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

Fakhroddin Aghajanpour1, Reza Soltani1, Mohammad Amin Shahrbaf2, Ramin Pouriran2, Mohsen Nourozian3, Fatemeh Fadaei3, Hojjat-Allah Abbaszadeh3, Reza Maštery Farahan3

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

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 mm³, 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 suggested 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.
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 macropthalmia, microphthalmas, 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 hypotelorism (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 prosthesis 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 hospitals.

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 ethic 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:

\[
\text{volume} = \frac{\text{anterior - posterior diameter} \times \text{transverse diameter}}{2} \times \frac{4}{3} \pi
\]

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.

<table>
<thead>
<tr>
<th>Index</th>
<th>Gender</th>
<th>Mean (mm) ± SD</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LA of the right eye</td>
<td>female</td>
<td>21.8 ± 1.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>male</td>
<td>22 ± 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LA of the left eye</td>
<td>female</td>
<td>21.6 ± 1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>male</td>
<td>22.7 ± 1.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA of the right eye</td>
<td>female</td>
<td>21.1 ± 1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>male</td>
<td>22.2 ± 1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA of the left eye</td>
<td>female</td>
<td>21.6 ± 1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>male</td>
<td>22.1 ± 1.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After calculating volumes of the orbit in both genders the mean volume in males was 5467 ± 854 mm³ and in females was 5730 ± 647 mm³.

**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 exposed 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 study concluded that the mean volume of the orbit in males is higher than females. In the study of 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 mm³ in men, respectively; the results were larger than the mean eye orbit volume of the right and left 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>
<thead>
<tr>
<th>Distances (mm)</th>
<th>Male (n = 50)</th>
<th>Female (n = 50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate interpupil distance</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Maxillary frontal processes posterior edge</td>
<td>19</td>
<td>34</td>
</tr>
<tr>
<td>Eye orbit equatorial surface</td>
<td>21</td>
<td>34</td>
</tr>
<tr>
<td>Site of entrance to the globe</td>
<td>40</td>
<td>66</td>
</tr>
<tr>
<td>BID across the globe posterior pole</td>
<td>21</td>
<td>41</td>
</tr>
<tr>
<td>In the posterior-most part of the eye orbit</td>
<td>23</td>
<td>43</td>
</tr>
<tr>
<td>The length of the intraorbital part of the visual nerve</td>
<td>Right 22</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Left 21</td>
<td>33</td>
</tr>
<tr>
<td>Anteroposterior diameter of the globe</td>
<td>Right 20</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Left 20</td>
<td>34</td>
</tr>
</tbody>
</table>
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 left eyes was larger in men than in women, which can be attributed to the more body mass in men. Since this type of study 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 needed to be performed across different communities, and the observed differences should be investigated with proper design and planning.

REFERENCES


