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Original Article *Özgün Araştırma*

COMPARISON OF ANTERIOR SEGMENT PARAMETERS IN PREADOLESCENT CHILDREN AND MIDDLE AGED ADULTS

Ergenlik Öncesi Çocuklar ve Orta Yaşlı Erişkinlerde Ön Segment Parametrelerinin Karşılaştırılması

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ABSTRACT

Objective: Comparison of anterior segment parameters, anterior/posterior keratometry, and corneal astigmatism values in preadolescent children and middle-aged adults.

Material and Methods: Right eye measurements from a total of 100 subjects (50 children and 50 adults) were included in the study. Central corneal thickness (CCT), aqueous depth (AD), anterior camera volume (ACV), iridocorneal angle (ICA), anterior/posterior keratometry (ant.K/post.K) values, and corneal astigmatism (Cast.) values were recorded. The groups were compared between themselves, and they were compared in terms of sex within each group.

Results: The mean age of the children was 7.82±1.45 and the mean age of the adults was 53.84±6.81. There were significant differences between the groups in terms of age and CCT, AD, ACV, ICA, anterior corneal astigmatism (ant.Cast.), and posterior vertical K (post.K2) values. There were significant differences in AD and ICA between males and females among the children (p=0.036, p=0.005, respectively). There were also significant differences in ACV and ICA between males and females among the adults (p=0.012, p=0.006, respectively). In the correlation analysis, CCT, AD, ACV, ICA, and post.K2 were negatively correlated with age, while ant.Cast. was positively correlated.

Conclusion: In our study, CCT and anterior segment parameters were significantly lower in adults. This situation was more evident in women. It is useful to consider these differences in the diagnosis and follow-up of corneal diseases, in deciding on refractive surgery, and in determining the type of surgery, as well as in the diagnosis and follow-up of glaucoma.

Keywords: *Aqueous depth, anterior chamber volume, central corneal thickness, keratometry*

ÖZ

Amaç: Ergenlik öncesi çocukluklarda ve orta yaşlı erişkinlerdeki ön segment parametreleri, ön/ arka keratometri ve korneal astigmat değerlerinin karşılaştırılması.

Gereç ve Yöntemler: Toplam 100 kişinin (50 çocuk ve 50 erişkin) sağ göz ölçümleri çalışmaya dahil edildi. Katılımcıların santral kornea kalınlığı (CCT), aköz derinliği (AD), ön kamera hacmi (ACV), iridokorneal açı (ICA), ön/ arka keratometri (ant.K/post.K) değerleri ve korneal astigmat (Cast.) değerleri kaydedildi. Gruplar kendi aralarında karşılaştırıldı, grup içinde de cinsiyet yönünden istatistiksel olarak karşılaştırıldı.

Bulgular: Çocukların yaş ortalaması 7.82±1.45, erişkinlerin yaş ortalaması 53.84±6.81 idi. Gruplar arasında yaş, CCT, AD, ACV, ICA, ön korneal astigmat (ant.Cast.) ve arka dik K (post.K2) değerleri açısından anlamlı fark vardı. Çocuk grubunda erkek ve kızlar arasında AD ve ICA arasında anlamlı fark vardı (sırasıyla p=0.036, p=0.005). Erişkin grubunda erkek ve kadınlar arasında ACV ve ICA arasında anlamlı fark vardı (sırasıyla p=0.012, p=0.006). Korelasyon analizinde CCT, AD, ACV, ICA ve post.K2'in yaşla negatif yönde, ant.Cast.'ın pozitif yönde ilişkisi bulundu.

Sonuç: Çalışmamızda CCT ve ön segment parametrelerinin erişkin grupta anlamlı olarak daha düşük olduğu görüldü. Bu durum kadınlarda daha belirgindi. Bu farklılıkların korneal hastalıkların tanı ve takip edilmesinde, refraktif cerrahiye karar verme ve cerrahi çeşidinin belirlenmesinde ayrıca glokom tanı ve takibinde dikkate alınmasında fayda vardır.

