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Clinical outcomes and comparison of intraocular lens calculation formulas in eyes with long axial myopia

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Abstract:

PURPOSE: The purpose of this study was to report the clinical and refractive outcomes of eyes with long axial length (AL) and high myopia that underwent cataract surgery and compare the performance of intraocular lens (IOL) calculation formulae on these eyes.

MATERIALS AND METHODS: This retrospective cohort included 183 eyes that underwent cataract surgery from January 2010 to December 2018. Demographics, AL, postoperative best-visual acuities, IOL power data, and postoperative complications were recorded. Refractive outcomes were analyzed and absolute predicted errors were compared between five IOL calculation formulas.

RESULTS: The mean age included in the study was 65.4 ± 9.39 years with a mean AL of 26.76 ± 1.75 mm. Postoperatively, the mean sphere, cylinder, and manifest refraction spherical equivalent were 0.22 D ± 0.54, −0.78 D ± 0.50, and − 0.16 D ± 0.50, respectively. The average IOL power implanted was 11.12 D ± 4.59 D. No intraoperative complications were encountered, but there was one incidence of retinal tear with detachment reported postoperatively (0.55%). The Kane formula had the lowest mean absolute predicted error (MAE). A significant positive correlation between increasing AL and MAE was seen in the Sanders, Retzlaff and Kraft-Theoretical (SRK-T) and Ladas formulae but not statistically significant when the Kane, Barrett Universal II, and the Emmetropia Verifying Optical (EVO) formulae were used.

CONCLUSION: Cataract surgery in eyes with long ALs and high myopia is safe with a low incidence of intraoperative and postoperative complications. The Kane, Barrett, and EVO formulae were equally accurate in calculating the IOL power and achieved the least amount of residual error postoperatively.

Keywords:

Barrett, cataract surgery, Emmetropia Verifying Optical, high myopia, intraocular lens formula, Kane, Ladas, long axial length, SRK-T

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Introduction

The axial length (AL) of the eye is determined by the anterior chamber depth (ACD), lens thickness, and the vitreous chamber depth.[1] The normal AL is defined as an eye with an anteroposterior diameter of 23–25 mm. and eyes that are myopic or hyperopic tend to have ALs of more than 25 mm or <23 mm, respectively.[2,3] The American Academy of Ophthalmology defines high myopia as eyes with measured ALs of at least 26 mm or longer.[2]

Myopia is common in Asia with a prevalence of 1.3%–26% in the general population and up to 36.3% in cataractous patients older than 70 years of age.[3] Clinically, myopia is associated with early cataracts, retinal breaks and detachments, chorioretinal atrophy, optic disc abnormalities, staphyloma, open-angle glaucoma, and corneal higher-order aberrations. Cataract surgery in

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myopic eyes is associated with increased risk of posterior capsular rupture, retinal detachment, postoperative refractive surprise, and other complications.[4,5] It has also been reported that patients with long ALs who are younger than 50 years of age at the time of cataract surgery carry an increased risk of postoperative retinal detachment at a rate of 3.65% versus 2.52% in patients who are more than 50 years of age.[6]

Aside from the inherent risks and complications associated with cataract surgery in axial and clinical myopia, the refractive outcomes using existing formulae have so far been verified in several studies to be accurate for eyes whose ALs are within 22–25 mm, but there is no universal agreement in eyes longer than 25 mm.[7] Given the recent advances in IOL calculation formulae as well as the increased patient expectation for postoperative refractive results, it is imperative that the accuracy of the said formulae is evaluated, especially for those with long ALs.

Several studies have been done comparing older third- and fourth-generation formulae (SRK-T, Hoffer Q, and Holladay I, Haigis, Holladay 2, Wang-Koch AL Adjustment, and the Barrett Universal II) and newer generation formulae such as the Olsen, Hill-radial basis function (Hill-RBF), Kane, Emmetropia-Verifying Optical (EVO), and the Ladas formulae. An updated version of the archaic SRK formula, the SRK-T involves a theoretical mathematical model and empirical regression to optimize the postoperative ACD prediction, retinal thickness AL correction, and corneal refractive index[8] and was previously thought of as the better performing formula in normal and long eyes. However, more recent studies have shown that for long eyes, the Barrett Universal II formula is the more accurate formula to use. The Barrett Universal II formula, available as an online intraocular lens (IOL) calculator, is based on a theoretical model eye wherein the ACD is related to AL and keratometry and has the ability to maintain postoperative predictive accuracy across a wide range of AL and ACD.[9]

