SCHOOL of MEDICINE STUDENTS' JOURNAL

Original Article

doi:10.22037/smsj.v1i1.23143

Investigating the normal dimensions and sizes of human eye orbit by MRI in Labafinejad Hospital patients in 2016 in Tehran

Fakhroddin Aghajanpour[1], Reza Soltani[1], Mohammad Amin Shahrbaf[2], Ramin Pouriran[2], Mohsen Nourozian[3], Fatemeh Fadaei[3], Hojjat-Allah Abbaszadeh[3], Reza Mastery Farahan[3]

1- Department of reproductive biology and anatomy, Student Research Committee, Shahid Beheshti University of Medical science, Tehran, Iran
2- Student Research Committee, School of Medicine, Shahid Beheshti University of Medical science, Tehran, Iran
3- Department of reproductive biology and anatomy, Shahid Beheshti University of medical science, Tehran, Iran

Article Info
Date of acceptance: 25 June, 2019

Keywords
Human, Eye ball, MRI, Anthropometry

Corresponding Author
Reza Mastery Farahani
Biology and Anatomical Sciences Department, School of MedicineShahid Beheshti University of Medical Sciences, Tehran, Iran.
Tel: +98 21 2387 255
Fax: +98 21 22439976
Email: realmastery@hotmail.com

ABSTRACT

Background: Anthropometry is one of the principal researches in. The eye orbit is involved in most cranial abnormalities. Concerning the lack of adequate information in Iranian populations and the effect of factors including gender, age, and geographical region, the aim of this study was to investigate the normal dimensions and sizes of human eye orbit through MRI.

Materials and Methods: This was a descriptive, analytical, and prospective study which was performed on 120 patients referring to the MRI center of Labafinejad and Torfeh hospitals. In fact, 20 patients were excluded due to eye-associated disorders. The longitudinal and transversal axes, as well as the eye orbit volume were measured, and the age, gender, and the sidedness of eye were reported and evaluated.

Results: The mean age was 38, and the eye orbit volume, longitudinal axis, and transversal axes were measured as 5593 mm^3, 22 mm, and 21.9 mm, respectively. The minimum average measured value was related to the distance between the posterior edge of the frontal processes of the upper jaw bones (21 mm in females and 23 mm in males), while the maximum average was measured across the posterior poles of the two eye orbits (26 mm in females and 29 mm in males) ($P<0.4$).

Conclusion: The data suggestd that the longitudinal and transversal axes, as well as the volume of right and left eyes are larger in men than in women. The difference in the eye orbit volume of men, as compared to women can be attributed to a large body mass in men.

Cite This Paper as
F.Aghajanpour, R.Soltani, M.Nourozian, F.Fadaei, H.Abbaszadeh, R.Mastery Farahan. Investigating the normal dimensions and sizes of human eye orbit by MRI in Labafinehad Hostpital patients in 2016. *Sch Med Stud J*.2019;1(1):13-16.

INTRODUCTION

The anatomical association between different components of the visual system is a topic of interest for research in anthropometry recently [1]. The growth of the eye orbit could be influenced by the development of the brain, skull, and face during different developmental stages [2]. Apparently, eye is one of the main components of the visual sense, where some diseases, such as macrophthalmia, microphthalmia, myopia, and presbyopia affect the dimensions of the eye orbit, causing visual problems [3]. Assessing the bony interorbital distance (BID) is one of the major diagnostic criteria in eye disorders. For example, anthropometric investigations of the human skull and face are used to diagnose the face and skull abnormalities including: hypertelorism (abnormally short distance between the two eyes) and hypertelorism (abnormally long distance between the two eyes) [4]. The ocular TB disease leads to the diminished volume of the eye orbit, and glaucoma results in increased volume of the eye orbit [5]. The results obtained from these studies could be used in various disciplines including anatomy, embryology, plastic surgery, and eye surgery [6]. One of the advanced usage of orbit dimensions is designing prothesis for patients who have experienced trauma and fracture of the face. These prostheses significantly help in restoring the face to its previous state [7]. Therefore, in order to determine the sizes and dimensions of eye orbit, various methods are used including radiography, ultrasonography, angiography, CT-Scan, and MRI. The images obtained from MRI have a higher resolution, and do not have the limitations of other methods. Furthermore, its techniques are quite useful for analyzing the mechanism of diseases and the effect of treatment [8,9]. Additionally, MRI images can also be used in measuring the distance between the eyes and volume of the eye orbit in both normal and diseased eyes [10]. Evidently, the sage of three-dimensional structures is indispensable to investigate the anatomic forms and situation, as well as the eye abnormalities for diagnosis and planning surgery and predicting its outcomes. The application of these three-dimensional techniques in restorative and plastic surgery has overcome the limitations of two-dimensional scans, allowing for observing the face and head structures from different angles, as well as assessing its length and dimensions of its parameters through special software [11,12].