Anahtar Kelimeler: *Aköz derinliği, ön kamera hacmi, santral kornea kalınlığı, keratometri.*

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INTRODUCTION

Corneal thickness and anterior segment parameters are important for the diagnosis and follow-up of various ocular diseases (1). Central corneal thickness (CCT) is important in the diagnosis and follow-up of glaucoma, when deciding on refractive surgery, in the diagnosis of keratoconus, in the evaluation of endothelial function, and in deciding on corneal interventions such as cross-linking (2,3). Anterior segment parameters such as aqueous depth (AD), anterior camera volume (ACV), and iridocorneal angle (ICA) are also used for calculating the appropriate intraocular lens (IOL) power and deciding on phakic IOL and whether the eye is suitable for iris-fixed IOL or anterior chamber IOL (4,5). They are also used to determine the type of glaucoma and the risk of angle closure. Keratometry (K) and corneal astigmatism (Cast.) values are important when calculating the correct IOL power, applying toric IOL, and in the diagnosis and follow-up of keratoconus (6-8). A Sirius topography (Costruzione Strumenti Ophthalmici, Florence, Italy) device consists of a monochromatic Scheimpflug camera and a Placido disc that can evaluate all these parameters noninvasively. It enables evaluation of all corneal pachymetry, anterior and posterior corneal topography, and anterior segment parameters (9). Understanding how these parameters change with age can help us decide on the surgical interventions to be performed, determine the appropriate IOL type, and follow up corneal diseases.

In the present study, we aimed to find out how the parameters of the cornea and anterior segment change in healthy preadolescent children (under 12 years old) and middle-aged adults (45 years and older) and whether this change is significant.

MATERIALS AND METHODS

The study was carried out retrospectively in the ophthalmology clinic of Hitit University. After approval was obtained from the ethics committee of Hitit University (25.05.2022- 2022/53), data were collected in line with the Declaration of Helsinki. The measurements recorded in the Sirius topography device used in the eye clinic were used. Right eye measurements from 50 preadolescent children under the age of 12 years and 50 middle-aged adults aged 45 years and over were included in the study.

By scanning the hospital registry system, those with systemic disease (diabetes mellitus, coronary artery disease, or lung disease), those taking systemic or topical drugs that may affect anterior segment parameters, and those with a history of ocular surgery, an ocular diagnosis that may affect the anterior segment (dry eye, pterygium, corneal disorders, glaucoma, or diabetic retinopathy), refraction values (spherical equivalence) of 3 diopters and above, or amblyopia were excluded from the study.

The data included in the study were CCT, AD, ACV, ICA, anterior/posterior keratometry (ant.K/post.K), and anterior/posterior corneal astigmatism (ant.Cast./post.Cast.) values, which were approved by the device for acquisition quality. The anterior keratometry values flat K (ant.K1), steep K (ant.K2), mean K (ant.Km), and anterior corneal astigmatism (ant.Cast.) were used. Flat K (post.K1), steep K (post.K2), mean K (post.Km), and posterior corneal astigmatism (post.Cast.) were the posterior keratometry values used. Measurements recorded between 9 am and 3 pm were used to minimize diurnal variations. The measurements of children and adults were compared with each other. The groups were also compared statistically in terms of sex.

Device

The Sirius system consists of a 360-degree rotating Scheimpflug camera and Placido disc-based corneal topography system. With a blue LED light (475 nm), it measures approximately 35,000 points from the anterior corneal surface and approximately 30,000 points from the posterior cornea. With the Scheimpflug camera, profiles of the iris, anterior lens, and corneal surfaces and slope, curvature, and height data are calculated from Placido images. A pachymetric map is created using anterior and posterior corneal data (10,11).

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Statistical analysis

Statistical analyses were performed using commercial software (SPSS ver. 22.0; SPSS, Inc., Chicago, IL, USA). The Kolmogorov–Smirnov test was used to determine whether the data were normally distributed or not. Normally distributed data were evaluated with the independent t-test and those not normally distributed with the Mann–Whitney U test. Pearson and Spearman correlation tests were used for correlation analysis. Significance was accepted at $p<0.05$.

RESULTS

A total of 100 eyes of 100 subjects (50 preadolescent children and 50 middle-aged adults) were included in the study. The preadolescent children group consisted of 25 boys (50%) and 25 girls (50%), while the middle-aged adults group consisted of 22 men (44%) and 28 women (56%). There was no significant difference between the groups in terms of sex ($p>0.05$). The mean age of the children was 7.82±1.45 (6-11 years) and the mean age of the adults was 53.84±6.81 (45-74 years). The comparison of age, sex, CCT, AD, ACV, ICA, anterior/posterior keratometry, and corneal astigmatism values is shown in Table 1.

Table 1: Comparison of values of children and adults groups.

