ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

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Evaluation of Age-Related Changes in Corneal Parameters Using Scheimpflug Imaging: A Prospective Clinical Study

Scheimpflug Görüntüleme Tekniği Kullanılarak Yaşa Bağlı Kornea Parametrelerindeki Değişikliklerin Değerlendirilmesi: Prospektif Klinik Çalışma

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ABSTRACT Objective: To determine the changes in corneal parameters of the normal population with age using corneal topography. **Material and Methods:** This prospective study included 275 right-eye measurements from a total of 275 healthy participants. The participants were divided into 4 groups according to their age: 6 to 20 years (Group 1), 21 to 40 years (Group 2), 41 to 60 years (Group 3), and over 60 years (Group 4). Central corneal thickness (CCT), central 10 mm corneal volume (Cvol), keratometry (K) values, corneal astigmatism (Ast), and axis values obtained with a Sirius topography device were recorded. **Results:** The mean age of the participants was 35.94±21.04 (range 6 to 77). There was a significant difference in CCT, Cvol, and Ast measurements between the groups ($p<0.001$). Regression analysis found a decrease of 4.6 µm in CCT and 0.6 mm3 in Cvol for every 10 years. There was a significant negative correlation between age and CCT and Cvol ($r=-0.281$, $r=-0.336$, respectively). There was a statistically significant change in the astigmatic axis values in accordance with with-the rule (WTR) and against-the rule with age. There was a significant difference in overall and Group 1 and 2 K values in the evaluation according to sex. **Conclusion:** CCT, Cvol, and Ast values decrease significantly with age. Axis values shift from WTR to against-to-rule with age. Knowledge of these changes can help in the prediction of the long-term results of corneal diseases, ophthalmic operations, and intraocular lens power calculations.

Keywords: Central corneal thickness; corneal volume; keratometry values; corneal astigmatism

ÖZET Amaç: Bu çalışmanın amacı, yaşla birlikte normal popülasyonun kornea parametrelerinde meydana gelen değişiklikleri korneal topografi kullanarak belirlemektir. **Gereç ve Yöntemler:** Bu prospektif çalışma toplam 275 sağlıklı katılımcının 275 sağ göz ölçümlerini içermektedir. Katılımcılar yaşlarına göre 4 gruba ayrıldı: 6-20 yaş (Grup 1), 21-40 yaş (Grup 2), 41-60 yaş (Grup 3), 60 yaş üzeri (Grup 4). Sirius topografi cihazı ile alınan santral kornea kalınlığı [central corneal thickness (CCT)], santral 10 mm korneal hacim [corneal volume (Cvol)], keratometri (K) değerleri, korneal astigmat [corneal astigmatism (Ast)] ve aks değerleri kaydedildi. **Bulgular:** Katılımcıların ortalama yaşları 35,94 (aralık, 6-77 yaş) idi. Gruplar arasında CCT, Cvol ve Ast ölçümlerinde anlamlı fark mevcut idi ($p<0,001$). Regresyon analizinde her 10 yıl için CCT'de 4,6 µm, Cvol'de 0,6 mm3 azalma bulundu. Yaşla CCT ve Cvol arasında anlamlı negatif korelasyon vardı (sırasıyla, $r=-0,281$, $r=-0,336$). Düz K değerinde Grup 2 ve 3 arasındaki farktan kaynaklanan anlamlılık mevcut idi. Yaşla birlikte kurala uygun ve kurala aykırı astigmatik aks değerlerinde istatistiksel olarak anlamlı değişiklik var idi. Cinsiyetle ilişkili değerlendirmede tüm katılımcılar, Grup 1 ve 2'de K değerleri açısından anlamlı fark mevcut idi. **Sonuç:** CCT, Cvol ve Ast değerleri yaşla anlamlı olarak azalmaktadır. Aks değerleri yaşla birlikte kurala uygun astigmattan, kurala aykırı astigmata kaymaktadır. Bu değişimlerin bilinmesi cerrahi girişimlerin, göz içi lens gücü hesaplamalarının, kornea hastalıklarının, uzun dönem sonuçlarının tahmin edilebilmesinde yardımcı olabilir.

