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A perspective of biometric, visual and refractive outcomes of cataract surgery: a report of an ophthalmologist in compulsory governmental service

Elif Ceren Yeşilkaya

Department of Ophthalmology, Gölbaşı State Hospital, Adıyaman, Turkey

ABSTRACT

Objectives: Knowledge of normal values of biometric parameters in cohort and relationships of them is helpful for ophthalmologists who want to achieve successful results. The aim of this study is to define these parameters in the light of experiences of an individual cataract surgeon after her residency program.

Methods: This is a retrospective, register-based study. Preoperative biometric and postoperative refractive data including axial length (AL), mean keratometry (K), anterior chamber depth (ACD), astigmatism, lens thickness (LT) of 310 patients who had cataract surgery were reviewed. Ultrasound and optical biometry were used to evaluate the biometric parameters of the eyes.

Results: 0.5 D of refractive target (RT) was obtained in 52.1% (186 eyes) of eyes, 1.0 D of RT in 82.20% (293 eyes) and 2.0 D of RT in 98.3% (351 eyes). Analyses of visual acuity show that 43.7% and 86.3% of eyes reached 0.00 and 0.30 log MAR or better. Age, ACD, LT, AL, preoperative corrected distance visual acuity, preoperative astigmatism and preoperative K were correlated between each other significantly ($p < 0.001$). The longer AL was found associated with older age ($\beta = .745$, $p = 0.003$), and lower K ($\beta = -0.327$, $p < 0.001$). A significant association between K value and older age ($\beta = .680$, $p = .029$) and shorter AL ($\beta = -.660$, $p < 0.001$) was seen.

Conclusions: These data show the normative parameters of biometry values for the Turkish population. These results may be helpful in calculating intraocular lens power and evaluating refractive error for young ophthalmologists who have to work with ultrasound biometry in compulsory service.

Keywords: Cataract, biometric parameters, Turkish population, young ophthalmologists

Nowadays, the cataract surgery has taken the first line among the most frequently performed surgeries by ophthalmologists [1]. With the development of biometric devices and surgical techniques, cataract surgery is also considered a refractive form of surgery.

Therefore, it is an essential component of ophthalmology education for residents. The graduates of the ophthalmology residency program complete a number of phacoemulsification cataract surgeries, which vary depending on the clinic they are trained during their ophthalmology residency.

The parameters of ocular biometry including axial length (AL), keratometry (K), corneal and intraocular lens power calculation are known to be essential for

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Address for correspondence: *Elif Ceren Yeşilkaya, MD., Gölbaşı State Hospital, Department of Ophthalmology, Adıyaman, Turkey*
E-mail: yesilkayaceren@gmail.com, Tel: +90 416 7816133, Fax: +90 416 7816115

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achieving satisfactory refractive results in cataract surgery [2, 3].

Biometry measurements made with optical methods have higher accuracy than ultrasonic methods. Operator-dependent factors are more prominent in ultrasound biometry (UB) measurements, but not in optical biometry (OB) [4, 5]. Unfortunately, OB devices are still unavailable in manycenter where compulsory service is provided in Turkey.

Although there are many studies that define these main parameters by experienced surgeons, little attention has been paid to studies with new graduates from residency programs.

This study mainly has two purposes. Firstly, this study aims to present over 2-year retrospective review of consecutive series of a young ophthalmologist who has completed her residency program. The other purpose is evaluating the parameters of ocular biometry and relationships of these parameters in the cohort of cataract surgery and contributing to national survey in Turkey.

METHODS

Study Design

All patient charts undergoing corneal phacoemulsification at AdıyamanGölbaşı State Hospital (Turkey) between August 2017 and January 2020 were retrospectively reviewed. All patients were informed about the details of the study in brief and obtained with consent.The study was approved by the local ethics committee.

Study Population

A total of 377 eyes of 324 who were operated within 2 years and had no exclusion criteria were included in the study. The records of patients were obtained for clinical, biometric and demographic data. The criteria for exclusion from the study were determined as < 18 years, >90 years, < 2 0 mm AL, > 30 mm AL, < 35 D preoperative mean K, > 47 D preoperative mean K, corneal astigmatism was > 3 D and aphakia.

All eligible patients underwent a complete ophthalmologic examination with a standard protocol preoperatively and postoperatively including fundus examination, slit-lamp biomicroscopy, corrected distance visual acuity (CDVA) and intraocular pressure measurement preoperatively and postoperative first day, first week and first month.