	Mean values± SD			
	Children	**Adult**	**Difference**	**P**
Age (year) (min-max)	7.82±1.45 (6-11)	53.84±6.81 (45-74)	-46.02±6.74	<0.001[a]*
Gender (male/ female)	25/25	22/28		0.689[b]
CCT (µm)	557.62±33.83	531.90±30.23	25.72±42.82	<0.001[c*]
AD (mm)	3.14±0.23	2.70±0.28	0.44±0.41	<0.001[d*]
ACV (mm^3)	165.58±22.94	129.44±22.59	36.14±34.05	<0.001[d*]
ICA (degree)	45.06±6.50	38.06±4.94	7.00±8.96	<0.001[d*]
Ant.K1 (D)	43.24±1.18	43.32±1.61	-0.08±2.11	0.839[c]
Ant.K2 (D)	44.15±1.29	43.98±1.72	0.16±2.25	0.309[c]
Ant.Km (D)	43.69±1.22	43.65±1.65	0.04±2.17	0.517[c]
Ant.Cast. (D)	-0.90±0.40	-0.66±0.46	-0.25±0.54	0.005[d*]
Post.K1 (D)	-5.97±0.19	-6.04±0.26	0.07±0.34	0.159[d]
Post.K2 (D)	-6.30±0.24	-6.42±0.32	0.12±0.42	0.044[d]
Post.Km (D)	-6.13±0.21	-6.22±0.28	0.09±0.36	0.075[d]
Post.Cast. (D)	0.33±0.13	0.38±0.16	-0.05±0.21	0.118[c]

CCT: Central corneal thickness, AD: Aqueous depth, ACV: Anterior chamber volume, ICA: Iridocorneal angle, ant./post.K1: Flat keratometry values of anterior/posterior cornea, ant./post.K2: Steep keratometry values of anterior/posterior cornea, ant./post.Km: Mean keratometry values of anterior/posterior cornea, ant./post.Cast.: Corneal astigmatism values of anterior/posterior cornea, a: Fisher's exact test b: Pearson chi-square test, c: Mann Withney U test , d: Independent samples T test, * $p<0.05$.

For age, CCT, AD, ACV, ICA, ant.Cast., and post.K2 values, there was a significant difference between the groups (but not for sex) ($p<0.05$) (Figure 1). Figures 2A and B show the anterior and posterior keratometry values (Figure 2A-B).

Table 2 shows the measurements of males and females in the children's group. Only AD and ICA were significantly narrower in girls than in boys ($p=0.005$).

Table 3 shows the measurements of males and females in the adults' group. ACV and ICA values were significantly narrower in females than in males ($p=0.012$, $p=0.006$, respectively).

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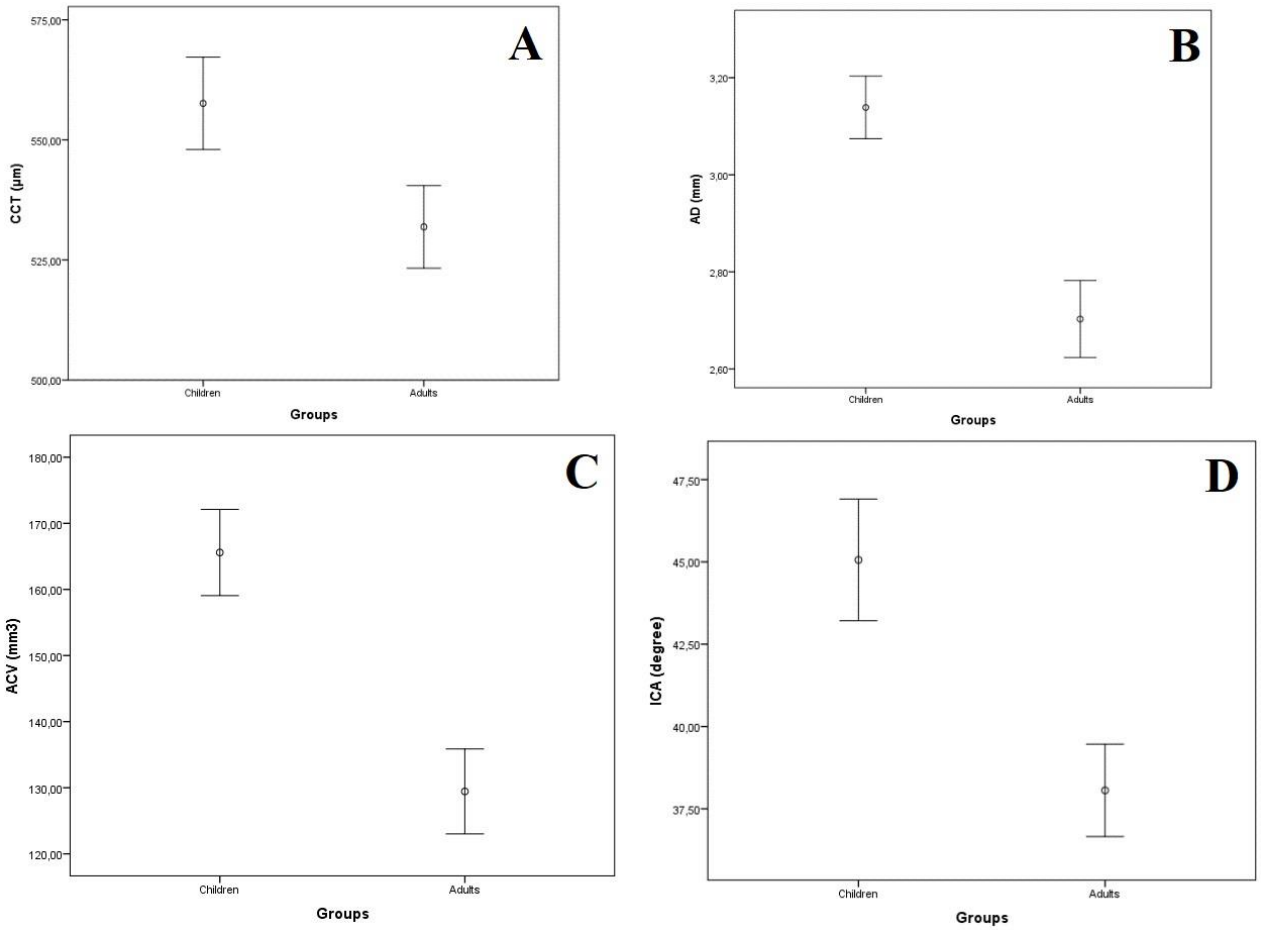

