Age- and Gender-Related Biometric Changes in Normal Eyes

Normal Gözlerde Yaş ve Cinsiyetle İlişkili Biyometrik Değişiklikler

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ABSTRACT Objective: To investigate the age- and gender-related changes in ocular biometric data in normal eyes. **Material and Methods:** This randomized prospective study was conducted on 160 volunteers with no ocular pathology. A-scan biometric measurements including anterior chamber depth, lens thickness, vitreous length, and total axial length were assessed in only one eye for each subject having a spherical equivalent in the range of -0.75 D to +0.75 D. The study subjects were divided into eight age groups. There were 20 subjects in each group (10 males and 10 females). **Results:** Negative correlations were found between age and anterior chamber depth in both genders (Male, r=-0.450, p<0.001; Female, r=0.583, p<0.001). Older individuals had smaller anterior chamber depths. There were high positive correlations between age and lens thickness in both sexes (Male, r=0.593, p<0.001; Female, r=0.382, p<0.001). Older individuals had thicker lenses. We did not detect an age-related difference in vitreous length and total axial length. When each group was compared separately, we found no gender-related difference in age groups. Anterior chamber depth was significantly deeper in males when all male and female subjects were compared (p<0.05). **Conclusion:** Anterior chamber depth and lens thickness significantly change with advancing age in normal eyes, while vitreous length and total axial length do not change by age. The age-related ocular biometric changes are the same in both genders.

Key Words: Sex; aging; biometry

ÖZET Amaç: Normal gözlerde yaş ve cinsiyete göre oküler biyometrik verilerde gözlenen değişiklikleri araştırmak. **Gereç ve Yöntemler:** Bu randomize prospektif çalışmada göz hastalığı olmayan 160 gönüllü değerlendirildi. Sferik eşdeğer aralığı -0,75D ile +0,75D arasında olan olgularda tek gözde ön kamara derinliği, lens kalınlığı, vitreus uzunluğu ve total aksiyel uzunluk ölçümü ile biyometrik tarama yapıldı. Çalışmaya katılanlar yaşları açısından sekiz gruba ayrıldılar. Her grupta 20 hasta vardı (10 erkek, 10 kadın). **Bulgular:** Her iki cinsiyette de yaş ve ön kamara derinliği arasında negatif korelasyon bulundu (Erkek, r=-0,450, p<0,001; Kadın, r=0,583, p<0,001). Yaşlılarda ön kamara derinliği daha azdı. Yaş ve lens kalınlığı arasında da iki cinste pozitif korelasyonlar saptandı (Erkek, r=0,593, p<0,001; Kadın, r=0,382, p<0,001). Yaşlılarda lens kalınlığı daha fazlaydı. Vitreus uzunluğu ya da toplam aksiyel uzunlukta yaşla ilişkili bir fark saptamanmadı. Her grup kendi içinde değerlendirildiğinde yaş gruplarında cinsiyet açısından da fark saptanmadı. Tüm kadın ve erkekler karşılaştırıldığında ön kamara derinliğinin erkeklerde daha fazla olduğu görüldü (p<0,05). **Sonuç:** Ön kamara derinliği ve lens kalınlığı normal gözlerde yaşın ilerlemesiyle beraber giderek artar, ancak vitreus uzunluğu ve toplam aksiyel uzunluk yaşla değişmez. Yaşla ilişkili oküler biyometrik değişiklikler her iki cinsiyette de aynıdır.

Anahtar Kelimeler: Cinsiyet; yaşlanma; biyometri

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Ocular biometric data such as anterior chamber depth, lens thickness, vitreous length, and total axial length are important parameters affecting ocular refractive state. To our knowledge, former

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reports evaluating age-and gender-related changes in biometric data are limited.[1-4] We could not find any studyies including pediatric age groups. Furthermore, the range of change that occurs in biometric data by each decade is not well known. Besides, it is not clear if these changes are affected by gender. Previous reports reveal that the central thickness of the lens increases with advancing age, but at the same time anterior chamber depth decreases.[1-5] Age-related changes in vitreous length and total axial length are controversial.

In this study, the participants from a wide range of ages between six and 91 years were assigned into eight age groups and age- and gender-related changes in ocular biometric data in normal eyes were investigated.

MATERIALS AND METHOD

This prospective, randomized study was approved by the local ethics committee and informed consents were obtained from all participants according to the guidelines of the Declaration of Helsinki.