Anahtar Kelimeler: Santral kornea kalınlığı; kornea hacmi; keratometri değerleri; korneal astigmat

With age, changes occur in all body tissues, including the layers of the eye. Disorders such as cataracts, age-related macular degeneration, and glaucoma increase in frequency with age, with deterioration of the tissues in the eye. It is known that there are changes in the corneal layers, such as steepening

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in keratometry (K) values or turning the astigmatic axis from with-the rule (WTR) to against-the rule (ATR) with age.[1-3]

The cornea is the tissue responsible for approximately 2/3 of the refractive power of the eye.[4] Therefore, corneal health and changes that may occur in the cornea for various reasons (such as age) are important. Corneal parameters are used before and after cataract surgery, for refractive surgery, and in the evaluation of corneal disorders. While evaluating the cornea, the central corneal thickness (CCT) and corneal volume (Cvol) give us information about corneal health. These parameters are especially important in terms of indirect evaluation of corneal endothelial function before cataract surgery, evaluation before refractive surgery, deciding which operation to perform, and the follow-up of ectatic corneal diseases. Accurate evaluation of intraocular pressure (IOP) in glaucoma patients is important for follow-up. While IOP may be incorrectly overestimated in people with thick corneas, it may be falsely underestimated in those with thin corneas.[5,6]

K values are used in the calculation of intraocular lens (IOL) power and the detection and follow-up of ectatic corneal diseases such as keratoconus.[7,8] Corneal astigmatism (Ast) and axis values, on the other hand, guide us in deciding on toric IOLs for the improvement of astigmatism in refractive surgery. In recent years, it has been aimed to maximize postoperative visual acuity without glasses after these types of surgery.[9]

In the present study, we aimed to find out what changes occur in the cornea with age and how these changes will affect our follow-up and operations, with measurements obtained using Scheimpflug imaging. We compared the measurements taken between the age groups and sexes.

MATERIAL AND METHODS

This study was carried out prospectively in the ophthalmology department of Hitit University, Erol Olçok Training and Research Hospital. It was performed in accordance with the principles of the Declaration of Helsinki. The study was approved by the Clinical Research Ethics Committee (date: August 25, 2022, no: 2022-73). Verbal and written consent were obtained from the participants or their parents. In the study, 275 healthy people who presented to the ophthalmology clinic for examination were randomly selected and right eye measurements were used. The participants were classified according to age into Group 1 (6-20 years), Group 2 (21-40 years), Group 3 (41-60 years), and Group 4 (>60 years).

Patients having a systemic disease (diabetes mellitus, coronary artery disease, lung disease) (except hypertension), using systemic and topical drugs that may affect anterior segment parameters, having a history of ocular surgery, having a diagnosis of ocular disease affecting the anterior segment (such as dry eye, pterygium, corneal disorders, glaucoma, diabetic retinopathy), wearing contact lenses, having refraction values (spherical equivalence) of 3 diopters and more, having Ast values of 3 diopters or more, or having amblyopia were excluded from the study.

The best corrected visual acuities of the participants were evaluated by Snellen chart. Anterior segment examinations were performed with a slit lamp. Without dilating the pupil, macula and optic nerve examinations were performed with a +90 D lens. Corneal topography was recorded with a Sirius topography device (Sirius; Costruzione Strumenti Oftalmici, Florence, Italy). If an acquisition quality of >90% or better was detected, the topography images were saved. Those with low acquisition quality were not included in the study. In the corneal topography, CCT, central 10 mm Cvol, anterior flat K1, steep K (K2), mean K (Km), Ast, and axis values were used in the study. Astigmatic axis values were grouped as WTR (90±30 degrees), ATR (180±30 degrees), and oblique astigmatism for the others. Measurements of the participants were obtained between 10 am and 1 pm to minimize the influence on diurnal variation.

The parameters were compared statistically in all participants and between groups. In addition, it was evaluated whether there was any difference in terms of sex.