The Kane formula uses artificial intelligence as well as theoretical optics, thin lens formula, and large sets of data from high-volume surgeons to make IOL predictions.[10] The EVO formula, based on the theory of emmetropization, takes into account the optical dimensions of the eye and generates an emmetropia factor for each eye to make predictions.[11] The Ladas superformula, created by Dr. John Ladas, was developed with the aim of being a single perfect IOL calculation formula.[11] It uses artificial intelligence to choose which existing available IOL formula is best for a particular AL or corneal power.[12]

Performing cataract surgery on eyes with long AL carries inherent risks because of the anatomy a long eyeball. In this paper, we aim to report the real-world incidence of intraoperative and postoperative complications in consecutive patients in a private practice. In eyes with long AL and high myopia, it is difficult to target emmetropia consistently. Given the recent advances in optimizing IOL power calculation, the other objective of our study is to compare the accuracy of the various IOL calculation formulas, including newer generation ones such as the Barrett Universal II, Kane, EVO, and Ladas formulae, in predicting postoperative refraction.

Methods

Patients

This is a single-surgeon retrospective review of medical charts of patients whose eyes have ALs of 25 mm or more who underwent phacoemulsification with IOL insertion at an ambulatory surgicenter from January 2010 to December 2018. The study was approved by the Institute's ethics review committee (St. Frances Cabrini Medical Center-Asian Eye Institute (SCMC-AEI) Ethics Review Committee #2019-005) and was conducted in accordance with the Declaration of Helsinki. Inclusion criteria were as follows: (1) 18 years old and above, (2) AL ≥25 mm, and (3) postoperative follow-up of more than 1 month. Excluded patients were those who had incomplete preoperative and postoperative data, had <1 month of postoperative follow-up, had existing cornea, iris, or pupil abnormalities, or had previous corneal surgeries performed.

Biometry was performed using the optical biometer IOLMaster 500 or 700 (Zeiss, Germany) or immersion ultrasound biometer Axis Nano II (Quantel Medical, France) if the IOLMaster was unable to get an acceptable biometry measurement. IOL power calculation was performed using the SRK-T formula from the biometry printout from 2010 to 2016 and online Barrett calculator from 2017 to 2018. We used the surgeon's personalized A-constant for each type of IOL. From the printouts, we selected the IOL power that corresponds to the second minus refraction in the SRK-T formula printout before 2016 and the first minus refraction from the Barrett formula printout beginning 2017. Phacoemulsification was performed in all patients through clear corneal temporal incisions made through a temporal approach using a femtosecond laser (Victus, Bausch, Germany) or corneal incision blades. All patients included had a minimum of 1-month follow-up. Manifest refraction and visual acuity were measured at every postoperative clinic visit. Dilated retina evaluation was performed at 1 month and every annual postoperative clinic visit, up to 8 years postoperatively in some patients. The institute's ethics review committee agreed to waive patients consent.

Data calculation and analysis

Information obtained during the chart review included the age at the time of operation, sex, IOL power used, biometry measurement, manifest refraction spherical equivalent (MRSE), intraocular pressure, slit lamp, and retina examination. Each eye underwent biometry measurement preoperatively; therefore, each eye had a printout with the SRK/T formula. Biometric data were then entered into the online calculators for the Barrett Universal II, Kane, EVO, and Ladas formulae, and the estimated preoperative target refraction corresponding to the actual IOL power used was obtained. By subtracting the preoperative target refraction from the actual 1-month postoperative MRSE, we were able to calculate the refractive predicted errors (PEs) per eye. A negative PE indicates a more myopic postoperative refractive result than predicted by the formula, while a positive PE indicated a more hyperopic refractive result. Absolute errors (AE) of the five formulae were obtained by removing the polarity of the PE of each eye and assigning it as the absolute value for analysis. The mean absolute error (MAE) with standard deviation (STDEV) and the median AE (MedAE) for each formula were calculated accordingly. Further, the percentage of eyes with PEs within 0.25 D, 0.50 D, 1.0 D, and 2.0 D was calculated for all five formulae. Subgroup analysis was done separating the eyes into three groups based on AL: 25–26 mm, 27–29 mm, and ≥30 mm.