SELECTION OF PARTICIPANTS

The study cohorts were composed of 160 normal volunteers having spherical equivalent in the range of -0.75 D to +0.75 D and ±0.50 D astigmatism. There were 20 subjects in each age group (10 males and 10 females): 6–10, 11–20, 21–30, 31–40, 41-50, 51-60, 61-70, and >71 years (Table 1). All participants were of Caucasian origin. Participants were selected randomly out of patients, employees, and students in our hospital. Any history of ocular surgery or ocular trauma and any ocular disease affecting ocular biometric data were regarded as exclusion criteria.

OCULAR EXAMINATIONS

All subjects underwent complete ophthalmic examinations including corrected visual acuity, anterior segment examination, and fundus examination.

A-scan ultrasonography was performed by Biovision International-Model:Axis ® ultrasonic biometry with corneal contact method to measure axial length, vitreous length, lens thickness, and anterior chamber depth after instillation of proparacain hydrochloride 0.5% (Alcaine, Alcon-Couvreur, Puurs, Belgium). The average value from the best 10 images was recorded for all axial dimensions. Biometric measurements were assessed in eyes with smaller refractive errors.

STATISTICAL ANALYSIS

Biometric parameters were assessed with one-sample Kolmogorov-Smirnov test and found to be normal ($p>0.05$). Analysis of variance (ANOVA) was performed on the biometric data to examine the differences among age groups. If a significant group effect was found, Tukey's HSD test was used to identify the location of differences between groups. The differences between males and females were compared with independent student's t test.

TABLE 1: Demographic features of the participants

	N		Mean Age (years±sd, range)		P
	Male	Female	Male	Female	
Group 1	10	10	8.60±0.69 (8-10)	8.80±1.62 (6-10)	0.850
Group 2	10	10	16.89±2.20 (13-20)	15.90±1.75 (13-18)	0.195
Group 3	10	10	26.80±2.86 (21-30)	25.50±3.14 (21-30)	0.370
Group 4	10	10	33.90±2.07 (31-38)	34.30±2.26 (31-38)	0.971
Group 5	10	10	45.40±2.71 (41-49)	45.20±2.79 (41-49)	0.703
Group 6	10	10	53.50±4.41 (51-57)	52.30±1.63 (51-55)	0.227
Group 7	10	10	65.90±2.13 (63-69)	63.45±2.54 (61-68)	0.094
Group 8	10	10	78.80±9.39 (71-92)	77.00±3.77 (71-81)	0.122

Pearson correlation analysis test was used for correlation analyses. Statistical significance was defined as p<0.05. SPSS 8/0 package program (IBM, USA) was used for analyses.

RESULTS

Demographic features of the study subjects are presented in Table 1. Mean ages (p>0.05) and the number of males and females were similar in each group. The spherical equivalent values were similar in all groups (p>0.05).

In variance analysis for anterior chamber depth, a statistically significant difference was found among the age groups in both sexes [(Male (M), p=0.003; Female (F), p<0.001)], (Figure 1). In post-hoc test, the difference between group 1 and group 8 was statistically significant for both genders (M, p=0.002; F, p<0.001). There was also a significant difference between groups 2 and 8 in both genders (M, p=0.018; F, p<0.001), and there were significant differences between group 3 and group 8 (p=0.001), and group 6 and group 8 (p=0.037) in females. There were negative correlations between age and anterior chamber depth in both genders (M, r=-0.450, p<0.001; F, r=0.583, p<0.001), (Pearson correlation analysis test).

Lens thickness also varied with age (ANOVA; M, p<0.001; F, p=0.030), (Figure 2). In men, there were statistically significant differences in lens thickness values between group 1 and group 5 (p=0.007), group 1 and group 6 (p=0.007), group 1 and group 7 (p=0.002), group 1 and group 8 (p<0.001), group 2 and group 8 (p<0.001), group 3 and group 8 (p=0.042), and group 4 and group 8 (p=0.010). In women, there were not statistically significant differences among the age groups. Despite a significant difference was not detected in double comparison for lens thickness in females, there were positive correlations between age and lens thickness in both sexes (M, r=0.593, p<0.001; F, r=0.382, p<0.001) by correlation test.

Vitreous length and total axial length values of the study groups are seen in Figure 3 and Figure 4.

