RESEARCH ARTICLE

Nurhan Akyer [1]
Seyma Toy [2]
Yusuf Secgin [2]
Deniz Senol [3]
Serkan Oner [4]
Zulal Oner [5]
Muhammed Kamil Turan [6]

[1] Karabük University Graduate School of Education, Department of Anatomy, Karabük, Türkiye
[2] Department of Anatomy, Faculty of Medicine, Karabük University, Karabük, Türkiye
[3] Department of Anatomy, Faculty of Medicine, Düzce University, Düzce, Türkiye
[4] Department of Radiology, Faculty of Medicine, İzmir Bakirçay University, İzmir, Türkiye
[5] Department of Anatomy, Faculty of Medicine, İzmir Bakirçay University, İzmir, Türkiye
[6] Department of Medical biology and genetics, Faculty of Medicine, Karabük University, Karabük, Türkiye

Corresponding Author:
Seyma Toy
mail: seymatoy@karabuk.edu.tr

Received: 15.02.2024
Acceptance: 22.10.2024
DOI: 10.18521/ktd.1437644

Congress Presentation: 2nd International Dr. Safiye Ali Congress on Multidisciplinary Studies in Health Sciences, 10/12/2022.

Konuralp Medical Journal
e-ISSN1309–3878
konuralptipdergi@duzce.edu.tr
konuralptipdergisi@gmail.com
www.konuralptipdergi.duzce.edu.tr

Evaluation of the Differences in Parameters Obtained from the Computed Tomography Images of the Eyeball and the Structures in the Orbit by Age and Gender

ABSTRACT

Objective: The aim of this study is to show the variation of eyeball and orbital structures according to different age groups and gender.

Method: The study was conducted on computerized tomography (CT) images of 4 age groups: 30-40, 41-50, 51-60, and over 61 years old. The parameters were, the angle between the optic nerve and axis of eyeball (A-Cr2AA), the length of the medial rectus muscle (MRML) and the length of the lateral rectus muscle (LRML) up to the Zinn ring, the thickness of the lens (LT), the length of the optic nerve from the Zinn ring (Cr2L), optic nerve thickness (Cr2T), distance between two eyeballs (BOD) and the others.

Results: As a result of the study, in the comparison of males in four groups, significant difference was found between the groups in LT, Cr2L, A-Cr2AA, MRML parameters in the right eyeball and Cr2L and LRML parameters in the left eyeball ($p<0.05$). In the comparison of females in four groups, significant difference was found between the groups in BOD, LT, Cr2L, LRML, MRML in the right and left eyeball and Cr2T parameter in the left eyeball ($p<0.05$).

Conclusion: As a result of the study, it was determined that age and gender differed in the determined parameters.

Keywords: Bulbus Oculi, Orbit, Computed Tomography, Age and Gender Difference.

Göz Küresi ve Orbitadaki Yapıların Bilgisayarlı Tomografi Görüntülerinden Elde Edilen Parametrelerdeki Farklılıkların Yaş ve Cinsiyete Göre Değerlendirilmesi

ÖZET

Amaç: Bu çalışmanın amacı göz küresi ve yörünge yapılarının farklı yaş gruplarına ve cinsiyete göre değişimini ortaya koymaktır.

Yöntem: Çalışma 30-40, 41-50, 51-60, 61 yaş üzeri 4 yaş grubuna ait bilgisayarlı tomografi (BT) görüntüleri üzerinden gerçekleştirildi. Parametreler, optik sinir ile göz küresi ekseni arasındaki açı (A-Cr2AA), medial rektus kasının uzunluğu (MRML) ve lateral rektus kasının uzunluğu (LRML) Zinn halkasına kadar, lensin kalınlığı (LT), optik sinirin Zinn halkasından itibaren uzunluğu (Cr2L), optik sinir kalınlığı (Cr2T), iki göz küresi arasındaki mesafe (BOD) ve diğerleri idi.

Bulgular: Çalışma sonucunda erkeklerde dört grup karşılaştırıldığında, sağ göz küresinde LT, Cr2L, A-Cr2AA, MRML parametreleri ile sol göz küresinde Cr2L ve LRML parametrelerinde gruplar arasında anlamlı fark bulundu ($p< 0,05$). Kadınlarda dört grup karşılaştırıldığında sağ ve sol göz küresinde BOD, LT, Cr2L, LRML, MRML ve sol göz küresinde Cr2T parametresinde gruplar arasında anlamlı fark bulundu ($p<0,05$).