In a study, Hansman measured the interorbital distance cranial radiography in healthy individuals. He reported that this distance, from childhood up to adulthood, is always lower in girls than boys, where the mean interorbital distance in adults was reported as 25 and 28 mm for women and men, respectively [13].

Tomask et al. (2005) examined the dependence of development of the orbit on the eye development in 18 normal 17-28-week human fetuses. They found that during the fetal period, the dimensions of the eye and orbit increased concurrently [14].

Han et al. observed that the eye orbit has a rapid growth from the birth up to the age of two. This growth continues further up to age of 30, but after that it diminishes [15].

Gregori et al. (1988) tested the association between the eye volume and orbit dimensions in physical models designed based on 5 dry skulls. In these models, the obtained orbit volume were associated to the relations of the status of orbit wall; moreover, its volume is useful which can be eventually used for orbit regeneration [16].

Based on the aforementioned and the importance of investigating the normal dimensions and sizes of the orbit in assessing the status of the healthcare system, as well as the extensive usage of this type of study and sparsity of tables related to normal dimensions and sizes of the eye, along with the effect of the mentioned factors on these sizes, the aim of this research was to investigate the dimensions and sizes of the orbit in patients referring to Labafinezhad and Torfeh

MATERIALS and METHODS

in this descriptive, analytical, and prospective study, 120 individuals referring to the MRI center of Labafinezhad and Torfeh hospitals in Tehran were investigated. After acquiring informed consent form from the patients and the permission from the ethics committee, questionnaires were prepared for all subjects referring to the MRI center, in which age, gender, history of thyroid diseases, trauma to the eyes and face, eye inflammation, and congenital syndromes associated with the eyes were recorded. Moreover, 20 individuals were excluded from the study due to having these conditions. MRI (Philips) device was used in this study. The investigated indicators included approximate inter-pupil distance, the upper jaw frontal process posterior edge, equatorial surface of the eye orbit, the surface of the posterior poles of the eye orbit, the distance between the two visual nerves entering the eye orbit, the posterior-most part of the eye orbit, the length of the intraorbital part of the visual nerve of the right and left eyes, and the anterior posterior diameter of the right and left eye orbits. Determination of the longitudinal axis of the eyes in axial view was equal to the axis elongated from the anterior surface of the cornea up to the posterior wall of the choroid. Furthermore, the width was equal to the distance between two points of the nose and temporal of the eyes in axial view. To determine the volume of the eye orbit, the following formula was used:

$$\left[\frac{anterior - posterior\ diameter + \frac{transverse\ diameter}{2}}{2}\right]^3 \cdot \frac{4}{3}\pi$$

The data were analyzed by SPSS 16. Moreover, t-test was employed to compare the means of different sizes in both genders and to compare to the right and left eyes.

RESULTS

In the current study, 200 eyes were tested in 100 patients with the minimum age of 17 years and the maximum age of 75 years, in which the mean age was 38 years.

The dimensions of the eye orbit are presented in Table 1 in terms of the indicators and for each individual gender. The data indicates that these indicators have been larger in both the left and right eyes of men than in women, though the difference was not statistically significant ($p = 0.6$).

Table 2 reports the means and range of the BID sizes based on measurement at different points of the orbit and the size of some of the other orbital diameters for each individual gender. According to the table 2, the minimum mean value of the interorbital distance in the section examined in both genders was maxilla frontal processes posterior edge (23 mm in men and 21 mm in women), while its maximum belonged to the surface of the posterior poles of the orbit of both eyes (29 mm in men and 26 mm in women). Nevertheless, no significant difference was observed between the two sides in terms of orbit sizes.

Investigation of the diameters of the eye orbit involved examining the MRI images of 100 patients 17-75 years of age referring to Labafinezhad and Torfeh hospitals. The distances of the external and internal walls of the orbits of two eyes and other distances of interest were measured through millimeter graduated anthropometric method and using MRI measurement software mentioned above. These stages were repeated for both the right and left sides, and the sizes of both sides were recorded.

Table 1. The dimensions of the eye orbit in terms of the indicators for each individual gender in eye orbit measurement. LA = Longitudinal axis. TA = Transverse axis.