STATISTICAL ANALYSIS

Statistical analyses were performed using SPSS version 22 (SPSS, Inc., Chicago, IL, USA). The compatibility of the data with the normal distribution was

evaluated with the Kolmogorov-Smirnov test. Normally distributed data were compared using one-way ANOVA. Homogeneity of variances was evaluated with Levene's test. $p<0.05$ was considered significant. When there was a significant difference between the groups, pairwise post-hoc comparisons were made using Tukey's and Tamhane's T2 tests. The groups were compared using the Kruskal-Wallis test for data that did not show normal distribution. Pairwise comparisons were made using the Mann-Whitney U test and evaluated using Bonferroni correction.

RESULTS

Of the 275 participants, 138 (50.2%) were male and 137 (49.8%) were female. The mean [±standard deviation (SD)] age of the participants was 35.94±21.04. There was no significant difference between the groups in terms of sex. The mean age in Groups 1 to 6, respectively, was 9.85±3.86 years (range 6-20 years), 31.53±5.67 years (range 21-40 years), 49.61±5.44 years (range 41-60 years), and 65.70±4.08 years (range 61-77 years) (Table 1).

The CCT, Cvol, K1, Ast, and axis values differed significantly between the groups ($p<0.001$, $p<0.001$, $p=0.028$, $p<0.001$, $p<0.001$, respectively). The significant difference in CCT was due to the difference between Group 1 and the other groups (Groups 2, 3, and 4) ($p=0.031$, $p=0.002$, $p<0.001$, respectively). The significant difference in Cvol was due to the difference between Group 1 and Groups 3 and 4 ($p=0.001$, $p<0.001$, respectively) and Groups 2 and 4 ($p=0.004$). The significant difference in K1 was due to the difference between Groups 2 and 3 ($p=0.030$). For Ast, the difference between Group 1 and Groups 3 and 4 (respectively, $p<0.001$, $p<0.001$) and between Group 2 and Groups 3 and 4 (respectively, $p=0.007$, $p=0.001$) was significant. There was no significant difference between the other parameters examined. Table 2 shows the mean, SD, and minimum-maximum values of the parameters (Table 2). In the regression analysis, it was found that there was a decrease in CCT of 4.6 µm/decade with age. CCT had a significant but weak negative correlation with age ($r=-0.281$, $p<0.001$). The regression analysis also indicated that Cvol decreased by 0.6 mm^3/decade and was negatively correlated with age ($r=-0.336$, $p<0.001$) (Figure 1).

Table 3 shows the distribution of Ast axis values between the groups in terms of WTR, ATR, and oblique (Table 3). While the axis values were significantly different in Groups 1, 2, and 3, there was no significant difference in Group 4 ($p<0.001$, $p<0.001$, $p<0.001$, $p=0.250$, respectively). The change in WTR and ATR astigmatism was significant with age, but the change in oblique astigmatism was not significant ($p<0.001$, $p<0.001$, $p=125$, respectively).

When all the groups were evaluated together (overall), the K1, K2, and Km values were significantly different ($p<0.001$, $p=0.002$, $p<0.001$, respectively). When the age groups were examined

TABLE 1: Demographic characteristics of the participants.

Groups	n	Age ($\bar{X}$±SD) (Minimum-maximum)	Gender (M/F) (%)	p*
Group 1	86	9.85±3.86 (6-20)	43/43 (50/50)	1.000
Group 2	58	31.53±5.67 (21-40)	27/31 (46.6/53.4)	0.599
Group 3	87	49.61±5.44 (41-60)	40/47 (46/54)	0.453
Group 4	44	65.70±4.08 (61-77)	28/16 (63.6/36.4)	0.070
Overall	275	35.94±21.04 (6-77)	138/137 (50.2/49.8)	0.952

*Chi-square test; n: Number of participants; M/F: Male/female; SD: Standard deviation; Group 1: 6-20 years; Group 2: 21-40 years; Group 3: 41-60 years; Group 4: 61-77 years.

TABLE 2: Comparison of corneal parameters between groups.