Sonuç: Araştırma sonucunda belirlenen parametrelerde yaş ve cinsiyetin farklılık gösterdiği belirlendi.

Anahtar Kelimeler: Bulbus Oculi, Orbita, Bilgisayarlı Tomografi, Yaş ve Cinsiyet Farkı

INTRODUCTION

The orbit is a complex and important anatomical structure that contains the eyeball, lacrimal gland, adipose tissue, muscle tissue, vascular and nerve structures. It frequently becomes the subject of studies since it has the potential for many diseases due to its complex structure in the orbit (1). Ocular parameters have a significant of ophthalmology. For example, axial length (AL) (2, 3) in cataract surgery and in the detection of some eye-related clinical pictures, the parameter of length of anterior chamber (ACL) before and during intraocular surgery (4, 5), lens thickness (LT) (6) in the evaluation of lens weight and volume are of great importance and knowing the anatomy of these parameters fully affects the diagnosis, treatment and surgical intervention process of the clinician seriously.

The aim of the surgical intervention for diplopia is to restore the deteriorated parallelism of the eyes. Surgical treatment is provided by strengthening or relaxing the functions of the extraocular muscles. For this reason, it is important to know the radioanatomical structures of the rectus muscles (7). Although the length of vitreous body (VL) parameter is not used much in the clinic, it can provide clinically important information and important data for the literature since it is associated with AL (8).

It has been seen the optic nerve is frequently examined in literature in terms of being a cranial nerve that contains special somatic afferent fibres related to vision, has dense fibre count, complex crosses and has important neighbourhoods. A good knowledge of the anatomy is essential for the surgery of problems that arise in itself or in neighbouring structures (9-11).

Computed Tomography (CT) is based on dividing the projection of the object from different angles into cross-sectional images. Unlike other imaging methods, CT can also display soft tissue differences. Thanks to the developing technology, the fast and easy use of CT facilitates the examination of patients in emergency situations and the quick decision on surgical intervention (12-14).

The relationship of eyeball and structures of the orbit with age has been a matter of interest for many years. As a result of different studies conducted, it was found that the anterior-posterior diameter, transverse diameter, height, LT, ACL, VL, AL parameters of the eyeball vary depending on age (14-16).

The study was undertaken to demonstrate the changes in 13 parameters derived from CT imaging of structures in the eyeball and orbit in different age groups and gender

MATERIALS AND METHODS

Population Sample: The study was designed as 4 groups: 30-40 years old (Group 1), 41-50 years old (Group 2), 51-60 years old (Group 3) and 61 years and older (Group 4) with 20F, 20M in each group. Retrospective CT images of the individuals were used. Individuals who had pathologies such as orbital anomaly, uveitis, cataract, and trauma and those who had undergone surgical intervention were not included in the study.

Multidetector CT Protocol: Images were acquired by a 16-row Toshiba multidetector CT (Aquilion 16; Otawara, Japan) in the Radiology Department of the hospital. We retrospectively screened the images that met our exclusion criteria for different conditions.

Image Analysis: CT images in Digital Imaging and Communications in Medicine format were imported into Horos Medical Image Viewer (Version 3.0, USA). 3D Curved Multiplanar Reconstruction (3D-MPR) was then applied. All images were orthogonalized by determining the line passing through the nasion and inion of the axial, sagittal and coronal images (Figure 1).

