Original Article

Ocular Biometric Values and Prevalence of Corneal Astigmatism in Patients Candidate for Cataract Surgery

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Abstract

Purpose: To analyze the biometric values and the prevalence of corneal astigmatism in cataract surgery candidates.

Methods: This is a prospective study. Ocular biometric values and corneal keratometric astigmatism were measured by optical low-coherence reflectometry (Lenstar LS 900) before surgery in patients who were candidates for cataract extraction surgery. Descriptive measurements of biometric dimensions and keratometric cylinder data and their correlations with sex and age were evaluated.

Results: Ocular biometric and keratometric values from 2084 eyes of 2084 patients (mean age 66.43, range 19–95 years) were analyzed. The mean values were as follows: corneal astigmatism 0.89 diopter (D), mean corneal keratometry 44.29 D, central corneal thickness 534 μ, internal anterior chamber depth (ACD) 3.11 mm, lens thickness 4.50 mm, and axial length 23.35 mm. Corneal astigmatism was <1.25 D in 1660 (79.5%) of eyes. Astigmatism was with-the-rule in 976 (46.8%) of eyes, against-the-rule (ATR) in 702 (33.7%), and oblique in 406 (19.5%). Analysis of corneal astigmatism revealed a change toward "ATR" with age which was not statistically significant. The ACD was correlated with age. The amount of corneal astigmatism had no correlation with age and sex.

Conclusion: Corneal astigmatism was higher than 1.25 D in about 21% of cataract surgery candidates with slight differences between the various age ranges and had no correlation with age and sex.

Keywords: Astigmatism, Cataract, Lenstar, Ocular biometry

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Submitted: 23-Jan-2021; **Revised:** 21-Aug-2021; **Accepted:** 24-Aug-2021; **Published:** 16-Apr-2022

Introduction

Cataract is the first cause of blindness, and phacoemulsification is the main surgical procedure for addressing this condition. Accurate measurement of ocular axial length (AL), keratometry, anterior chamber depth (ACD), and corneal diameter before cataract surgery is necessary for exact measurement of intraocular lens (IOL) power to achieve an acceptable postoperative refractive result and improve the visual quality for these patients.[1,2]

Ocular biometric parameters are known to vary with ethnicity.[3] Most previous studies on this issue focused on the European and American populations as well as the Chinese.[1,4-10]

Access this article online

Quick Response Code:

Website: www.jcurrophthalmol.org

DOI: 10.4103/joco.joco_33_21

Lenstar LS 900 (Haag-Streit AG, Koeniz, Switzerland) is a noncontact instrument that uses optical low-coherence reflectometry. Previous studies have reported the accuracy and repeatability of ocular biometry by use of the Lenstar biometer.[11,12] In addition, ocular biometry measurements by use of the Lenstar instrument show a high degree of consistency with measurements made by use of the partial coherence interferometry-based IOLMaster biometer and A-scan.[11]

The aim of this study was to present and analyze the prevalence of corneal astigmatism and the ocular biometric values in

How to cite this article: Hashemian SJ, Hashemian SM, Karimian F, Hadavandkhani A, Jafari ME, Hashemian MS, *et al*. Ocular biometric values and prevalence of corneal astigmatism in patients candidate for cataract surgery. J Curr Ophthalmol 2022;34:56-9.

Iranian patients' candidates for cataract surgery. The results of this research may help ophthalmologists in the management of astigmatism and IOL power calculation in patients with cataracts.

Methods

This prospective study enrolled patients who underwent phacoemulsification and IOL implantation between March 2016 and August 2018 at Rassoul Akram Hospital and Iranian Eye Clinic, Tehran, Iran. The study adhered to the tenets of the Declaration of Helsinki, and all patients signed an informed consent form. This study was approved by the Institutional Review Board of Iran University of Medical Sciences (IR.IUMS.REC.1398.704).