Statistical analysis

Demographic data were analyzed using mean and STDEV for continuous variables, while for categorical variables, frequency and percentage were used. Analysis of variance (ANOVA) was used to determine if there was a significant difference between the IOL calculation formulas, and the *P* value was set at 0.05. Pearson correlation was used to determine the relationship between AL and refractive absolute PE. The differences within the AL subgroups were assessed using ANOVA followed by Tukey's honestly significant difference in case a significant difference was seen. All statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS) Program (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY, USA: IBM Corp).

Results

One hundred and eighty-three eyes were included in the study with a mean age of 65.4 years ± 9.39 (range, 40–90 years) and mean AL of 26.76 mm ± 1.75 (range, 25.00–34.59 mm). The mean IOL power implanted is 11.12 D ± 4.59 D (range, −5.0 D–17.5 D) [Table 1].

Preoperatively, three eyes that had lattice degeneration and one eye that had a retinal hole underwent focal retina laser treatment. One eye had a previous retinal detachment which had a scleral buckle at the time of surgery. Six eyes had preexisting posterior vitreous detachment (PVD) which did not worsen postoperatively.

Table 1: Demographic data

Parameter	Mean±SD (range) or percentage
Age (years)	65.4±9.39 (40-90)
Sex (male/female)	45 (42.5)/61 (57.5)
Preoperative UCDVA (logMAR)	1.34±0.56 (0.0-2.4)
Preoperative BCDVA (logMAR)	0.25±0.28 (0.0-1.3)
Sphere	−6.40±5.83 (1.5-−29.5)
Cylinder	−1.16±0.81 (0.0-−5.0)
MRSE	−6.97±5.87 (1.25-−29.5)
AL (mm)	26.76±1.75 (25.00-34.59)
ACD (mm)	3.47±0.40 (2.51-4.41)
Mean K	44.11±1.29 (41.3-47.5)
Mean corneal astigmatism	−1.04±0.65 (−0.32 D-−2.98 D)
Corneal astigmatism ≥ 1.0 D	101/183 (55.2)
Corneal astigmatism ≤ 1.0 D	82/183 (44.8)
Toric/nontoric	76/107 (41.5/58.5)
IOL power	11.12 D±4.59 D (−5.0 D-17.5 D)

Values are presented as mean±SD (range) or percentages. MRSE=Manifest refraction spherical equivalent, SD=Standard deviation, logMAR=Logarithm of the minimum angle of resolution, UCDVA=Uncorrected distance visual acuity, BCDVA=Best-corrected distance visual acuity, AL=Axial length, ACD=Anterior chamber depth, IOL=Intraocular lens

However, six eyes which did not previously have PVD developed PVD postoperatively. One eye that had an epiretinal membrane preoperatively had a best-corrected distance visual acuity (BCDVA) of 20/40 (logarithm of the minimum angle of resolution [logMAR] 0.3) 1 month after cataract surgery. Postoperatively, one eye had a lattice hole and underwent focal retina laser treatment at 4 months postcataract surgery. Two eyes developed cystoid macular edema (CME) and had topical medical therapy. Eleven out of 183 (11/183, 6.01%) eyes had intraocular pressure spike on the 1st postoperative day necessitating use of antiglaucoma medication which normalized intraocular pressures of all eyes after 1 week of treatment. All eyes had uneventful course and BCDVA of at least 20/40 (logMAR 0.3) or better except for one eye that developed retinal detachment wherein the eye progressed to phthisis [Table 2].

The patient that had the retinal detachment and phthisis was a 54-year-old male with a preoperative uncorrected distance visual acuity (UCDVA) of 20/400 (logMAR 1.3) in both eyes and MRSE of −5.00 D and −6.00 D and BCDVA 20/20 (logMAR 0). AL for the right eye was 27.13 mm and 27.15 mm for the left eye. At 1 month postoperatively, UCDVA was 20/20 (logMAR 0) for both eyes (MRSE −0.13D OD, −0.38D OS). One year postoperatively, the patient had sudden blurring of vision upon waking up, chiefly in the middle and bottom fields of vision in the left eye. It was revealed that the patient did strenuous workout the previous night. Upon examination, three horseshoe tears were seen at 11 o'clock, 12 o'clock, and 7:30 associated with superior detachment. Repair of the retinal detachment was performed through pars plana vitrectomy with gas tamponade and focal laser treatment. One month postvitrectomy, hyphema was noted in the anterior chamber as well as re-detachment of the retina. Scleral buckling with silicone oil injection was then performed. Three years postvitrectomy (4 years after cataract surgery), the patient's eye became phthisical. The fellow eye developed PVD 2 years after cataract surgery and traction with impending tear was seen 4 years postcataract surgery. Laser indirect ophthalmoscopy was performed with no further sequela. There were no intraoperative complications such as posterior capsular rupture encountered in the entire study group.