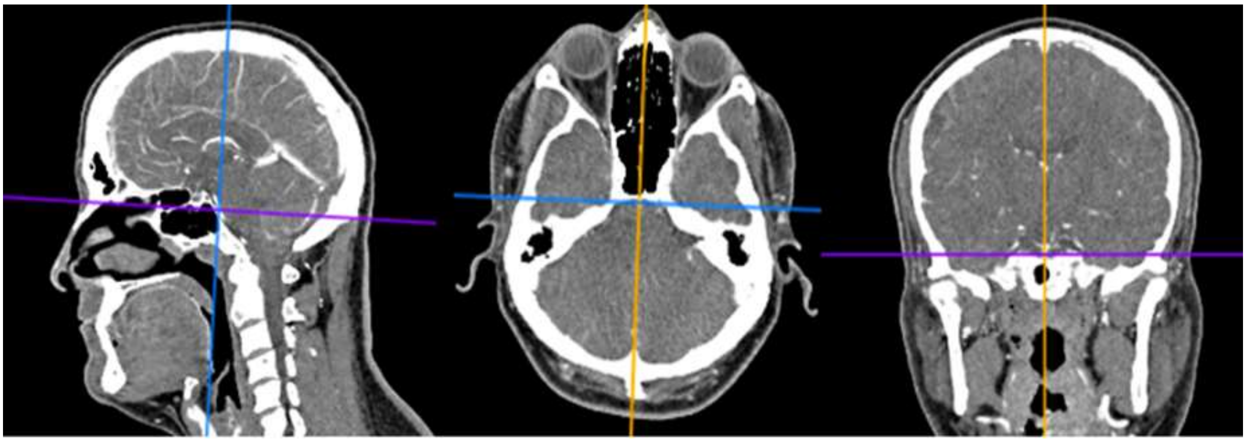

Figure 1. Bringing to the orthogonal plane

The measurement of the width of bulbus oculi (BOW), the length of the axis of eyeball (AL), the angle between the optic nerve and axis of eyeball (A-Cr2AA), the length of the medial rectus muscle (MRML) and the length of the lateral rectus (LRML) up to the Zinn ring, the length of the anterior chambers of eyeball (ACL), the thickness of the lens (LT), the length of the lens (LL), the length of the vitreous body (VL), the length of the optic nerve from the Zinn ring (Cr2L), optic nerve thickness (Cr2T), distance between orbits (OD), distance between two bulbus oculi (BOD) were made by the same radiologist (Figure 2, 3).