Surgical Procedure

Surgery was conducted by 1 skilled surgeon who used the same method with Ozil torsional handpiece (Infiniti; Alcon Laboratories, Inc.) for all surgeries. All eyes had phacoemulsification cataract surgery using a standard method consisting of a 2.8 mm clear corneal incision with a 45-degree bevel Kelman con-figuration tip with an ultra-sleeve. Continuous curvilinear capsulorhexis was made using cystotome needle. Hydrodelineation and hydrodissection were performed using a 27-gauge hydrodissectioncannula. The cataract was extracted with a similar prechop and vertical chop technique. Bimanual irrigation/aspiration (I/A) was performed for cortex and viscoelastic removal. The IOL was implanted in the remaining lens capsule and side ports were hydrated. Acrylic aspheric mono focal IOL was used for all patients [Eyecryl Plus HSAS600, Biotech Vision Care] except IOLs implanted in sulcus [which was used 3 pieces IOL Model MN60AC (AlconLaboratories, Inc.).

Data Collection

Collected data included patient clinical history (age-related macular degeneration and diabetes), demographics (gender, age), preoperative measurements like uncorrected visual acuity [UCVA], CDVA, manifest refraction [sphere and cylinder] and K [measurements were obtained with auto refractor keratometer (Topcon KR 8900)], AL [measured by ultrasound with contact method (Nidek US-3300) and by optical method (IOL Master)], and cataract grade [non-dense (grade1-2) or dense (grade 3-4)], procedural details (operated eye, procedure date, IOL power, refractive target), and postoperative outcomes at 1 day and 1 month (manifest spherical equivalent (SE), UCVA, CDVA). The same physician assessed all biometric values.

Visual acuity evaluated with Snellen chart and Snellen UCVA and CDVA were converted to log MAR for analyses. For patients with an AL of below 22 mm the Hoffer Q formula was used and for those 22 mm and over the SRK/T and SRK II formula was used.

Statistical Analysis

TheSPSS Software (Version 22.0, SPSS Inc.)was used for data analysis. The evaluations of visual acuity were based on log MAR units. Continuous variables were presented as mean ± standard deviation (SD). Categorical variables were presented as numbers (n) and percentages (%). The distribution was reached with the Kolmogorov–Smirnov test. Continuous variables were evaluated by Student t-test or Mann-Whitney U test, while categorical variables among the groups were tested by Chi- Square or Fisher's exact test when appropriate. Wilcoxon test was used for comparison of preoperative and postoperative values. The Spearman test was performed to analyze the correlation between parameters. Regression models considering age, gender, K, anterior chamber depth (ACD), cornealastigmatismand lens thickness (LT) were performed to analyze relationships with associated biometric parameters (K, AL and ACD). A P <0.05 value was acceptedsignificant.

RESULTS

Fourteen patients (20 eyes) were excluded from the study because of the missing data, age, biometric and refractive measurements. Patient demographic characteristics, preoperative ocular and biometric features and operative targets are shown in Table 1. At surgery the mean age was 67.5 ± 10.5 years, and 39.4% of patients were female.

Surgical details and complications

Local anesthesia (34.7% subtenon anesthesia and 65.3% topical anesthesia) was used for all operations, except one which general anesthesia was needed. The IOL was implanted in the capsular bag in 96.6% eyes, in the sulcus for 2.5% eyes, and in 0.8% eyes no IOL was implanted (aphakic). Overall 3.3% (95% CI: 3.1-3.5%) cases had a peri-operative complication, the most common being rupture of posterior capsular (PCR) or loss of vitreous or both (1.68%, 95% CI: 1.59-1.92%). PCR was occurred in 6 patients. Peri-operative complication rates were lower for the last six months than first six months but this is not significant statistically ($p > 0.05$). No retinaldetachment and endophthalmitis were seen within 6 months of surgery.

Visual and refractive outcomes

Visual and refractive outcomes of the study patients during the preoperative and postoperative follow up were summarized in Table 1. Preoperative CDVA was 1.40 ± 0.64 log MAR and improved to 0.05 ± 0.06 log MAR at postoperative 1 month follow up. When we look the SE and astigmatism results, preoperative SE was -1.25 ± 5.8 D and changed significantly to -0.04 ± 1.2 D at the postoperative 1 month ($p < 0.05$). Similarly, preoperative astigmatism was -1.8 ± 2.06 D and postoperative astigmatism was -0.73 ± 0.82 D and this change was statistically significant ($p < 0.05$). 0.5 D of refractive target (RT) was obtained in 52.1% (186 eyes) of eyes, 1.0 D of RT in 82.20% (293 eyes) and 2.0 D of RT in 98.3% (351 eyes) postoperatively.