The mean preoperative refractive errors were −6.40 D sphere ± 5.83 D, −1.16 D cylinder ± 0.8 D, and MRSE of – 6.97D ± 5.87 [Table 2]. Postoperatively, UCDVA and BCDVA were logMAR 0.14 D ± 0.16 and logMAR 0.05 D ± 0.10, respectively [Table 3].

ANOVA of refractive predicted AEs of all eyes showed no statistically significant difference among the formulae ($P = 0.22$), however, the Barrett formula had the lowest MedAE and the second-lowest mean absolute error (MAE) at par with the EVO formula. In our study, the Kane formula performed best by having the lowest MAE as well as the highest percentage of eyes within 0.25 D, 0.50 D, and 2.0 D [Table 4]. The SRK-T formula had the highest MAE in this study and the lowest percentage of eyes within 0.25 D, 0.50 D, and 2.0 D. The LADAS formula had the second-lowest percentage of eyes within 0.25 D, 0.50 D, 1.0 D, and 2.0 D.

To determine whether there is an association between increasing AL and absolute PEs, Pearson correlation [Table 5] and linear regression were performed [Figure 1] for each formula. A significant positive correlation was seen between increasing AL and absolute PEs when using the SRK-T and LADAS formulae, $P < 0.05$ for both. Although the Barrett, Kane, and EVO formulae also showed a positive correlation, these were not found to be significant.

Subgroup analysis of the MAE was also performed based on AL (25–26 mm, $n = 128$; 27–29 mm, $n = 40$; 30 mm or more, $n = 15$) which showed that the differences in the PEs of the formulae are seen only in the extremely long ALs of more than 30 mm ($P < 0.05$) [Table 6]. In this subgroup, a significant difference was seen only when the SRK-T formula was compared to the Barrett ($P < 0.01$), Kane ($P < 0.01$), and EVO ($P < 0.05$) formulae but not when the comparison is between SRK-T and LADAS.

Discussion

This study evaluated the clinical and refractive outcomes

Table 2: Preoperative ocular conditions and postoperative complications in 183 eyes that underwent phacoemulsification with intraocular lens implantation

Ocular conditions	Eyes	Rate (%)
Preoperative		
Primary open angle glaucoma	7	3.83
Myopic degeneration*	6	3.28
Posterior staphyloma	6	3.28
Chorioretinal scar	4	2.19
Posterior vitreous detachment	4	2.19
Lattice degeneration with laser	3	1.64
Pathologic myopia**	2	1.09
Asteroid hyalosis	1	0.55
Epiretinal membrane	1	0.55
Retinal detachment (buckled)	1	0.55
Retinal hole s/p laser	1	0.55
Postoperative		
Postoperative intraocular pressure spike	11	6.01
Posterior vitreous detachment	6	3.28
Cystoid macular edema	2	1.64
Retinal tear s/p laser	1	0.55
Retinal tear with detachment (PPV)	1	0.55

*Myopic degeneration is the vision-threatening condition in patients with high myopia comprising macular atrophy, lacquer cracks, macular Bruch's membrane defects, choroidal neovascularization, and Fuchs spot.[13] **Pathologic myopia refers to excessive axial length elongation in myopia leading to posterior segment structural changes.[13] PPV=Pars plana vitrectomy

Table 3: Postoperative refractive and visual outcomes of all eyes

Parameter	Mean±SD (range)
Sphere	0.22 D±0.54 (−1.5-2.75)
Cylinder	−0.78 D±0.50 (0.0-−3.00)
MRSE	−0.16 D±0.50 (−1.75-2.38)
UCDVA (logMAR)	0.14±0.16 (−0.10-0.70)
UCIVA (logMAR)	0.13±0.13 (−0.10-0.40)
UCNVA (logMAR)	0.28±0.22 (0.0-1.30)
BCDVA (logMAR)	0.05±0.10 (0.0-0.60)
DCNVA (logMAR)	0.08±0.09 (0.0-0.70)