Figure 1: Comparison of between groups A; Central corneal thicknesses (CCT), B; Aqueous depth (AD), C; Anterior chamber volume (ACV), D; Iridocorneal angle (ICA).

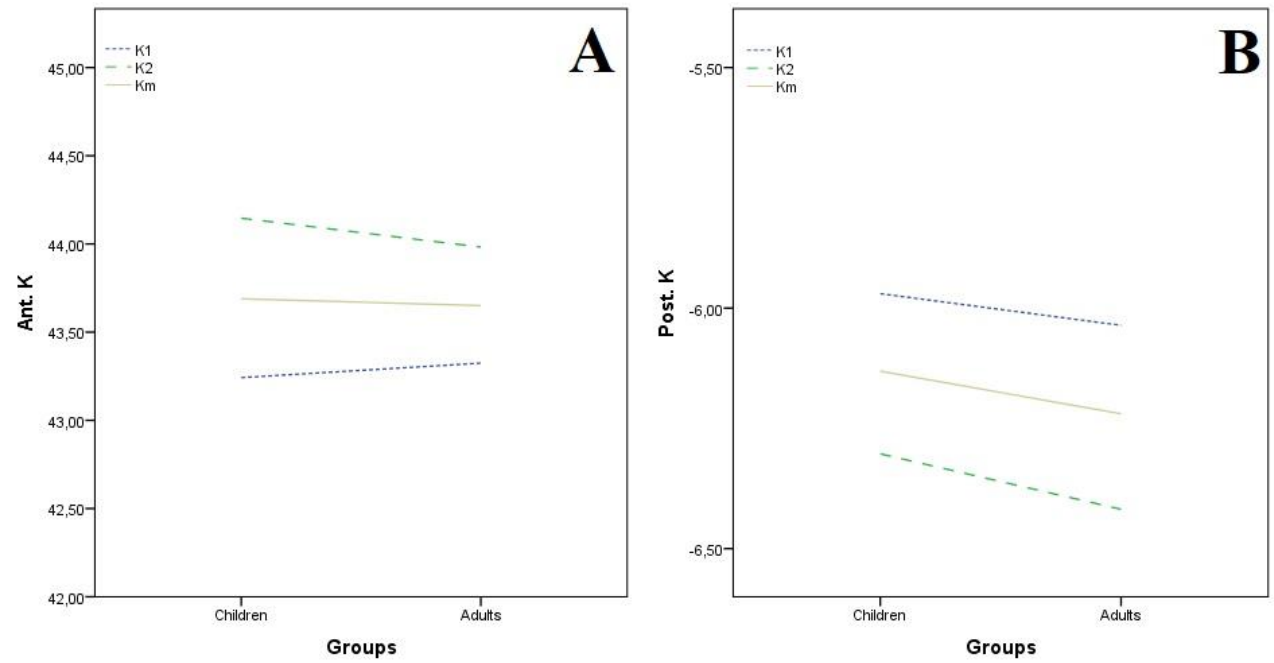

Figure 2: A, shows anterior keratometry values, B, shows posterior keratometry values. Anterior/ posterior flat keratometry values (ant.K1/post.K1), anterior/ posterior steep keratometry values (ant.K2/post.K2), anterior/ posterior mean keratometry values (ant.Km/post.Km).

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Table 2: Comparison of boys and girls in the children group.

	Mean values± SD			
	Children		Difference	P
	Male	Female		
CCT (µm)	557.00±40.89	558.24±25.76	-1.24	0.861[a]
AD (mm)	3.21±0.20	3.07±0.24	0.14	0.036[b*]
ACV (mm3)	169.48±22.17	161.68±23.48	7.8	0.233[b]
ICA (degree)	47.60±6.21	42.52±5.86	5.08	0.005[b*]
Ant.K1 (D)	42.93±1.03	43.55±1.25	-0.62	0.081[a]
Ant.K2 (D)	43.89±1.11	44.40±1.43	-0.51	0.237[a]
Ant.Km (D)	43.41±1.05	43.97±1.33	-0.56	0.143[a]
Ant.Cast. (D)	-0.95±0.42	-0.85±0.38	-0.1	0.386[b]
Post.K1 (D)	-5.92±0.16	-6.02±0.21	0.1	0.068[b]
Post.K2 (D)	-6.27±0.20	-6.34±0.27	0.07	0.311[b]
Post.Km (D)	-6.08±0.17	-6.17±0.24	0.09	0.143[b]
Post.Cast. (D)	0.35±0.14	0.32±0.11	0.03	0.303[a]