Parameter	Overall 275	Group 1 (n=86)	Group 2 (n=58)	Group 3 (n=87)	Group 4 (n=44)	p value
CCT (µm)	542.55±34.14 (454-646)	555.99±35.29 (486-646)	540.55±28.13 (492-596)	537.83±30.44 (467-627)	528.23±37.92 (454-618)	**<0.001**[a]
Cvol (mm^3)	57.37±3.46 (49.6-66.9)	58.80±3.45 (50.80-66.90)	57.56±2.81 (51.60-63.70)	56.85±2.95 (50.60-63.60)	55.34±4.00 (49.60-65.30)	**<0.001**[a]
K1 (D)	43.18±1.43 (40.07-47.85)	43.30±1.26 (40.73-46.67)	42.68±1.55 (40.07-45.98)	43.35±1.53 (40.36-47.85)	43.28±1.24 (40.24-46.17)	**0.028**[a]
K2 (D)	44.05±1.51 (40.54-47.85)	44.28±1.40 (40.93-48.28)	43.63±1.60 (40.54-47.28)	44.11±1.60 (40.76-48.78)	44.03±1.33 (40.70-46.45)	0.122[b]
Km (D)	43.61±1.45 (40.37-48.31)	43.78±1.31 (40.83-47.46)	43.15±1.56 (40.37-46.62)	43.72±1.55 (40.67-48.31)	43.65±1.25 (40.47-46.31)	0.052[a]
Ast (D)	0.87±0.50 (0.07-2.94)	0.99±0.46 (0.09-2.39)	0.95±0.46 (0.34-2.51)	0.76±0.49 (0.07-2.33)	0.74±0.59 (0.17-2.94)	**<0.001**[b]

[a]One-way ANOVA test; [b]Kruskal-Wallis test; bold: p<0.05; CCT: Central corneal thickness; Cvol: Corneal volume; K1: Flat keratometry value; K2: Steep keratometry value; Km: Mean keratometry value; Ast: Corneal astigmatism; D: Diopter; Group 1, 6-20 years; Group 2, 21-40 years; Group 3, 41-60 years; Group 4, 61-77 years.

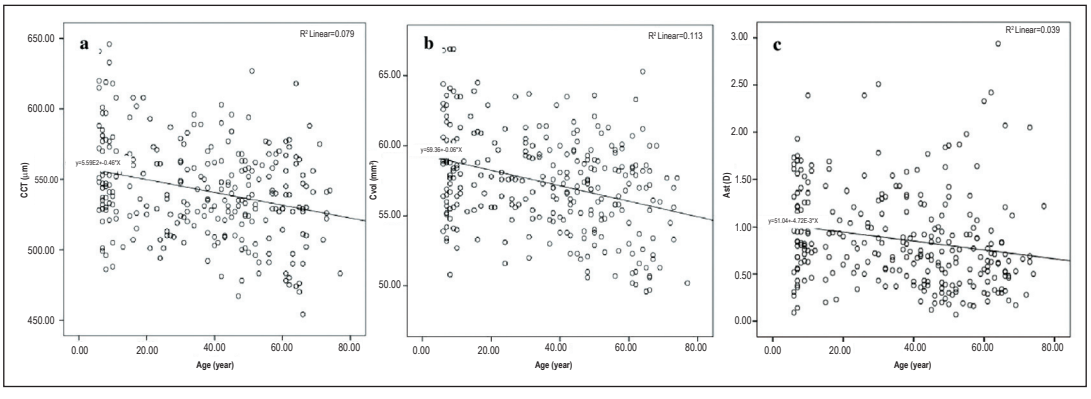

FIGURE 1: Correlation plot and linear regression line between a) CCT b) Cvol c) Ast.
CCT: Central corneal thickness; Cvol: Cornea volume; Ast: Cornea astigmatism.

TABLE 3: Distribution of Ast axis rates between groups.