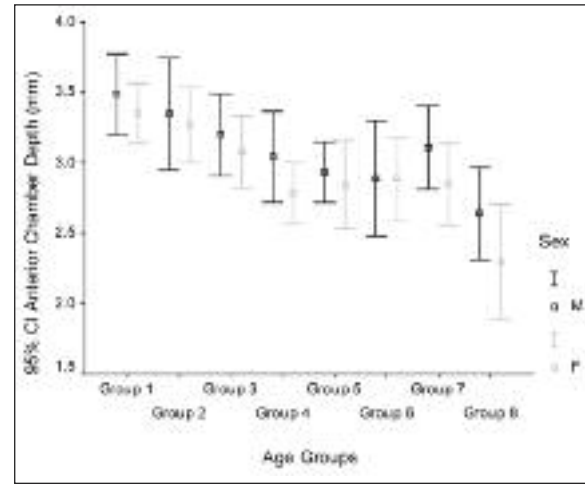

FIGURE 1: Mean anterior chamber depth values by gender and age groups (There were statistically significant differences among age groups (M, p=0.003; F, p<0.001)) M: Male, F: Female, CI: Confidence Interval.

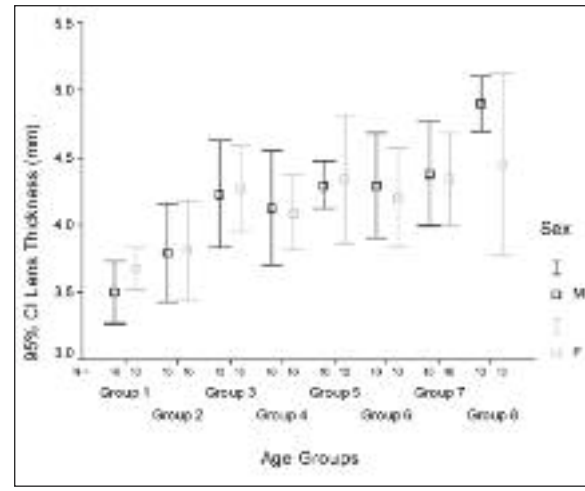

FIGURE 2: Mean lens thickness values by gender and age groups (There were statistically significant differences among age groups (M, p<0.001; F, p=0.030)) M: Male, F: Female, CI: Confidence Interval.

A significant difference was not found among the groups (p>0.0 5).

Table 2 shows mean biometric parameters in all groups by genders. There was no gender-related difference among all age groups. When all age groups were included, anterior chamber depth was deeper in males than females (p<0.05), and lens thickness, vitreous length and total axial length were similar in both genders (p>0.05).

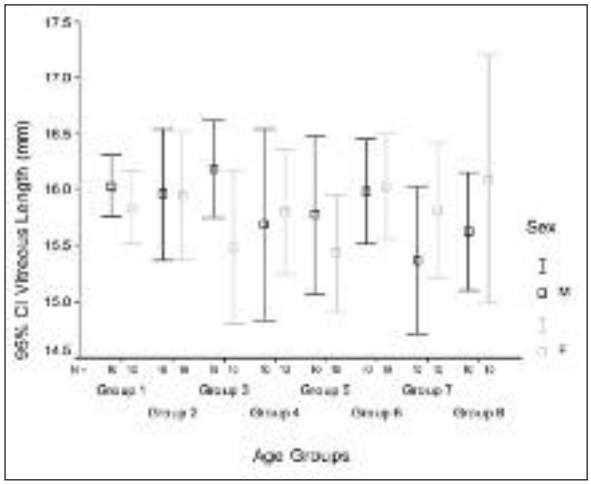

FIGURE 3: Mean vitreous length values by gender and age groups (There was no statistically significant difference among age groups (M, p=0.426; F, p=0.668)) M: Male, F: Female, CI: Confidence Interval.

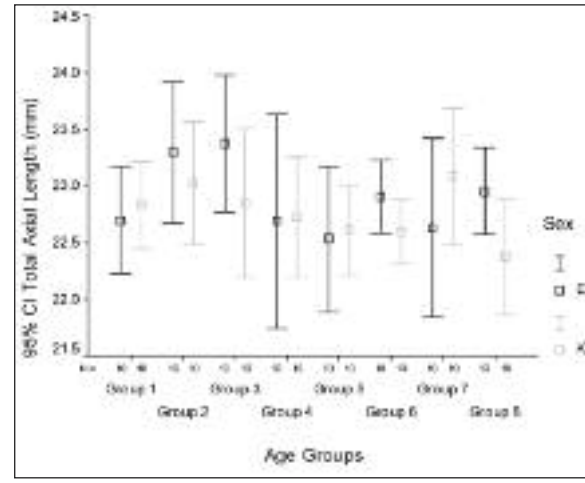

FIGURE 4: Mean total axial lengths by gender and age groups (There was no statistically significant difference among age groups (M, p=0.286; F, p=0.365)) M: Male, F: Female, CI: Confidence Interval.