UCDVA=Uncorrected distance visual acuity, UCIVA=Uncorrected intermediate visual acuity, UCNVA=Uncorrected near visual acuity, BCDVA=Best-corrected distance visual acuity, DCNVA=Distance-corrected near visual acuity, MRSE=Manifest refraction spherical equivalent, SD=Standard deviation, logMAR=Logarithm of the minimum angle of resolution, SD=Standard deviation

Table 4: Predicted errors and predictability of outcomes arranged by increasing mean absolute error

Formula	MAE±SD	MedAE	Percentage of eyes within PE			
			±0.25 D	±0.50 D	±1.0 D	±2.0 D
Kane	0.34±0.31	0.29	47.5	80.9	91.3	100
Barrett	0.35±0.34	0.26	47.5	79.2	95.6	99.5
EVO	0.35±0.34	0.26	47.0	80.3	95.1	100
Ladas	0.39±0.40	0.28	45.4	75.4	93.4	98.9
SRK-T	0.42±0.52	0.29	44.3	72.1	93.4	98.4
P	0.22					

MAE=Mean absolute error, SD=Standard deviation, MedAE=Median absolute prediction error, PE=Prediction error, EVO=Emmetropia Verifying Optical, SRK-T=Sanders, Retzlaff and Kraft-Theoretical