Index	Gender	Mean (mm) ± SD
LA of the right eye	female	21.8 ± 1.6
	male	22 ± 1
LA of the left eye	female	21.6 ± 1.5
	male	22.7 ± 1.7
TA of the right eye	female	21.1 ± 1.1
	male	22.2 ± 1.1
TA of the left eye	female	21.6 ± 1.1
	male	22.1 ± 1.1

After calculating volumes of the orbit in both genders the mean volume in males was 5467 ± 854 mm^3 and in females was 5730 ± 647 mm^3.

DISCUSSION

In the present study, the orbit size and dimensions, as well as the BID sizes were tested in a population of men and women 17 to 75 years of age. The minimum and maximum mean values of the distances between the eye orbits in both genders were measured as frontal processes posterior edge of two maxillary bones and across the posterior poles of the orbit of both eyes. The size of the eye structures differs from one person to another, but in a normal population, the difference is less significant [17]. The eye orbits volume is generally affected by age and gender [18]. During the developmental period, the orbit volume is slightly more in boys than in girls, and this difference remains throughout the entire life [15].

Optical coherence tomography, high-resolution sonography, CT scan, and MRI are among the imaging methods for the eyes [19]. CT scan is a method which measures the precise value of the eye dimensions. However, the main issue is exposure to ionization beams. Another usage of CT scan is measuring the distance through eyes, as well as assessing the soft and hard tissue disorders of the eyes associated with hyper- and hypertelorism [15, 20]. In the present study, MRI was used; the superiority of this method compared to CT scan was not exposured to ionization beams by the patient. Nevertheless, the limitations of MRI include being expensive and lower resolution compared to optical methods [21].

Bentli et al. assessed the normal changes of the orbit volume throughout childhood from one month of age up to 15 years by using MRI. In this study, gender differences, as well as the different signs of the right and left orbits were tested and compared. They found that during childhood, the volume of the orbit is larger in boys than in girls, but they have the same developmental pattern. Meanwhile, no significant difference was observed in the right and left orbits volumes [22].

In another study, Miczhel tested the orbit size across different samples obtained from various geographical regions of the world. He concluded that the Europeans have the largest orbit volume. In addition, the Europeans have the maximum intergroup differences [23].

Futdar et al. within the age range of 59-64 years reported the mean longitudinal axis of 23.60 mm, which is larger than the mean longitudinal mean in this study [24]. This difference can be attributed to the various sample sizes and measurement methods, as well as the range of age and the geographical regions.

This stydy concluded that the mean volume of the orbit in males is higher than females. In the study oy Iser et al., they estimated the eye volume and eye orbit by CT scan, the mean orbit volume of the right and left eyes was obtained as 7450 ± 1.19 and 7450 ± 1.125 in women 7320 ± 0.74 and ±1.04 mm^3 in men, respectively; the results were larger than the mean eye orbit volume in both eyes and both genders in this study [25]. The difference in the results of this study and other findings which were discussed above can be attributed to the usage of various measurement methods, age differences, and gender differences. The attained data from the present study suggested

Table 2. Comparing the BID sizes in the studied subjects for each individual gender in the eye orbit measurement

Distances (mm)		Male (n = 50)			Female (n = 50)		
		Min	Max	Mean	Min	Max	Mean
Approximate interpupil distance		54	78	66	50	72	61
Maxillary frontal processes posterior edge		19	34	23	14	32	21
Eye orbit equatorial surface		21	34	28	17	32	25
Site of entrance to the globe		40	66	53	28	67	48
BID across the globe posterior pole		21	41	31	17	31	26
In the posterior-most part of the eye orbit		23	43	33	21	41	31
The length of the intraorbital part of the visual nerve	Right	22	33	28	21	34	25
	Left	21	33	27	20	34	24
Anteroposterior diameter of the globe	Right	20	34	27	21	36	25
	Left	20	34	27	20	32	24

that the dimensions and sizes of the human orbit are associated with factors, such as age and gender. The size of longitudinal and transverse axes of the right and lift eyes was larger in men than in women, which can be attributed to the more body mass in men. Since this type of studies is important in terms of determining the index for development and health, and various factors including environmental, age, and gender affect the dimensions of orbit, Indeed, more studies are need to be performed across different communities, and the observed differences should be investigated with proper design and planning.