Biometricparameters

Histograms showing the distribution of measured K, AL, ACD and corneal astigmatism values are given in Figu 1. The mean AL found as 23.32 ± 0.87 mm. 15 (4.2%) eyes had an AL < 22.0 mm, 319 (89.3%) between 22.0 and 24.5 mm, 20 (5.6%) between 24.5 and 26.0 mm and 3 (0.8%) > 26.0 mm. Male eyes had more non-dense cataract grade than female eyes ($p < 0.001$); Nevertheless, there was no statistically significant difference when looking at other parameters. Subgroup analysis was also performed according to UB and OB of IOL. The achieved refraction results were not found statistically significant in UB or OB ($p > 0.05$), and when the two different of IOL measurement methods were compared, no statistically significant differences was seen.

Correlations

Correlations were constructed for age, visual outcomes and ocular biometric parameters. Age, ACD, LT, AL, preoperative CDVA, preoperative astigmatism and preoperative K were correlated between each other significantly ($p < 0.001$). No significant correlation was found when looking at the other parameters ($p > 0.05$). Correlations are summarized in Table 2.

Regression models

The models of regressions were assessed for K, AL and ACD in regarding to gender, age, LT, ACD, K, and Corneal astigmatism. A longer AL was associated

Table 1. Baseline characteristics of the study patients

Demographics	Total	Male	Female
Age	67.5 ± 10.5	66.13 ± 10.7	69.46 ± 9.6
Gender		216 (60.6%)	141 (39.4%)
Side			
Right	177 (49.7%)	109 (50.4%)	68 (48.5%)
Medical and Ocular History			
Diabetes	32 (8.9%)	19 (8.7%)	13 (9.2%)
ARMD	7 (1.9%)	5 (2.3%)	2 (1.4%)
Preoperative Ocular Characteristics			
Cataract Grade			
Dense Cataract	147 (41.1%)	69 (31.9%)	78 (55.3%)
Non-dense Cataract	210 (58.8%)	147 (68.1%)	63 (44.7%)
CDVA (Log MAR, median)	1.40 ± 0.64	1.27 ± 0.64	1.60 ± 0.57
Intraocular Tonus	16.92 ± 2.5	17.10 ± 2.7	16.63 ± 2.3
Preop SEQ (D)	-1.25 ± 5.8	-0.67 ± 6.02	-2.20 ± 5.3
Preop Astigmatism (D)	-1.8 ± 2.06	-1.65 ± 2.11	-2.14 ± 1.94
Preoperative Biometry Measurements			
Biometry Type			
Manuel Biometry	299 (83.8)	174 (80.6%)	125 (88.7%)
Optic Biometry	58 (16.2%)	42 (19.4%)	16 (11.3%)
AL (mm)	23.32 ± 0.87	23.38 ± 0.85	22.93 ± 0.84
K (D)	43.60 ± 1.79	43.20 ± 1.69	44.22 ± 1.78
ACD (mm)	3.41 ± 0.21	3.55 ± 0.24	3.21 ± 0.19
Corneal Astigmatism (D)	0.87 ± 0.51	0.83 ± 0.49	1.15 ± 0.60
Lens Thickness (mm)	4.14 ± 0.4	4.18 ± 0.44	4.09 ± 0.39
Operative Details			
Intraoperative Complications	15 (4.2%)	9 (4.1%)	6 (4.2%)
Postoperative Complications	1 (0.02)	1 (0.46%)	0 (0%)
IOL Power	21.81 ± 1.82	21.65 ± 1.86	22.06 ± 1.75
Postoperative Measurements			
Postop SEQ (D)	-0.04 ± 1.2	-0.20 ± 1.32	0.30 ± 1.05
Postop Astigmatism (D)	-0.73 ± 0.82	-0.67 ± 0.83	-0.88 ± 0.80
CDVA (Log MAR, median)	0.05 ± 0.06	0.03 ± 0.5	0.9 ± 0.7