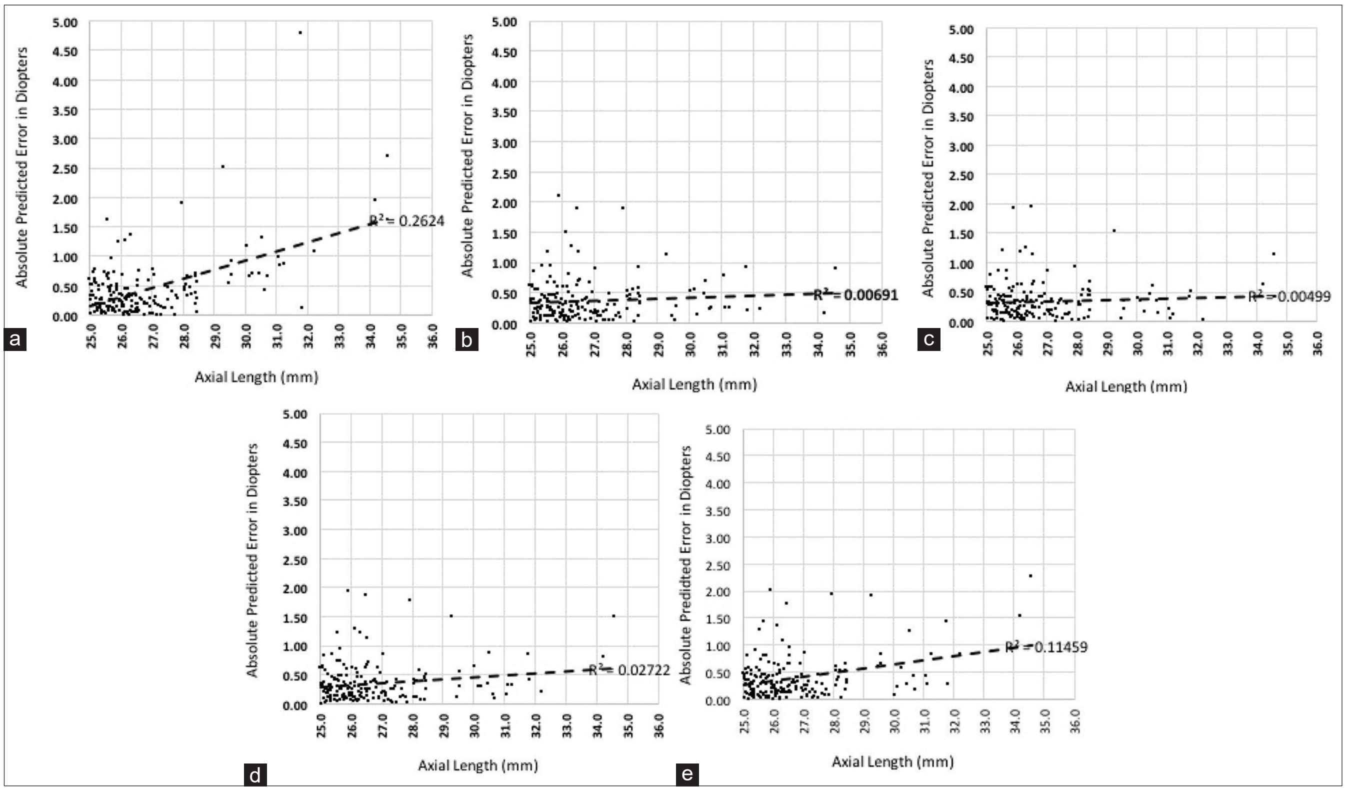

Figure 1: Correlation between axial length and absolute predicted error with axial length on the X-axis and absolute predicted error on the Y-axis ([a] SRK-T; [b] Barrett; [c] Kane; [d] Emmetropia Verifying Optical; [e] Ladas)

Table 5: Correlation between axial length and absolute predicted error

	Correlation coefficient (*r*)	*P*
SRK-T	0.51	0.00001*
Barrett	0.08	0.84
Kane	0.07	1.00
EVO	0.16	0.19
Ladas	0.34	0.0001*

EVO=Emmetropia Verifying Optical, SRK-T=Sanders, Retzlaff and Kraft-Theoretical, **P* value <0.0001, SRK-T – Moderate positive correlation. **P* value <0.001, Ladas – Low positive correlation

Table 6: Subgroup analysis of mean absolute errors of each formula based on axial length

Formula	Group 1 (25-26 mm) (*n*=128)	Group 2 (27-29 mm) (*n*=40)	Group 3 (≥30 mm) (*n*=15)
SRK-T	0.32	0.45	1.26
Barrett	0.35	0.33	0.44
Kane	0.34	0.31	0.37
EVO	0.34	0.32	0.48
Ladas	0.35	0.38	0.72
P<0.05	0.90	0.49	0.001*

EVO=Emmetropia Verifying Optical, SRK-T=Sanders, Retzlaff and Kraft-Theoretical, *Analysis of Variance (ANOVA)

of cataract surgery with IOL implantation in eyes with long ALs and high myopia. All 183 eyes included in the study underwent similar cataract extraction techniques followed by implantation of a foldable IOL. Surgical incisions were made manually using corneal incision blades or with the assistance of femtosecond laser, depending on patient preference. Multiple types of IOLs were included in the study such as monofocal, monofocal toric, multifocal, and multifocal toric, a variety reflective of the assortment of IOLs implanted in a real-world clinical setting.

Our study cohort had lower intraoperative and postoperative complications compared to other retrospective cohorts published previously. There was no incidence of intraoperative complication such as posterior capsule rupture (PCR) in our study group compared to the PCR rates of 2.8% and 1.3% in Zuberbuhler and Alio study.[5,6] Our study group had one occurrence of retinal tear with retinal detachment (0.55%), compared to previous reports of 1.3% to 2.2% rate of postoperative retinal detachment.[5,14-16] In Zuberbuhler's cohort, two cases had retinal detachment postoperatively. One case occurred at 17 months following cataract surgery and 1 month after neodymium-doped yttrium aluminum garnet capsulotomy while the other case occurred 66 months after cataract surgery. In our study, the lone postoperative retinal detachment occurred 12 months after cataract surgery and a day after strenuous exercise. It is important to note, however, that the population included in the Lam and Zuberbuhler studies evaluated eyes whose ALs are ≥30 mm while our study included 183 eyes with ALs of 25 mm to 34.59 mm, 15 of which had an AL of ≥30 mm. The patient who had the lone retinal tear with detachment in our study group had an AL of 27.13 mm. Clinically significant CME occurred in 2 out of 183 (1.09%) patients in our cohort which is slightly higher than the 0.6% CME rate reported by Zuberbuhler.[5] Macular edema in both our patients resolved after 2 months of topical ketorolac.

Apart from determining safety of cataract surgery in eyes with long AL by documenting complication rates, an additional objective of our study was to determine which formula would allow us to target emmetropia more accurately in these difficult cases.