CCT: Central corneal thickness, AD: Aqueous depth, ACV: Anterior chamber volume, ICA: Iridocorneal angle, ant./post.K1: Flat keratometry values of anterior/posterior cornea, ant./post.K2: Steep keratometry values of anterior/posterior cornea, ant./post.Km: Mean keratometry values of anterior/posterior cornea, ant./post.Cast.: Corneal astigmatism values of anterior/posterior cornea, a: Mann Withney U test , b: Independent samples T test, * p<0.05.

Table 3: Comparison of men and women in the adult group

	Mean values± SD			
	Adult		Difference	P
	Male	Female		
CCT (µm)	528.09±26.00	534.89±33.34	-6.8	0.506[a]
AD (mm)	2.77±0.26	2.65±0.28	0.12	0.118[b]
ACV (mm3)	138.36±20.97	122.43±21.64	15.93	0.012[b*]
ICA (degree)	40.18±4.90	36.39±4.37	3.79	0.006[b*]
Ant.K1 (D)	43.12±1.35	43.49±1.79	-0.37	0.762[a]
Ant.K2 (D)	43.78±1.37	44.14±1.96	-0.36	0.845[a]
Ant.Km (D)	43.45±1.34	43.81±1.87	-0.36	0.815[a]
Ant.Cast. (D)	-0.66±0.50	-0.65±0.43	-0.01	0.951[b]
Post.K1 (D)	-5.99±0.23	-6.46±0.35	0.47	0.281[b]
Post.K2 (D)	-6.36±0.28	-6.46±0.35	0.1	0.283[b]
Post.Km (D)	-6.17±0.24	-6.26±0.30	0.09	0.251[b]
Post.Cast. (D)	0.38±0.15	0.39±0.17	-0.01	0.777[a]

CCT: Central corneal thickness, AD: Aqueous depth, ACV: Anterior chamber volume, ICA: Iridocorneal angle, ant./post.K1: Flat keratometry values of anterior/posterior cornea, ant./post.K2: Steep keratometry values of anterior/posterior cornea, ant./post.Km: Mean keratometry values of anterior/posterior cornea, ant./post.Cast.: Corneal astigmatism values of anterior/posterior cornea, a: Mann Withney U test , b: Independent samples T test, * p<0.05.