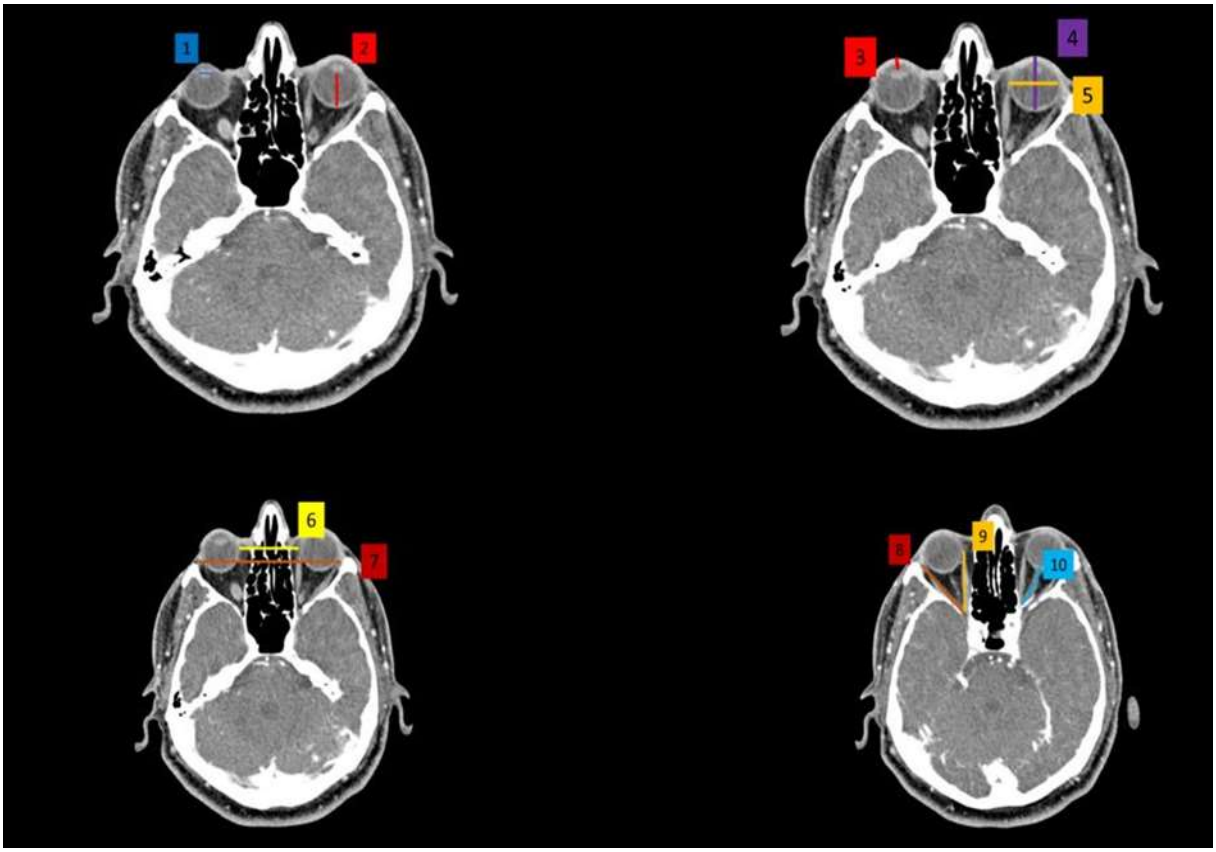

Figure 2. Measurement of LL (1), VL (2), ACL (3), AL (4), BOW (5), BOD (6), OD (7), LRML (8), MRML (9), Cr2L (10) parameters

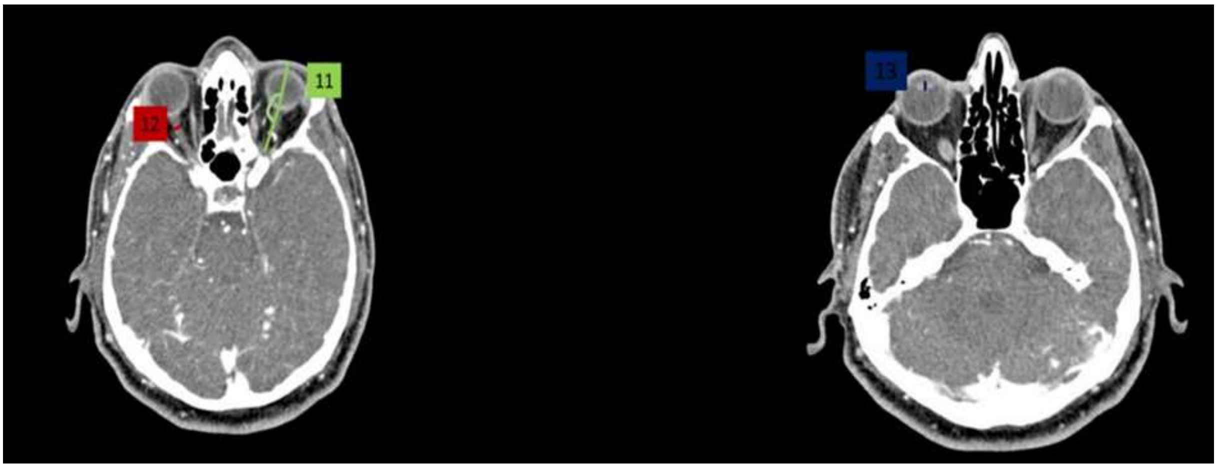

Figure 3. Measurement of A- Cr2AA (11), Cr2T (12), LT (13) parameters

Statistical Analysis: Median, minimum (min) and maximum (max) values of the data were used. Mann-Whitney U test was applied to all data obtained for gender comparison. The relationship between the groups was revealed by Kruskal-Wallis H test. Pairwise Comparison test was preferred as the post-hoc test of Kruskal-Wallis H test. IBM SPSS Statistics 22.0 program running on Windows-based computers was used in the analyses and $p<0.05$ was used as the significance level.

RESULTS

In the study, 13 parameters were evaluated from CT images of 160 people. Table 1 shows the descriptive statistics of the parameters of the right side, which were found to be significant as a result of the comparisons between the genders. No statistically significant difference was found between genders in parameters in group 3 ($p>0.05$).