DISCUSSION

Studies investigating age- and gender-related changes in biometric parameters are scarce and these reports do not include pediatric age groups. Koretz et al. measured ocular biometric parameters in normal emmetropic subjects between 18 and 70 years of age.[5] The report by Atchison et al. includes participants between 18 and 69 years of age within ±0.75 of emmetropia.[1] In the study of Wong et al., the cases between 40 and 81 years of age were included.[2] There was no limitation for refractive errors in this study. In the study by Shufelt et al., the participants were over 40 years of age.[3] In this study, there was not any limitation for refractive errors either. Our study subjects were between 6 and 91 years of age.[3]

In our study, we have found that anterior chamber depth is decreased and conversely lens thickness is increased with advancing age. Previous reports state similar results.[1-5] Koretz et al.[5] have reported that anterior chamber depth is decreased and lens thickness is increased linearly over the entire age group. Atchison et al.[1] have reported that anterior chamber depth decreases by 0.011 mm/ye-

TABLE 2: Differences in biometric parameters according to genders (There was no gender-related difference in all parameters and in all age groups)

	Anterior Chamber Depth		Lens Thickness		Vitreous Length		Total Axial Length	
	Male	Female	Male	Female	Male	Female	Male	Female
Group 1	3.48±0.4	3.35±0.3	3.50±0.3	3.67±0.2	16.03±0.4	15.84±0.4	22.70±0.6	22.83±0.5
Group 2	3.34±0.5	3.27±0.4	3.79±0.5	3.81±0.5	15.96±0.8	15.9±40.9	23.29±0.7	23.03±0.7
Group 3	3.19±0.4	3.07±0.3	4.33±0.5	4.27±0.4	16.18±0.6	15.48±0.9	23.37±0.8	22.85±0.9
Group 4	3.04±0.4	2.78±0.3	4.12±0.6	4.09±0.3	15.68±1.2	15.80±0.8	22.69±1.3	22.72±0.7
Group 5	2.93±0.3	2.84±0.4	4.29±0.2	4.33±0.6	15.78±1.0	15.43±0.7	22.53±0.9	22.61±0.5
Group 6	2.88±0.5	2.88±0.4	4.29±0.5	4.20±0.5	15.98±0.6	16.02±0.6	22.90±0.4	22.60±0.4
Group 7	3.10±0.4	2.84±0.4	4.37±0.5	4.34±0.5	15.37±0.9	15.81±0.8	22.63±1.1	23.08±0.8
Group 8	2.64±0.4	2.29±0.6	4.89±0.3	4.45±1.0	15.62±0.7	16.09±1.5	22.95±0.5	22.38±0.7

ar, and lens thickness increases by 0.024 mm/year. Wong et al.[2] reported that people aged 40 to 49 years had deeper anterior chamber depth (10.52 mm), and thinner lenses (20.70 mm) compared to those of 70 to 81 years. Shufelt et al.[3] also reported that older individuals had smaller anterior chamber depths, and thicker lenses. Satıcı and Çam[6] reported that lens thickness decreased proportionally in eyes with longer axial length and increased in those with shorter axial length, and the size of lens increased throughout life.

In our study, there were no age-related differences in vitreous length and total axial length in both genders. Age-and gender related changes in vitreous length and total axial length were controversial. Koretz et al. similarly reported that vitreous length and total axial length were independent of age.[5] Atchison et al.[1] reported that total axial length increased by 0.011 mm/year, and vitreous length did not vary significantly by age. Wong et al.[2] reported that people aged 40 to 49 years, compared to those 70 to 81 years, had longer total axial lengths (mean difference, 0.58 mm), and longer vitreous lengths (0.72 mm). Shufelt et al. found no significant age-related difference in total axial length or vitreous length in men, while the older women had significantly smaller vitreous lengths compared to the younger ones.[3]