Enrolled were cataract surgery candidates older than 18 years, and only the right eye of each patient was used for analysis. Exclusion criteria were as follows: corneal disease or ocular surface disorders, previous corneal or intraocular surgery, a history of ocular inflammation or trauma, severe systemic disease, irregular corneal astigmatism, and keratometry reading lower than 40 diopter (D) and higher than 47 D. Ocular examinations including visual acuity, refraction, slit-lamp examination, intraocular pressure measurement, and fundus examination were done before the operation. In patients with corneal astigmatism >1 D, corneal imaging using Orbscan II (Bausch and Lomb, Rochester, NY, USA) was performed to exclude the irregular corneal astigmatism.

Lenstar LS 900 was used to obtain keratometry and AL, white-to-white diameter, ACD, and lens thickness (LT) measurements. The mean of three measurements was used for each parameter. The same experienced examiner tested all patients.

Astigmatism was further analyzed as against-the-rule (ATR: steepest meridian 180° ± 29°), with-the-rule (WTR: 89° ± 30°), and oblique (OB: 30°–60° or 120°–150°). Patients were divided into six distinct age groups (<40, 40–49, 50–59, 60–69, 70–79, and >80 years old) for further analysis, and all patients were analyzed irrespective and with respect to the axis of corneal astigmatism. In addition, the magnitude of corneal astigmatism was divided into three distinct groups (<1.25, 1.25–2, and >2 D).

Statistical analysis was performed using SPSS software (version 21.0, SPSS, Inc., Chicago, Illinois, USA). Kolmogorov–Smirnov test was used to check the normality of the data. Pearson's coefficient was used to calculate correlation coefficients. $P < 0.05$ was considered statistically significant.

Results

In this study, 2084 eyes of 2084 patients were enrolled, 62% ($n = 1293$) of which were women and 38% ($n = 791$) were men. The mean age of the participants was 66.43 ± 10.6 years (from 19 to 95 years), which had a normal distribution pattern. Patients were divided into six age groups, and the highest percent of patients (35.9%) were in the range of 60–69 years. The details are shown in Table 1.

The mean AL was 23.35 ± 1.17 mm (from 19.34 to 31.96) with statistically significant correlation with age ($P < 0.01$, $r = 0.096$) and sex ($P < 0.01$). It was higher in men (23.68) than women (23.15), Table 2.

The mean central corneal thickness (CCT) was 534.22 ± 35.6 μm (from 420 to 681) and was significantly correlated with age ($P = 0.004$, $r = 0.074$) which showed an increase of thickness with aging. There was no significant difference in central corneal thickness between the two genders ($P = 0.27$).

The mean internal ACD was 3.11 ± 0.39 mm (from 2.09 to 5.68) which revealed a significant negative correlation with age ($P < 0.01$, $r = -0.248$). No correlation was found between sex and ACD ($P = 0.38$).

The mean LT was 4.5 ± 0.4 mm (from 2.09 to 6.00) and had a strong positive correlation with age ($P = 0.00$, $r = 0.389$). LT was significantly greater in men ($P = 0.001$).

The mean keratometry in flat and steep meridians was 43.85 ± 1.44 D (40–47.27) and 44.73 ± 1.44 D (from 40.11 to 47.5), respectively. The average mean keratometry was 44.29 ± 1.4 D (from 40.06 to 47.39). All three revealed significant correlation with age ($P < 0.00$, $r_{flat\ K} = 0.11$, $r_{steep\ K} = 0.105$, $r_{mean\ K} = 0.11$) but had no correlation with sex.