REFRENCES

1. S. Traynor, A. N. Gurtov, J. H. Senjem and J. Hawks.Assessing eye orbits as predictors of N eandertal group size.American journal of physical anthropology.2015;157(4):680-83.
2. W. Mak, M. W. M. Kwan, T. S. Cheng, K. H. Chan, R. T. F. Cheung and S. L. Ho.Myopia as a latent phenotype of a pleiotropic gene positively selected for facilitating neurocognitive development, and the effects of environmental factors in its expression.Medical Hypotheses.2006;66(6):1209-15.
3. P. Galluzzi, C. Venturi, A. Cerase, I. M. Vallone, S. Bracco, A. M. Bardelli, et al.Coats Disease: Smaller Volume of the Affected Globe.Radiology.2001;221(1):64-69.
4. M. F. Mafee, G. E. Valvassori and M. Becker. Imaging of the Head and Neck. Georg Thieme Verlag; 2004.
5. M. Misra and S. Rath.Computed tomographic method of axial length measurement of emmetropic Indian eye a new technique.Indian journal of ophthalmology.1987;35(1):17.
6. S. Korani, R. Masteri Farahani, F. Fadaei, N. Vallae, F. Naelayni, S. Faizi, et al.Measurement of ocular volume and associated factors by the use of MRI in Kermanshah, 2013. Research in Medicine.2014;38(2):93-97.
7. M. Peter and D. Hugh.Head and neck imaging, Mosby; St.Louis Missouri.2003:1496-97.
8. B. O. Igbinedion and O. U. Ogbeide.Measurement of normal ocular volume by the use of computed tomography. Nigerian Journal of Clinical Practice.2013;16(3):315.
9. L. Fanea and A. J. Fagan.Magnetic resonance imaging techniques in ophthalmology.Molecular vision.2012;18:2538.
10. M. M. Bahn, R. E. Gordon, F. J. Wippold and M. G. Grand.Findings of retinues on gadolinium-enhanced turbo fluid-attenuated inversion recovery images.Retina.1998;18(2):164-68.
11. A. Ciardella, N. Borodoker, D. Costa, S. Huang, E. Cunninghamjr and J. Slakter.Imaging the posterior segment in uveitis.Ophthalmology Clinics of North America.2002;15(3):281-96.
12. Y. Ji, Z. Qian, Y. Dong, H. Zhou and X. Fan.Quantitative morphometry of the orbit in Chinese adults based on a three-dimensional reconstruction method.Journal of Anatomy.2010;217(5):501-06.
13. C. F. Hansman.Growth of Interorbital Distance and Skull Thickness as Observed in Roentgenographic Measurements.Radiology.1966;86(1):87-96.
14. E. Tomasik, D. Czepita, M. Zejmo and F. Czerwinski.Fetal ocular and orbital development in humans.Durham Anthropology Journal.2005;12:2-3.
15. F. J. Hahn and W.-K. Chu.Ocular volume measured by CT scans.Neuroradiology.1984;26(6):419-20.
16. G. S. Parsons and R. H. Mathog.Orbital Wall and Volume Relationships.Archives of Otolaryngology - Head and Neck Surgery.1988;114(7):743-47.
17. G. Forbes, D. G. Gehring, C. A. Gorman, M. D. Brennan and I. T. Jackson.Volume measurements of normal orbital structures by computed tomographic analysis.American Journal of Roentgenology.1985;145(1):149-54.
18. H. C. Fledelius and A. C. Christensen.Reappraisal of the human ocular growth curve in fetal life, infancy, and early childhood.British Journal of Ophthalmology.1996;80(10):918-21.
19. K. A. Townsend, G. Wollstein and J. S. Schuman.Clinical application of MRI in ophthalmology.NMR in Biomedicine.2008;21(9):997-1002.
20. P. Tessier.Orbital Hypertelorism: I. Successive Surgical Attempts. Material and Methods. Causes and Mechanisms. Scandinavian Journal of Plastic and Reconstructive Surgery.1972;6(2):135-55.
21. T. Q. Duong, S.-C. Ngan, K. Ugurbil and S.-G. Kim.Functional magnetic resonance imaging of the retina.Investigative ophthalmology & visual science.2002;43(4):1176-81.
22. A. Haas, A. Weiglein, C. Faschinger and K. Mollner.Fetal development of the human orbit.Graefe's Archive for Clinical and Experimental Ophthalmology.1993;231(4):217-20.
23. J. Kwon, J. E. Barrera and S. P. Most.Comparative Computation of Orbital Volume From Axial and Coronal CT Using Three-Dimensional Image Analysis.Ophthalmic Plastic & Reconstructive Surgery.2010;26(1):26-29.
24. R. Fotedar, J. J. Wang, G. Burlutsky, I. G. Morgan, K. Rose, T. Y. Wong, et al.Distribution of Axial Length and Ocular Biometry Measured Using Partial Coherence Laser Interferometry (IOL Master) in an Older White Population.Ophthalmology.2010;117(3):417-23.
25. N. Acer, M. Demir, T. Ucar, H. Pekmez and A. Goktas.Estimation Of The Eyeball And Orbital Volume Using The Cavalieri Principle On Computed Tomography Images.2011;2011(2):184-88.