We did not find any gender-related difference for any biometric parameters in any age groups. We could not find any study among the previous reports in which their subjects were divided into different age groups and genders. When we performed an overall evaluation including all age groups, anterior chamber depth was found to be deeper in males compared to females and there was no significant difference between males and females with respect to lens thickness, vitreous length and total axial length. In Atchison et al.'s study, there was a tendency towards deeper anterior chamber depth in males compared to females, but the difference was not statistically significant. Males have a tendency towards thicker lenses compared to females but the difference was not statistically significant. Vitreous length and total axial length were significantly longer in males compared to females.[1] In Wong et al.'s study, females had shorter total axial and vitreous lengths, shallower anterior chamber depths, but thicker lenses compared to males.[2] Shufelt et al. reported that females had significantly shorter total axial length, shallower anterior chamber depth and vitreous length compared to males.[3] Cosar and Sener,[7] Eysteinsson et al.,[8] Foster et al.,[9] Klein et al.,[10] Wickremasinghe et al.[11] also found significantly deeper anterior chamber depths in males, and Klein et al.[10] and Wickremasinghe et al.[11] found significantly greater lens thickness in males.

Erdol et al.[12] reported that lens thickness increased with age and anterior chamber depth decreased while lens thickness increased. In this study, axial length was longer in men than women, and there was no difference between both sexes for anterior chamber depth. In the study of Erdol et al., participants having refractive errors were not excluded.[12]

In conclusion, our results revealed that in normal eyes, anterior chamber depth significantly decreases, and lens thickness significantly increases with advancing age. Vitreous length and total axial length are not affected by aging. Age-related changes are generally similar in both sexes, but males have deeper anterior chamber compared to females.

REFERENCES

1. Atchison DA, Markwell EL, Kasthurirangan S, Pope JM, Smith G, Swann PG. Age-related changes in optical and biometric characteristics of emmetropic eyes. J Vis 2008;8(4): 1-20.
2. Wong TY, Foster PJ, Ng TP, Tielsch JM, Johnson GJ, Seah SK. Variations in ocular biometry in an adult Chinese population in Singapore: the Tanjong Pagar Survey. Invest Ophthalmol Vis Sci 2001;42(1):73-80.
3. Atchison DA. Age-related paraxial schematic emmetropic eyes. Ophthalmic Physiol Opt 2009;29(1):58-64.
4. Shufelt C, Fraser-Bell S, Ying-Lai M, Torres M, Varma R; Los Angeles Latino Eye Study Group. Refractive error, ocular biometry, and lens opalescence in an adult population: the Los Angeles Latino Eye Study. Invest Ophthalmol Vis Sci 2005;46(12): 4450-60.
5. Koretz JF, Kaufman PL, Neider MW, Goeckner PA. Accommodation and presbyopia in the human eye--aging of the anterior segment. Vision Res 1989;29(12):1685-92.

6. Satıcı A, Çam V. [The relationship of lens thickness with age and axial length]. Turkiye Klinikleri J Ophthalmol 1998;7(3):165-8.
7. Cosar CB, Sener AB. Orbscan corneal topography system in evaluating the anterior structures of the human eye. Cornea 2003;22(2): 118-21.
8. Eysteinsson T, Jonasson F, Arnarsson A, Sasaki H, Sasaki K. Relationships between ocular dimensions and adult stature among participants in the Reykjavik Eye Study. Acta Ophthalmol Scand 2005;83(6): 734-8.
9. Foster PJ, Alsbirk PH, Baasanhu J, Munkhbayar D, Uranchimeg D, Johnson GJ. Anterior chamber depth in Mongolians: variation with age, sex, and method of measurement. Am J Ophthalmol 1997;124(1):53-60.
10. Klein BE, Klein R, Moss SE. Correlates of lens thickness: the Beaver Dam Eye Study. Invest Ophthalmol Vis Sci 1998;39(8):1507-10.
11. Wickremasinghe S, Foster PJ, Uranchimeg D, Lee PS, Devereux JG, Alsbirk PH, et al. Ocular biometry and refraction in Mongolian adults. Invest Ophthalmol Vis Sci 2004;45(3): 776-83.
12. Erdol H, Cetinkaya K, Avunduk MA, Imamoglu HI. [Biometric measurements in normal eyes by a-mode ultrasonography]. Turkiye Klinikleri J Ophthalmol 1998;7(1):1-3.