Several published studies have compared the different IOL calculation formulas with regard to accuracy in postoperative prediction of refraction and showed that the Barrett formula is more accurate than the Olsen, Haigis, Holladay 1, Holladay 2, and SRK/T formulas.[17-21] Recently, Rong *et al*. stratified 79 patient eyes based on AL and compared the accuracy of Barrett Universal II, Haigis, and Olsen formulae and showed that for ALs <30 mm, all three formulas were accurate. However, the Barrett Universal II formula performed better in eyes with AL equal to or >30 mm[18] while Liu *et al*. reported on the accuracy of several IOL formulas in 136 eyes of Chinese patients with ALs >26.0 mm and found that the Barrett Universal II, Hill-RBF, and the Wang-Koch AL adjustment formulas decreased the percentage of hyperopic outcomes in the study population.[19]

Kane *et al*. published a study involving 846 patients comparing older third- and fourth-generation formulae with their own formula and showed that the Kane formula performed better across a wide range of AL (22 mm–31 mm) than the Barrett, Hill, Olsen, Holladay 2, Haigis, SRK-T, and Hoffer Q formulae by having the lowest MAE, STDEV, MedAE, as well as the highest percentage of eyes within 0.25 D (52.4%), 0.50 D (77.9%), and 1.00 D (96.6%) of the refractive PEs. Subgroup analysis in their study showed that at long ALs of ≥26 mm, the Kane formula was equally as accurate to Haigis, Barrett, Holladay 2, Olsen, and Hill 2.0 formulae but was significantly more accurate than the older-generation formulae such as SRK-T, Hoffer Q, and Holladay 1.[10] A follow-up study by Kane *et al*. involving a larger patient pool of 10,930 eyes showed that in the subgroup of eyes with long AL (≥26 mm), the Kane formula still had the lowest MAE compared to the other older formulae including the Barrett and SRK-T formulae.[22] These outcomes were comparable to our study results with the Kane formula having the lowest MAE and the highest percentage of eyes within 0.25 D and 0.50 D.

A separate study by Carmona-González *et al*. compared 11 formulae (including the SRK-T, Barrett, Kane, EVO, and LADAS) across a wide range of ALs and showed that in their data set, the Barrett formula had the lowest MAE overall (0.29D) followed by the Kane formula (0.30 D). This finding was also seen in the subgroup analysis for long eyes (0.26 D and 0.27 D, respectively).[23] Although our study showed that the Kane formula performed better than the Barrett formula based on MAE (0.34 D vs. 0.35 D), consistent with the group's findings, our data show that, overall, across the AL range included in our study, the five formulae were not significantly different from each other.

A 2016 study by Zhang *et al*.[24] in highly myopic eyes (AL > 26 mm) showed a strong positive correlation between absolute PE and AL with the SRK-T (R^2 = 0.144) and Barrett formulae (R^2 = 0.086). These findings were similar to our data set where all five formulae showed a positive correlation between increasing AL and PE. However, we found that the strong positive correlation seen in the SRK-T and LADAS formulae was significant, but the positive correlation seen when using the Barrett, Kane, and EVO formula was weak, even in the extremely long AL.

Careful selection of the IOL power to be implanted is paramount in ensuring an ideal refractive outcome. The use of standard formulae such as the SRK/T, Holladay, Hoffer, and Haigis as well as the new-generation formulae such as Barrett Universal II, Olsen, and Holladay 2 has yielded predictable results where a majority of patients with long ALs are within ±0.5 to ±1.0 D of their target.[7,13,19,20] Our results show that the Kane, Barrett, and EVO formulae were more accurate than the SRK-T and LADAS formulae, especially in the extremely long eyes.

One limitation of our study is that the patient population analyzed included mostly eyes with ALs of 25 mm–29 mm. Although there were several eyes with ALs longer than 29 mm, a more meaningful analysis could be presented if we had more eyes with extremely long ALs (>30 mm). This is particularly important in the Asian region where myopia is increasing in prevalence and a growing number of eyes have ALs that tend to be in the longer side. Therefore, it is prudent to have a more robust sample population in order to determine if outcomes and complications associated with long ALs are similar to those with extremely long ALs.

Conclusion

Cataract surgery in eyes with long ALs and high myopia is safe with a low incidence of intraoperative and postoperative complications. Cataract surgery provides an opportunity for effective correction of refractive error and results in good visual and refractive outcomes. The data suggest that the Kane formula was the most accurate in predicting postoperative refraction. Overall, the Kane, Barrett, and the EVO formulae performed similarly well even in extreme ALs.

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Nil.

Conflicts of interest

The authors declare that there are no conflicts of interests of this paper.

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