Groups	Ast WTR	Ast ATR	Ast Oblique	p*
Overall	202	46	27	**<0.001**
	73.5%	16.7%	9.8%	
Group 1	80	4	2	**<0.001**
	93%	4.7%	2.3%	
Group 2	52	4	6	**<0.001**
	82.8%	6.9%	10.3%	
Group 3	59	19	9	**<0.001**
	67.8%	21.8%	10.3%	
Group 4	15	19	10	0.250
	34.1%	43.2%	22.7%	
p*	**<0.001**	**<0.001**	0.125	

*Chi-square test, bold: p<0.05; Ast: Corneal astigmatism; WTR: With-the rule; ATR: Against-the rule; Group 1, 6-20 years; Group 2, 21-40 years; Group 3, 41-60 years; Group 4, 61-77 years.

independently, K1 values (p=0.006, p=0.040, respectively), K2 values (respectively, p=0.044, p=0.036), and Km values (respectively, p=0.013, p=0.029) differed significantly between Groups 1 and 2. There was no significant difference in Ast values (Table 4). There was no significant difference between the sexes in terms of axis values (p=0.219).

DISCUSSION

In the present study, CCT, Cvol, and Ast values were found to decrease significantly with age. K1 values differed significantly between Groups 2 and 3. Axis values were changing from WTR astigmatism to ATR astigmatism with age. When evaluated in terms of sex, there was a significant difference in K1, K2,

TABLE 4: Comparison of corneal parameters by gender within groups.

Paremeters	Groups	Male	Female	p value
CCT (µm)	Overall	543.59±34.43 (454-646)	541.49±33.93 (467-633)	0.610[a]
	Group 1	557.77±39.82 (486-646)	554.21±30.47 (496-633)	0.643[a]
	Group 2	537.59±26.17 (494-583)	543.13±29.93 (492-596)	0.460[a]
	Group 3	539.03±26.76 (478-596)	536.81±33.51 (467-627)	0.737[a]
	Group 4	534.14±37.09 (454-618)	517.88±38.30 (470-578)	0.174[a]
Cvol (mm^3)	Overall	57.10±3.71 (49.70-66.90)	57.64±3.18 (49.60-66.90)	0.191[a]
	Group 1	58.81±3.85 (50.80-66.90)	58.79±3.05 (53.20-66.90)	0.970[a]
	Group 2	56.82±2.90 (51.60-61.30)	58.22±2.60 (54.60-63.70)	0.057[a]
	Group 3	56.29±3.03 (50.60-63.60)	57.33±2.82 (51.00-63.50)	0.103[a]
	Group 4	55.88±4.25 (49.70-65.30)	54.39±3.44 (49.60-58.60)	0.239[a]
K1 (D)	Overall	42.88±1.35 (40.07-47.21)	43.49±1.44 (40.51-47.85)	**<0.001**[a]
	Group 1	42.93±1.20 (40.73-45.98)	43.67±1.23 (41.53-46.67)	**0.006**[a]
	Group 2	42.24±1.32 (40.07-44.70)	43.07±1.65 (40.51-45.98)	**0.040**[a]
	Group 3	43.01±1.54 (40.36-47.21)	43.64±1.48 (40.98-47.85)	0.055[a]
	Group 4	43.24±1.19 (40.24-45.83)	43.37±1.37 (41.68-46.17)	0.735[a]
K2 (D)	Overall	43.75±1.40 (40.54-47.52)	44.35±1.56 (41.05-48.78)	**0.002**[b]
	Group 1	43.95±1.27 (40.93-46.92)	44.62±1.46 (41.67-48.28)	**0.044**[b]
	Group 2	43.13±1.35 (40.54-45.84)	44.07±1.69 (40.51-45.98)	**0.036**[b]
	Group 3	43.77±1.54 (40.76-47.52)	44.40±1.61 (40.98-47.85)	0.085[b]
	Group 4	44.02±1.30 (40.70-46.13)	44.04±1.42 (41.68-46.17)	0.788[b]
Km (D)	Overall	43.31±1.35 (40.37-47.37)	43.91±1.48 (40.77-48.31)	**<0.001**[a]
	Group 1	43.43±1.22 (40.83-46.45)	44.13±1.33 (41.60-47.46)	**0.013**[a]
	Group 2	42.68±1.31 (40.37-45.26)	43.56±1.66 (40.77-46.62)	**0.029**[a]
	Group 3	43.38±1.52 (40.67-47.37)	44.01±1.53 (41.16-48.31)	0.057[a]
	Group 4	43.62±1.20 (40.47-45.94)	43.70±1.37 (42.01-46.31)	0.849[a]
Ast (D)	Overall	0.88±0.51 (0.12-2.94)	0.87±0.49 (0.07-2.51)	0.940[b]
	Group 1	1.02±0.44 (0.20-1.93)	0.95±0.48 (0.09-2.39)	0.434[b]
	Group 2	0.89±0.45 (0.34-2.39)	1.00±0.47 (0.37-2.51)	0.350[b]
	Group 3	0.76±0.51 (0.12-2.33)	0.77±0.49 (0.07-1.98)	0.885[b]
	Group 4	0.79±0.62 (0.21-2.94)	0.67±0.52 (0.17-2.42)	0.643[b]