Table 1. Comparison of the parameters found to be significant in the right eyeball by gender

Parameters	Group	Gender	Median	Minimum	Maximum
Cr2T (mm)	Group 1	Female	3.79	3.10	5.63
		Male	4.65	3.27	6.53
VL (mm)	Group 1	Female	14.72	13.42	16.68
		Male	15.67	14.07	18.59
AL (mm)	Group 2	Female	23.99	21.10	27.03
		Male	25.15	22.54	27.10
Cr2L (mm)	Group 2	Female	21.94	17.79	27.26
		Male	25.80	21.59	35.02
Cr2T (mm)	Group 2	Female	4.13	3.08	6.28
		Male	4.54	3.78	7.71
A- Cr2AA (˚)	Group 2	Female	168.60	155.64	176.48
		Male	173.86	164.09	177.81
LRML (mm)	Group 2	Female	37.00	31.12	42.11
		Male	38.44	34.26	48.93
MRML (mm)	Group 2	Female	30.66	27.02	33.20
		Male	33.45	28.38	43.08
LT (mm)	Group 4	Female	3.73	2.19	5.31
		Male	3.29	2.53	4.34
AL (mm)	Group 4	Female	24.23	21.29	25.35
		Male	24.89	22.58	26.79

Table 2 includes the descriptive statistics of the parameters of the left side, which were found to be significant in terms of gender as a result of the comparisons between the genders. It was concluded that the parameters found to be significant were greater in males than females.

Table 2. Comparison of the parameters found to be significant in the left eyeball by gender.

Parameters	Group	Gender	Median	Minimum	Maximum
Cr2L (mm)	Group 1	Female	21.41	15.96	25.08
		Male	23.30	17.63	26.96
Cr2T (mm)	Group 1	Female	3.73	3.16	5.45
		Male	4.77	2.70	5.99
MRML (mm)	Group 1	Female	30.01	25.48	34.52
		Male	32.23	26.42	36.07
ACL (mm)	Group 2	Female	3.69	2.42	4.87
		Male	4.34	2.74	5.37
Cr2L (mm)	Group 2	Female	23.16	18.27	33.34
		Male	25.84	18.98	36.15
Cr2T (mm)	Group 2	Female	4.07	3.31	5.42
		Male	4.88	3.29	6.30
BOW (mm)	Group 2	Female	22.88	21.93	25.46
		Male	23.99	21.10	26.92
LRML (mm)	Group 2	Female	34.69	30.80	43.08
		Male	37.73	28.86	43.72
MRML (mm)	Group 2	Female	31.21	25.35	34.82
		Male	33.48	28.68	42.84
Cr2L (mm)	Group 3	Female	23.09	17.62	29.05
		Male	25.45	20.15	29.29
Cr2T (mm)	Group 3	Female	3.75	2.70	5.39
		Male	4.73	3.46	6.87
MRML (mm)	Group 4	Female	33.31	29.10	40.31
		Male	31.17	28.74	42.31

Table 3 includes the descriptive statistics of the parameters of the midline, which were found to be significant in terms of gender as a result of the comparisons between the genders. It was concluded that the parameters found to be significant were greater in males than females.

Table 3. Comparison of the parameters found to be significant in midline by gender

Parameters	Group	Gender	Median	Minimum	Maximum
BOD (mm)	Group 1	Female	36.88	29.13	40.91
		Male	38.78	32.68	45.75
OD (mm)	Group 1	Female	91.28	81.72	100.99
		Male	92.92	87.88	101.00
BOD (mm)	Group 2	Female	36.44	29.68	41.32
		Male	39.58	35.04	47.15
OD (mm)	Group 2	Female	90.07	83.17	95.08
		Male	95.61	88.04	99.43
OD (mm)	Group 3	Female	89.74	84.52	95.04
		Male	93.17	85.12	99.57

The parameters of male and female individuals in four groups were tested with the Kruskal-Wallis H test and the p values of the parameters that were found to be statistically significant were included ($p<0.05$), (Table 4, 5). Of the parameters in the midline, BOD parameter was found to be statistically significant in females, and it was statistically significantly higher in males than in females ($p=0.04$).