The mean corneal astigmatism was 0.89 ± 0.68 D (from 0 to 6 D). Six hundred and sixty-one (31.7%) eyes had < 0.5 D of corneal astigmatism, 997 eyes (47.8%) had 0.5–1.25 D, 287

Table 1: Age groups distribution

Age	*n* (%)
<40	36 (1.7)
40-49	76 (3.6)
50-59	372 (17.9)
60-69	748 (35.9)
70-79	666 (32)
80 and more	186 (8.9)

Table 2: Optical biometric data

Optical biometric data	Mean (SD)
Axial length	23.35 (1.80)
Central corneal thickness	534.22 (35.61)
Internal anterior chamber depth	3.11 (0.40)
Lens thickness	4.50 (0.40)
Flat keratometry	43.85 (1.44)
Steep keratometry	44.73 (1.45)
Mean keratometry	44.29 (1.41)
Mean corneal astigmatism	0.89 (0.68)
White-to-white	11.88 (0.48)

SD: Standard deviation

eyes (13.8%) had 1.25–2 D, and 139 (6.7%) eyes had more than 2 D of corneal astigmatism [Figure 1].

WTR, ATR, and OB astigmatism were found in 976 eyes (46.8%), 702 eyes (33.7%), and 406 eyes (19.5%) with a mean of 0.98 D, 0.88 D, and 0.74 D, respectively [Figure 2, $P = 0.003$]. There was no correlation between corneal astigmatism and sex ($P = 0.15$) or age ($P = 0.66$). Analysis of corneal astigmatism revealed a change toward "ATR" with age which was not statistically significant. Among the parameters, only AL showed a significant correlation with corneal astigmatism ($P < 0.01$).

Discussion

This study assessed the distribution of ocular biometric values and corneal astigmatism in a population of Iranian candidates for cataract surgery. The mean age of our participants was 66.43 ± 10.61 (19–95) years, which is higher than Ferrer-Blasco *et al.*[13] (60.59 ± 9.87) and lower than Khan and Muhtaseb[7] (75.54 ± 10.71), Hoffmann and Hütz[5] (median 74), Guan *et al.*[9] (72.27 ± 11.59), Chen *et al.*[10] (70.56 ± 9.55), and De Bernardo *et al.*[6] (71.89 ± 10.19). All of the abovementioned studies had a higher percentage of female participants, similar to ours.

The mean AL was 23.55 ± 1.80 mm which is comparable with Hoffer[14] (23.65), Hoffmann and Hütz[5] (23.43), Lim *et al.*[15] (23.55), and Pan *et al.*[16] (23.45), and was statistically higher in men, but this correlation was not significant clinically. This result is in concordance with the other studies.[2,4,17-19]

This study showed that mean CCT and mean LT increased, whereas AL and internal ACD decreased significantly with age. AL reduction in the adult eye may be part of an emmetropization mechanism in face of the increase in ocular refractive power.[20]

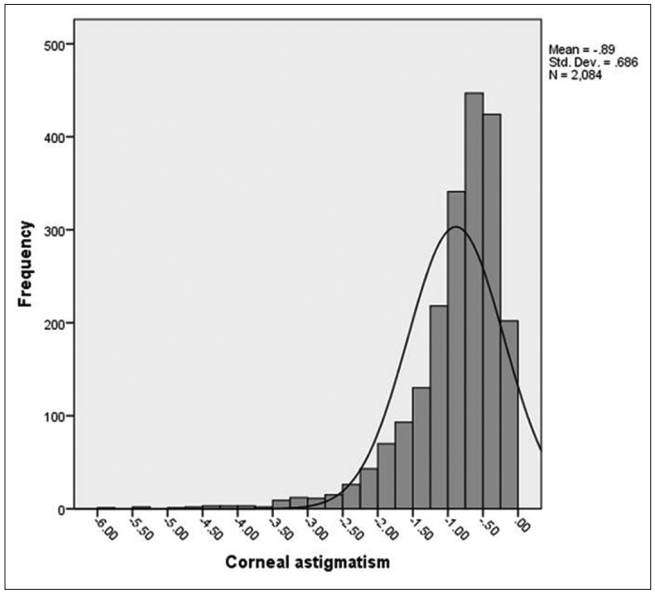

Figure 1: Distribution of corneal astigmatism in 0.5 diopter increments for all 2084 eyes

We found considerable differences between the two genders in terms of LT and AL which both were higher in men.

