barrett Universal II and SRK-T formulas. The post-operative The post-operative visual acuity (UCVA at 6 weeks) was significantly better when the Barrett Universal II IOL Power calculation formula was used in comparison with SRK-T formula and the difference was statistically significant (P value= 0.0023). But the difference of post-operative visual acuity (BCVAat6weeks) was statistically not significant (Pvalue=0.18). It was also seen that the post-operative refractive error showed better when Barrett Universal II formula was used in comparison with SRK-T formula and the difference was statistically significant (P value=0.011). Considering the entire study population in this study, the mean absolute error in prediction was lower in Barrett Universal II (0.33±0.27D) as compare to SRK-T (0.6±0.48D). There was statistically significant difference between the mean absolute error obtained by Barrett Universal II and SRK-T formulas (P value=0.001). The percentage of prediction error within the range of ±1D and ±0.5 was 100% and 70%respectively in Barrett Universal II and 80% and 53.3% respectively in SRK-T. This is well within the benchmark standard determined for National Health Services, United Kingdom (85% of prediction error within ±1D and 55% of prediction error within ±0.5D)[10]. On comparison with other studies, our study showed similar results with Barrett Universal II formula. In our study, there was no division of eyes based on axial length. There were no patients with very short and long eyes in our study population. This might be the reason why there was no refractive surprises when the Barrett Universal II formula was used for IOL power calculation. The percentage of eyes with prediction error within ±1D was 100% in Barrett Universal II formula in above study but not with other studies where they had included very short and long eyes. A large sample study comparing the Barrett Universal II IOL power calculation formula with other newer generation formulas such as Holladay 2, Olsen, Hoffer Q, Haigis, Hill-RBF etc. can further enlighten our knowledge of its accuracy in predicting post-operative refraction.

In a study conducted by **Kane etal**[11]in which they compared seven formulas using IOL master (Carl,Jena,Germany) Biometry measurements, after statistically comparing the mean absolute prediction error, the Barrett Universal II was a more accurate predictor of actual postoperative refraction than the other formulas. In a study done by **Cooke et al**[12] where they evaluate the accuracy of nine intraocular lens calculation formulas using two optical bio-meters, IOL master was based on partial coherence interferometry (PCI) and the Lenstar on optical low coherence interferometry (OLCR). Here ranking of nine IOL power calculation formulas was done by standard deviation of the prediction error. The Barrett Universal II performed the best if only PCI(without lens thickness)was used. In a study by **Wang Q et al.**[13] where they compare the accuracy of intraocular lens power calculation in long eyes. Out of six IOL power calculation formulas, the mean absolute error was lower in Barrett Universal II formula which shows superiority in predicting IOL power in long eyes. In a study conducted by **MellesRBetal.**[14]comparing the accuracy of intraocular lens (IOL) calculation formulas (Barrett Universal II, Haigis, Hoffer Q, Holladay 1, Holladay 2, Olsen, and SRK/T) in the prediction of postoperative refraction using a single optical biometry device. The standard deviation of the prediction error was lower in Barrett Universal II formula who shows significantly better than the other formulae in postoperative refraction prediction.

In above study, we statistically compared the mean absolute prediction errors of Barrett Universal II formula and SRK-T formula using IOL Master 500 measurements which didn't include lens thickness measurement. In this study, the mean absolute prediction error was found to be lowered in Barrett Universal II formula in comparison with SRK-T formula and the difference was statistically significant. For statistical analysis we used mean absolute error instead of mean numerical error as a marker of accuracy because using mean numerical error as a marker of accuracy can lead to erroneous results due to cancellation during summation. The analysis of mean absolute error as a marker of accuracy was suggesting by **Aristodemo Pet al.**[15] in response to the article by **Hofferetal.**[16]

CONCLUSION

From the above conducted study we can conclude that the Barrett Universal II formula shows more accuracy in prediction of actual post-operative refraction than SRK-T formula.

Glossory Of Abbrevations

IOL	Intraocular lens
PCI	Partial Coherence Interferometry
OLCI.	Optical Low Coherence Interferometry
PCIOL	Posterior Chamber Intraocular Lens
ACIOL	Anterior Chamber Intraocular Lens
ELP	Effective Lens Position
SRK	Sanders, Retzlaff and Kraff
AL	Axial Length
KM	Keratometry
ACD	Anterior Chamber Depth
WTW	White to white
BU II	Barrett Universal II
UCVA	Uncorrected Visual Acuity
BCVA	Best Corrected Visual Acuity

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