Table 4. Comparison of right eyeball parameters of male and female individuals

Parameters	Gender	p
LT (mm)	Female	**0.00**
	Male	**0.01**
Cr2L (mm)	Female	**0.00**
	Male	**0.00**
A- Cr2AA (˚)	Female	0.68
	Male	**0.03**
LRML (mm)	Female	**0.00**
	Male	0.06
MRML (mm)	Female	**0.01**
	Male	**0.01**

Table 5. Comparison of left eyeball parameters of male and female individuals

Parameters	Gender	P
LT (mm)	Female	**0.02**
	Male	0.06
Cr2L (mm)	Female	**0.00**
	Male	**0.03**
Cr2T (mm)	Female	**0.05**
	Male	0.98
LRML (mm)	Female	**0.00**
	Male	**0.00**
MRML (mm)	Female	**0.00**
	Male	0.07

According to the Pairwise Comparison test, statistically significant difference was found between Group 1 and Group 2 in LT, Cr2L, A-Cr2AA, MRML parameters and between Group 1 and Group 4 in LT parameter ($p<0.05$). Statistically significant difference was found between Group 1 and Group 2 and Group 1 and Group 4 in LRML parameter in the left eyeball ($p<0.05$), (Table 6).

Table 6. Parameters found to be significant in male individuals in the comparison between groups

Right Bulbus Oculi	Groups	p
LT (mm)	1 vs 2	**0.01**
LT (mm)	1 vs 4	**0.04**
Cr2L (mm)	1 vs 2	**0.00**
A- Cr2AA (˚)	1 vs 2	**0.02**
MRML (mm)	1 vs 2	**0.00**
Left Bulbus Oculi	Groups	p
LRML (mm)	1 vs 2	**0.01**
LRML (mm)	1 vs 4	**0.04**

DISCUSSION

This study was conducted to show the differences in the parameters obtained from the structures in the eyeball and orbit according to age and gender. As a result of the study, in the comparisons between genders, significant difference was found in BOD, OD, Cr2T, VL in right eyeball, Cr2T, Cr2L, MRML in left eyeball in Group 1; BOD, OD, AL, Cr2L, Cr2T, A-Cr2AA, LRML, MRML in right eyeball, ACL, Cr2L, Cr2T, LRML, MRML and BOW in left eyeball in Group 2; OD, Cr2L, Cr2T in left eyeball in Group 3 and AL and LT in right eyeball in Group 4 ($p<0.05$). In the analysis conducted according to age groups, significant correlation was found between first and second groups of LT, Cr2L, A-Cr2AA, MRML parameters in the right eyeball, between the first and fourth groups of LT parameter, and between the first and second and first and fourth groups of LRML parameter in the left eyeball ($p<0.05$).

Chan et al. found that the diameter of the optic nerve sheath complex in the right and left eyeball did not differ significantly between males and females (17). Shen et al. measured the diameter of the optic nerve-sheath complex from behind the eyeball using MRI and found as 5.4; while it was found as 4.2 mm in another measured from 7 mm behind the eyeball (18). In a study they conducted on male cadavers with ages between 3 and 69, Tunahan et al. measured Cr2L as 11 mm on the right and as 9.9 mm on the left and they concluded that the difference they found between right and left optical nerves was not statistically significant (19). Cr2T and Cr2L parameters were measured in this study and it was found that the median value of Cr2T parameter varied between 3 and 5 mm, while the median value of Cr2L parameter varied between 21 and 26 mm. We think that this difference is due to the population, different methods used and the number of sample. Statistically significant difference was found between genders in both right and left eyeball of Group 1 and Group 2 ($p<0.05$). While no statistically significant difference was found between genders in the parameters measured in right eyeball in Group 3, statistically significant difference was found between genders as a result of measurements in the left eyeball ($p<0.05$). In values which were found to be statistically significant, Cr2L was found to be longer in males than in females, and Cr2T was found to be thicker in males than in females. When comparison was made in male individuals of the four groups in terms of age, Cr2L in right and left eyeball was found to have significant difference in Group 1, Group 2, Group 3 and Group 4 ($p<0.05$). When comparison was made in male individuals of the four groups in terms of age, statistically significant difference was found in Cr2L in right and left eyeball in Group 1, Group 2, Group 3 and Group 4 ($p=0.00$ in both sides); in addition, statistically significant difference was found in Cr2T in left eyeball between Groups 1,2,3,4 and groups and Cr2L and Cr2T values were found to increase with age ($p=0.05$).

In CT studies on interzygomatic line length, it was found to be between 97 and 101.5 mm in females and between 101 and 103.8 mm in males (20-22). In our study, length of interzygomatic line, which we determined as OD, was 91.28 mm in female and 92.92 mm in male in Group 1, 90.07 mm in female and 95.61 mm in male in Group 2, 89.74 mm in male and 93.17 mm in female in Group 3. These measurements showed that there was a statistically significant difference between genders and females were found to have more OD than males ($p<0.05$). OD parameter was also found to increase with age. The results found support the literature.