[a]Independent samples test, [b]Mann-Whitney U test, bold: p<0.05; CCT: Central corneal thickness; Cvol: Corneal volume; K1: Flat keratometry value; K2: Steep keratometry value; Km: Mean keratometry value; Ast: Corneal astigmatism; D: Diopter; Group 1, 6-20 years; Group 2, 21-40 years; Group 3, 41-60 years; Group 4, 61-77 years.

and Km (overall and Groups 1 and 2). It was observed that women had steeper corneas than men.

In studies evaluating CCT, the mean CCT was found to be between 520 and 579 µm.[10,11] In our study, it was 542.5 µm. Kazancı et al. showed that the CCT was 541.5 µm (214 eyes, range 18-56 years) in their study with the Sirius topography device in a Turkish population.[12] In studies conducted with Scheimpflug imaging, the mean CCT in normal children was found to be between 537 and 555 µm.[13,14] Similarly, in our study, we found a mean CCT of 555.99±35.29 in Group 1 (6-20 years). CCT may also differ according to race. Aghaian et al. evaluated 6 different races in their study that included 801 patients, 23.2% of which were Caucasian, 19.6% Chinese, 15.1% Japanese, 14.5% Hispanic, 14.2% Filipino, and 13.4% African American. The mean CCT of all participants was 542.9 µm. The group with the thinnest corneas was the African Americans (521.0.0 µm), followed by the Japanese participants (531.7 µm). No significant differences were found between the Chinese, Caucasian, Hispanic, and Filipino participants (555.6, 550.4, 548.1, 550.6 µm, respectively). The mean CCT values of the Turkish population were similar to those of the Chinese, Hispanic, Caucasian, and Filipino populations and greater than those of the Japanese and African American populations.[15] There are many studies in the literature evaluating the change in corneal thickness with age. Galgauskas et al., in their study with 211 Caucasian patients, showed that the cornea decreases in thickness with age. However, they stated that the CCT correlation with age was weak.[16] Foster et al., in a study involving participants aged 10-87 years, showed a decrease in corneal thickness of 5 µm in men and 6 µm in women every 10 years.[17] Eballe et al. reported a decrease in CCT of 4.2 µm per 10 years.[18] According to the regression analysis performed in our study, the CCT decreased approximately 4.6 µm with age (for 10 years). The weak negative correlation of CCT with age has been shown in our study and many others.[16,19] There are studies with different results for CCT comparison between the sexes. The Beijing Eye Study with 3,251 participants showed that men have thicker corneas than women.[20] Moreover, according to Suzuki et al., CCT was 521 µm in men and 514 µm in women.[21] In contrast to these, in many studies no significant difference was found between the sexes in terms of CCT. Lekskul et al. showed that there was no difference in their study with 467 participants aged 12-60 years.[6] Eballe et al. did not find a significant difference between men and women in terms of CCT in 970 eyes.[18] In our study, there was no significant difference between the sexes (p=0.610). The reason for these differences may have been the structural characteristics of the participants or the different measuring instruments used. In addition, it has been shown that while CCT is lowest at the beginning of the menstrual cycle in women, it is highest during ovulation.[22] Hormone levels may also have affected the measurements of women during the study period.