Previous studies have shown that the ACD is greater in Asians than in Inuit and is greatest in the White population.[21] The mean ACD in our series is shorter than the reported values in European and American studies.[4,5,14,19,22] Contrary to some studies, we did not find a significant difference between the two genders in terms of ACD measurements.[4,5,17] This could be due to our smaller number of participants. The ACD is known to be affected by age, gender, and race.[23]

The flat keratometry, steep keratometry, and mean keratometry values in our study were correlated with age, which is consistent with other reports.[5,7,9,13,24]

However, against some former studies which claimed that women had steeper cornea compared to men,[5,13] we did not discover any relation between gender and keratometry values.

Pre-existing corneal astigmatism is a critical factor for refractive cataract surgery. When corneal astigmatism of 1.25 D or more is considered for a toric IOL, 21% of all eyes are considered for the implantation of such IOLs. We found mean astigmatism value of 0.89 D that is consistent with Hoffer's value of 1.00 D, Hoffmann's value of 0.98 D, and Mohammadi's value of 1.12 ± 1.10 D in an Iranian population.[5,14,25] About79.5% of our series had <1.25 D of astigmatism which is comparable to other studies by De Bernardo *et al.*[6] (82.43%), Khan and Muhtaseb[7] (79.5%), Ferrer-Blasco *et al.*[13] (83.53%), Guan *et al.*[9] (79.46%), and Chen *et al.*[10] (81.51%) although they reported the cases with <1.5 D of astigmatism.

About 6.7% of our patients had more than 2 D of corneal astigmatism which is near but somehow lower than other reports which could be related to the ethnic differences (Khan and Muhtaseb[7] [9.69%], De Bernardo *et al.*[6] [8.32%], Ferrer-Blasco *et al.*[13] [9.26%], Guan *et al.*[9] [10.42%], Chen *et al.*[10] [8.22%], Hoffmann and Hütz[5] [8.0%], Lekhanont *et al.*[26] [7.88%]).

The majority of our patients had WTR astigmatism (46.8%), and the OB astigmatism had the lowest prevalence (19.5%)

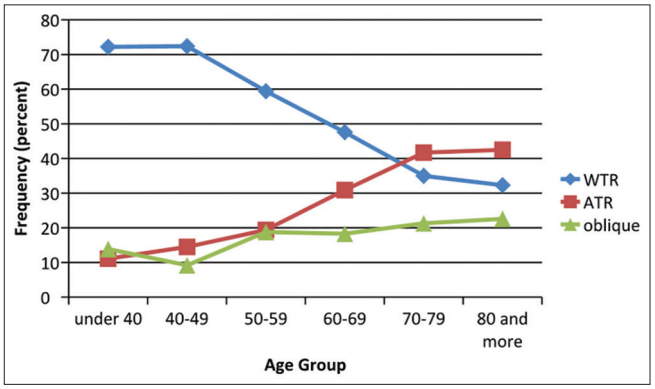

Figure 2: Frequency distribution of the astigmatism axis in different age groups

among our data. These results are comparable to former studies.[5,7,14]

The amount of corneal astigmatism did not show any correlation with age, while the axis clinically significantly turned to ATR with increasing age [Figure 2].

Our results related to AL, keratometry, and ACD are comparable to other studies that used Lenstar 900 for measurements.[27-29]

In conclusion, the current study revealed the distribution of ocular biometric dimensions and the corneal astigmatism among Iranian patients who were candidates for cataract extraction. We found that CCT and LT increased, whereas AL and ACD decreased significantly with age. There were considerable differences between the two genders in terms of LT and AL which both were higher in men. The amount of corneal astigmatism did not show any correlation with age, while the axis clinically significantly turned to ATR with increasing age.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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