SD = standard deviation, N = number, ARMD = Age related macular degeneration, CDVA = Corrected distance visual acuity, log MAR = log of the minimum angle of resolution, Preop = preoperative, SEQ = spherical equivalent refraction, AL = Axial length, K = keratometry, ACD = Anterior chamber depth, IOL = Intraocular lens. Values are presented as Median or Mean ± SD / N (%)

Table 2. Correlations of age, visual outcomes and ocular biometric parameters of study population

		R	*p* value
Age			
	ACD	-.675	< 0.01
	LT	.859	< 0.01
LT			
	ACD	-.532	0.019
	AL	-.570	0.011
Preoperative CDVA		.459	< 0.01
	Preoperative Astigmatism		
AL		-.518	< 0.01
	Preoperative K		

R = Correlation coefficient, *p* = Significant correlation (0.05), ACD = Anterior chamber depth, LT = Lens thickness, AL = Axial length, CDVA = Corrected distance visual acuity, K (D) = mean Keratometry.

with older age (β = .745, *p* = 0.003), and lower K (β = -0.327, *p* < 0.001). When we look at K, we found a significant association with older age (β = .680, *p* = 0.029) and shorter AL (β = -.660, *p* < 0.001). No significant relationship was found with the other parameters analyzed.

DISCUSSION

The present study has been conducted for a few purposes. The primary aim in carrying out is to reflect the experience of a young ophthalmologist in cases of cataracts encountered in compulsory service after residency training. In addition to, It is aimed to reach the desired refractive error target after cataract surgery. For this purpose, investigations considering current status of using different ocular biometry methods on refractive results of phacoemulsification surgery are insufficient in the literature. So, this study also aimed

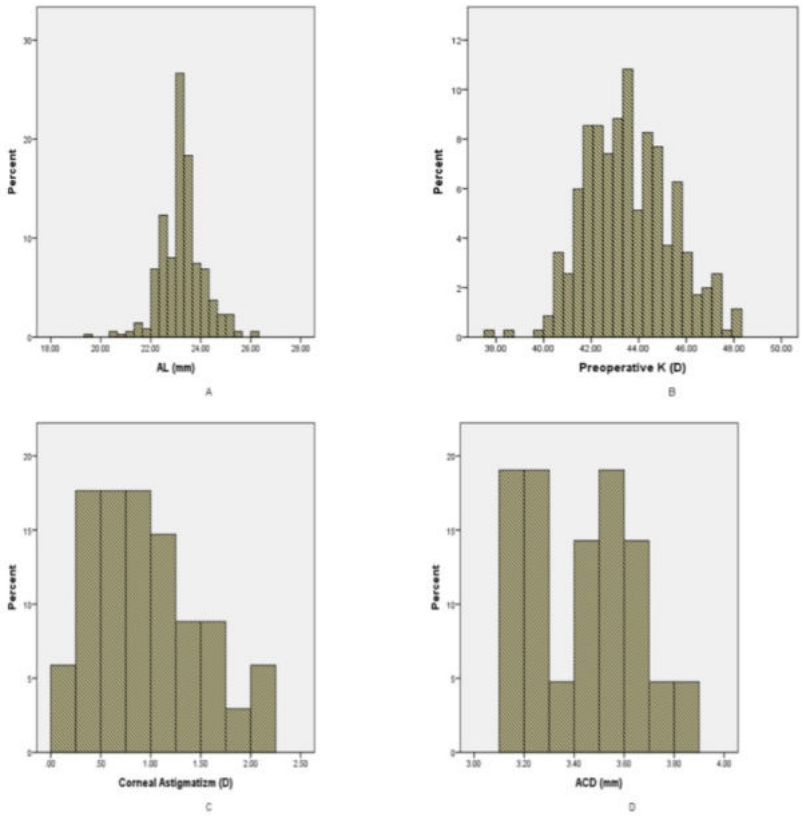

Fig. 1. A. Histogram of axial length (AL) of the study population, B. Histogram of mean keratometry (K) of the study population, C. Histogram of corneal astigmatism of the study population and D. Histogram of anterior chamber depth (ACD) of the study population.

to presents mainly the average values of the biometric parameters, which assessed using OB and UB and secondly refractive and visual outcomes of candidates for phacoemulsification surgery in Turkish population.