Uygur et al. found that the anteroposterior diameter of the right eyeball, the transverse diameter of the right-left eyeball, and the height of the right-left eyeball decreased significantly with age (14). In our study, there was a significant gender difference in the BOW parameter in Group 2 of only the left eyeball ($p=0.04$). We think that this difference is due to the number of samples.

Tuncer et al. investigated age- and sex-related changes in ocular biometric data from healthy eyes, and it was found that ACL decreased as age increased (15). In their study, Özdemir et al. found the ACL parameter to be statistically significant in terms of gender and higher in males ($p<0.05$) and reported that ACL and LT parameters in healthy eyes changed with advancing age, while VL and AL parameters did not change according to age. When each group was compared separately, no significant gender-related difference was found in age groups (16). In our study, statistically significant difference was found between genders in the AL parameter in the right eyeball in Group 2 and in LT and AL parameters in Group 4. AL was found to be longer in males, while LT was found to be longer in females ($p<0.05$). As a result of measurement in male individuals in four groups, statistical significance was found in right eyeball, LT parameter, Group 1, 2, 3 and 4, while as a result of measurement in female individuals in four groups, statistical significance was found in LT parameter in right-left eyeball, in Group 1, 2, 3 and 4 and LT parameter was found to increase in left eyeball in terms of age ($p<0.05$). These results found support the literature.

Mean length of lateral rectus muscle has been reported to be 40 mm (23). Kocabıyık et al. measured it as 36.38 mm on average in right eyeball, as 37.01 on average in left eyeball. No statistically significant difference was found in another study conducted between right and left eyes ($p\geq0.05$) (24). Our study measured the length of lateral rectus and medial rectus muscles from Zinn ring. The median values of LRML and MRML parameters were found to vary between 30 mm and 38 mm. We think that this difference is due to the population and sample size. In Group 1, the MRML parameter in the left eyeball was found to be longer in males than in females. In group 4, the MRML parameter in the left eyeball was found to be longer in females than in males. In group 2, LRML and MRML parameters in the right-left eyeball were found to be longer in males (p<0.05).

CONCLUSION

The limited number of images in the age groups included in the study is a limitation of this study. We believe that the age- and sex-related differences obtained in our study will contribute to the understanding of eye and orbital morphometry in basic and forensic sciences and in the surgical intervention at different ages in clinical sciences.

Funding: None

Acknowledge: I would like to thank all the authors who contributed to the completion of the study.

Ethics Committee Approval: This study was conducted with the 2021/459 numbered decision of Karabük University Non-interventional Clinic Research Ethics Committee.

Informed Consent: The study is a retrospective study and was carried out by scanning images in the hospital archive system.

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: N.A., S.T., Y.S., Z.O., Design: N.A., S.T., Y.S., Z.O., Data Collection or Processing: N.A., S.T., Y.S., D.Ş., S.O., M.K.T., Analysis or Interpretation: Y.S., D.Ş., Literature Search: N.A., Writing: N.A., S.T., Y.S., Z.O

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: There is no financial support.