In the correlation analysis, CCT, AD, ACV, ICA, and post.K2 were negatively correlated with age [respectively, (-0.38, p<0.001), (-0.64, p<0.001), (-0.62, p=0.001), (-0.50, p<0.001), (-0.20, p=0.04)], while ant.Cast. was positively correlated with age (0.26, p=0.01). AD was positively correlated with ACV and ICA [respectively, (0.89, p<0.001), (0.73, p<0.001)] and negatively correlated with ant.Cast. (-0.26, p=0.01). ACV was positively correlated with ICA, post.K1, post.K2, and post.Km [respectively, (0.60, p<0.001), (0.28, p=0.01), (0.32), p<0.001), (0.31, p<0.001)]. A positive correlation was found between Ant.Cast. and post.K2 and post.Km [(0.31, p<0.001), (0.24, p=0.02)] and a negative correlation with post.Cast. (-0.38, p<0.001).

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DISCUSSION

Our study showed that there were significant decreases in CCT, AD, ACV, and ICA with age. In keratometry values, a significant difference was found in the value of only ant.Cast. In terms of sex, AD and ICA were significantly narrower in females than in males among the children. In the adults' group, females' ACV and ICA were significantly narrower than males'.

There are many studies on CCT in the literature. Different results were found in studies evaluating the relationship with age. There are studies showing that age is not associated with CCT (12,13). Rieth et al. showed that CCT increases with age (14). Contrary to these studies, the majority of studies have shown that CCT decreases with age (15-18). It has been shown that there is a decrease of approximately 4 μm in men and 5 μm in women every 10 years (19). Valdez et al., in their study comparing CCT according to age groups, showed that people under 20 years old had approximately 20 μm thicker corneas than those over 40 years old (20). In our study, CCT was significantly thinner (approximately 25 μm) in the adults, which is consistent with the literature. The reason for this has been shown to be a decrease in keratocytes with age (21). In addition, some studies have shown that there is a progressive thickening of the stromal collagen bundle and a decrease in the interfibrillar space with age (22,23).

Regarding ACD, Bhardwaj et al. did not find a significant difference between age groups (24). Contrary to that study, many studies have shown that AD and ACV decrease with age (25,26). In our study, AD and ACV were significantly narrower in the adults. Pareven et al. attributed this to the increase in lens thickness and narrowing of the anterior chamber especially after the age of 40 (27). Sheppard and Davis found that the ciliary muscle thickens with age and shifts in the anterior-interior direction (28). Saw et al. found ACD to be deeper in boys and taller children among children aged 7-9 years (29). In our study, when we evaluate in terms of sex, AD, ACV, and ICA are narrower in both children and women. This may explain why glaucoma, especially angle-closure glaucoma, is more common in adults and especially in women.

There is little change in the corneal curvature after the age of 3 years (30). Kazanci et al. showed that women (mean age 28) had a higher mean K value (31). Saw et al., among children, found the corneal curvature to be steeper in older girls (29). Shimizu et al., in their study comparing children and adults, found that the corneal curvature was wider in children (adults: children; 7.40:7.70 mm) (32). In our study, although females had higher K values in both children and adults, it was not statistically significant. Hayashi et al. found that there was no change in the posterior cornea in people over 40 years of age (33). In our study, only ant.Cast. and post.K2 values were significantly different. Ant.Cast. was 0.25D less in the adults than in the children. Although the change in the post.K2 value (0.12D) is statistically significant, we cannot regard it as clinically significant. This situation differs from previous studies. The reason for this may have been the different measuring instrument used in the studies, race, or genetic factors. The fact that the anterior cornea is more affected by age than the posterior cornea may also be the reason for this situation.

Our study has limitations. The first is that the sample size was small. These results may not apply to large populations. The second is that people with values greater than SE ±3 D were not included in the study. Further studies are needed to understand how these anterior segment parameters change with age in people with high refractive values. The third is the lack of axial length (AL) values of the participants. Although not measuring AL is a shortcoming of our study, Saw et al., in their study with 1453 children (7-9 years old), found that an increase in AL did not cause any change in anterior segment parameters, and they interpreted this as showing that the development of anterior and posterior segments may be controlled by different factors (29). The fourth limitation is that the participants were grouped as children and adults only. It would be appropriate to group according to age ranges and to

compare these parameters between groups. This will be planned and implemented as a prospective study.

Finally, it is seen that the CCT and anterior segment values are lower in adults than in children. This situation is more evident in the female population. It is useful to consider these differences in terms of refractive surgery, monitoring of corneal pathologies, and diagnosis and follow-up of glaucoma. It is seen that large-scale and long-term studies are needed to understand the changes that occur in the anterior segment with age.

Conflict of Interest: The author has no conflict of interest to declare.

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