Although Cvol is not a parameter studied as much as CCT in the literature, we think it is important in terms of showing corneal health. Prakash et al. found mean Cvol to be 57.3 mm^3 and 58.1 mm^3 in their study with 300 South Asian and 300 Arab participants, respectively.[23] Çevik et al., in their study with 122 people, showed that the mean Cvol was 60.7 mm^3.[24] In our study, Cvol was 57.4 mm^3. It decreased significantly with age. This may occur due to a decrease in the number of keratocytes and interfibrillary distance with age.[25,26] There was no significant difference in Cvol between the men and women.

Among the studies examining K values, Vitályos et al. found a decrease in K1 and K2 values with age in their study in which they included 35 volunteers aged 14-67 years.[27] Orucoglu et al., on the other hand, showed that K1 increases with age, but there is no change in the K2 value.[28] Ferrer-Blasco et al., in their retrospective study, found that women had steeper corneas in the patients evaluated.[29] Kazancı et al. showed that women have steeper Km.[12] Contrary to these, Khan and Muhtaseb evaluated 343 male and 403 female patients and found no significant difference between the sexes.[30] In our study, there was a significant change with age in K values only in K1. While there was no difference between Groups 1, 3, and 4 in K1, this significance was due to the difference between Groups 2 and 3 (p=0.030). This led us to suppose that it was due to the structural character-

istics of the Group 2 participants. When we evaluated it in relation to sex, we found that women had significantly higher K1, K2, and Km values compared to men. This situation was significant in those under 40 years of age. Sex hormones may be responsible for this. It has been shown that there are hormone receptors in the epithelial, stroma, and endothelial layers of the cornea.[31] The fact that there is no significant difference over the age of 40 when the levels of sex hormones decrease supports this situation.

In some studies on Ast, WTR and <1 D astigmatism were found in the young population (20-30 years).[1,32] Ueno et al., in their study with 419 patients aged 8-93 with normal eyes, showed that the anterior cornea changed from WTR astigmatism to ATR astigmatism with age, but the majority of posterior astigmatism remained ATR.[33] Naeser et al. used Scheimpflug imaging in their study with 710 patients aged 20-88 years and found that astigmatism remained stable until the age of 50, and then changed to approximately 0.25 D ATR astigmatism every 10 years.[34] In our study, while Ast decreased significantly with age (approximately 0.25 D), astigmatic axis values were 93% WTR in Group 1, and this rate decreased to 34% in Group 4. ATR astigmatism was approximately 5% in Group 1, increasing to 43% in Group 4. Astigmatism values did not show a significant difference between the sexes. Although the reason for this change in astigmatism and axes is not fully understood, the change in corneal curvature, the position of the eyelid and tension, corneal stromal collagen fibers, and extraocular muscles have been thought responsible for this situation.[35] This change in axes that occurs with age should be considered before surgery such as refractive or toric IOL implantation for astigmatism.

Our study had limitations. The first is that our number of participants was relatively small. Larger studies are needed to confirm these changes. Secondly, the participants consisted of only the Turkish population who presented to our hospital. These findings should be supported by large-scale international research and applied to different races and societies. Third, there was a small number of participants over the age of 60. The increase in systemic diseases with age was responsible for this situation. Patients with diseases other than hypertension were not included in our study.

CONCLUSION

CCT and Cvol decreased with age in our study. It was observed that CCT decreased approximately 4.6 µm/decade and Cvol decreased 0.6 mm^3/decade. Ast values decreased significantly with age, while axis values shifted from WTR astigmatism to ATR astigmatism. In the comparison of men and women, it was seen that the women had higher K values under the age of 40. We think that sex hormones are responsible for this situation. Axis changes with age should be considered before surgery (cataract and refractive operations). Knowledge of these changes can be helpful in predicting the long-term results of corneal diseases, ophthalmic surgical procedures, and IOL power calculations.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

This study is entirely author's own work and no other author contribution.

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