REFERENCES

1. Burns NS, Iyer RS, Robinson AJ, Chapman T. Diagnostic imaging of fetal and pediatric orbital abnormalities. American Journal of Roentgenology. 2013;201(6):W797-W808.
2. Verhulst E, Vrijghem J. Accuracy of intraocular lens power calculations using the Zeiss IOL master. A prospective study. Bull Soc Belge Ophtalmol. 2001;281(281):61-5.
3. Ruiz-Moreno JM, Montero JA, de la Vega C, Alió JL, Zapater P. Retinal detachment in myopic eyes after phakic intraocular lens implantation. Slack Incorporated Thorofare, NJ; 2006. p. 247-52.
4. Congdon NG, Youlin Q, Quigley H, Hung T, Wang T, Ho T, et al. Biometry and primary angle-closure glaucoma among Chinese, white, and black populations. Ophthalmology. 1997;104(9):1489-95.
5. Casson R, Marshall D, Newland H, McGovern S, Muecke J, Tan E, et al. Risk factors for early angle-closure disease in a Burmese population: the Meiktila Eye Study. Eye. 2009;23(4):933-9.
6. Hoffer KJ. Axial dimension of the human cataractous lens. Archives of Ophthalmology. 1993;111(7):914-8.
7. Abbasoglu OE, Sener EC, Sanac AS. Factors influencing the successful outcome and response in strabismus surgery. Eye. 1996;10(3):315-20.
8. Hashemi H, Khabazkhoob M, Miraftab M, Emamian MH, Shariati M, Abdolahinia T, et al. The distribution of axial length, anterior chamber depth, lens thickness, and vitreous chamber depth in an adult population of Shahroud, Iran. BMC ophthalmology. 2012;12(1):1-8.
9. Songur A, Tunahan S, Tolgahan A, Yağmurca M, Orhan B, Küçüker H, et al. Nervus Opticus' un İntrakraniyal Seyrinin İncelenmesi Ve Histolojik Analizi. Kocatepe Tıp Dergisi. 2010;12(2):114-21.
10. Bartz-Schmidt KU, Thumann G, Jonescu-Cuypers CP, Krieglstein GK. Quantitative morphologic and functional evaluation of the optic nerve head in chronic open-angle glaucoma. Survey of ophthalmology. 1999;44:P41-S53.
11. Jonas JB, Schiro D. Localised wedge shaped defects of the retinal nerve fibre layer in glaucom. Br J Ophthalmol. 1994;78(4):285-90.
12. Erkartal HŞ, Tatlı M, Secgin Y, Toy S, Duman BS. Gender estimation with parameters obtained from the upper dental arcade by using machine learning algorithms and artificial neural networks. European Journal of Therapeutics, 2023; 29(3):352-8.
13. Secgin Y, Oner Z, Turan MK, Oner S. Gender prediction with the parameters obtained from pelvis computed tomography images and machine learning algorithms. Journal of the Anatomical Society of India. 2022;71(3):204.
14. Uygur AG, Polat SÖ, Öksüzler FY, Öksüzler M, Yücel AH. Bulbus oculi morfometrik analizi ve klinik önemi. Cukurova Medical Journal. 2020;45(1):127-33.
15. Tuncer İ, Karahan E, Zengin Mö. Yetişkin Popülasyonda Ön Kamara Derinliği, Lens Kalınlığı, Vitreus Uzunluğu ve Aksiyel Uzunluğun Değerlendirilmesi. Glokom-Katarakt. 2014;9(3).
16. Özdemir M, Gizir H. Age-and Gender-Related Biometric Changes in Normal Eyes/Normal Gözlerde Yas ve Cinsiyetle Iliskili Biyometrik Degisiklikler. Türkiye Klinikleri Tip Bilimleri Dergisi. 2011;31(5):1139.
17. Chan P, Mok K. Transorbital sonographic evaluation of optic nerve sheath diameter in normal Hong Kong Chinese adults. Hong Kong Journal of Emergency Medicine. 2008;15(4):197-204.
18. Shen S, Fong KS, Wong HB, Looi A, Chan LL, Rootman J, et al. Normative measurements of the Chinese extraocular musculature by high-field magnetic resonance imaging. Investigative ophthalmology & visual science. 2010;51(2):631-6.

19. Tunahan SH. Nervus Optıcus' un İntrakraniyal Seyrinin İncelenmesi ve Histolojik Analizi: Afyon Kocatepe Üniversitesi, Sağlık Bilimleri Enstitüsü; 2006.
20. Lee JS, Lim DW, Lee SH, Oum BS, Kim HJ, Lee HJ. Normative measurements of Korean orbital structures revealed by computerized tomography. Acta Ophthalmologica Scandinavica. 2001;79(2):197-200.
21. Ozgen A, Ariyurek M. Normative measurements of orbital structures using CT. AJR American journal of roentgenology. 1998;170(4):1093-6.
22. Özgen A, Aydingöz Ü. Normative measurements of orbital structures using MRI. Journal of computer assisted tomography. 2000;24(3):493-6.
23. Williams PL. Gray's anatomy. Nervous system. 1995:1240-3.
24. Kocabıyık N, Yalçın B, Kılıç C, Ozan H, Kırıcı Y. Morphological Study on Rectus Muscles of Eye. Gülhane tıp dergisi. 2004;46(3):209-12