In terms of visual and refractive outcomes, it was seen that a statically significant improving of all parameters that we evaluated had stabilized at 1-month postoperatively. The analyses of postoperative visual acuity demonstrated that 43.7 and 86.3% of all eyes achieved 0.00 and 0.30 log MAR or better. And, the analyses of postoperative refractive target showed 52.1%, 82.20% and 98.3% all eyes were within 0.5 D, 1.0 D and 2.0 D respectively. Taken together, these results are comparable to those reported in The Royal College of Ophthalmologists' National Ophthalmology Database study of cataract surgery and Cataract National Dataset [6, 7]. Cataract surgery is not free of risk. In our study procedure-related complication rate is 3.3%. These results appear to be compatible with the literature [8]. Over the study period, the rate of complications appears stable. Because of lower number of complication, it is not possible to make a meaningful comparison to detect predictors.

In the AL analysis, the mean AL was 23.32 ± 0.87 and also, AL had a non-normal distribution with high kurtosis. Longer AL was associated with lower corneal refractive power and thinner LT. These findings are in agreement with the data obtained in The Ural Eye and Medical Study (23.30 ± 1.1 mm) [9], in the Los Angeles Latino Eye Study (23.4 ± 1.1 mm) [10], and in the Beijing Eye Study (23.25 ± 1.14 mm) [11]. Interestingly, there was no significant difference between the genders in terms of AL.

The mean K in our study was 43.60 ± 1.79D as shown in Table 1, mean K was not significantly different in terms of gender. Mean K increased linearly to older age. However, this association was not statistically significant. The distribution of the K has been reported in different age groups and populations. When comparing K values with other populations, our value is lower than that reported in the Portugal population [12], mean K was 43.91 ± 1.71 D but higher than that reported in the Iranian population, was 43.48 D (95% CI: 43.41-43.56) [13]. Our findings are similar to those reported in the Canadian population, mean-K was 43.85 D and USA, mean K was 43.41 ± 1.60 [14].

In our study population, the mean corneal astigmatism value was 0.87 ± 0.51 D, with 58.8% of the eyes showing astigmatism < 1 D, in other words, almost half of eyes has corneal astigmatism value which is enough to prevent optimal visual acuity without optical correction. The current results did not identify significant differences between female and male patients. Our result is not surprising and is supported by previous studies, which conducted by Hoffmann and Hütz [15] in Germany (64%), by Ferrer-Blasco *et al*. [16] in Spain (65.2%) and Duman *et al*. [17] in Turkey (70.1%). And also, this current report did not detect any associations between corneal astigmatism and other biometric variables and age. This may be the result of the limited sample size.

The mean ACD in our population was 3.41 ± 0.21mm and ACD were negatively correlated with age and LT ($p < 0.05$). These findings described also in a study that conducted by Zong *et al*. [18] in China. On the other hand, because of its relationship to primary angle-closure glaucoma (PACG), correlation between ACD and age is not surprising. It is known that age is one of major predisposing factors for the development of PACG [19]. The current results also agreed with study, which conducted by Ferreira *et al*. [12] in Portugal. Our result was in contrast to the cross-sectional analysis of the Blue Mountains Eye Study in which ACD was not related with age [20].

Although LT was not previously used as a variable in calculating IOL power, fourth-generation formulas like Olsen began computing taking this into account [21]. For this reason there may be noticeable trend on impact of LT in future studies. The mean LT in our study was 4.14 ± 0.4 mm and agreed with the literature. Another finding of this study was the positive relation between age and LT and in contrast, negative correlation between ACD, AL and LT. More extensive studies may be needed on these findings.

Limitations

The current study had some strengths and weaknesses. One of the strength is that the data were aggregated and non-selective. Another strength is that all operations were made by the same surgeon and, so less publication bias than multiple-surgeon case series. A weakness of our study is that this is a retrospective, register-based study. Another weakness is that the

study sample size had limited number and did not include very long eyes (AL, >3 0.0 mm) or short eyes (AL, < 20.0 mm). Therefore, the number of peripheral groups for subgroup analysis was inevitably small.

CONCLUSION

In this study, data regarding preoperative biometric and postoperative refractive were reviewed in 310 patients undergoing cataract surgery. The results of our analysis showed that (1) There was no statistically significant difference on achieved refractions prediction when comparing the UB and optical methods of IOL measurement, (2) Male eyes had more non-dense cataract grade than female eyes, (3) Because of associations between each other pre-operative ocular biometryparameters played an important role in IOL power selection and patient assessment. The present study is the first report which providing valuable information about operation volumes of an individual cataract surgeon after her residency program. It also should be remembered that this study is one of few to present normative parameters of biometry and their relationships in Turkish population. The author expects this study will be helpful for future works.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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