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# YAŞLI İNSANLARDA GÖZ YUVASININ MORFOMETRİK GÖSTƏRİCİLƏRİNİN KOMPÜTER-TOMOQRAFİYA VASİTƏSİLƏ QİYMƏTLƏNDİRİLMƏSİ

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***Xülasə.*** *Yaşlı insanlarda göz yuvasının anatomik normal ölçülərinin morfometrik etalonunu əldə etmək məqsədilə onların yaşa, cinsiyyətə və kraniotiplərə görə fərqli xüsusiyyətləri araşdırılmışdır. Tədqiqat Donetsk diaqnostika mərkəzində avropeoid irqinə mənsub olan və yaşı 22-dən 74-ə qədər olan, kəllə-üz nahiyəsində heç bir patologiyası olmayan 96 nəfər üzərində (48 kişi və 48 qadın) onların razılığı alınmaqla aparılmışdır.*

*Tədqiqat zamanı kompüter-tomoqrafiya, morfometriya və riyazi üzuldan (variasion və korrelyasion analizlər) aparılmışdır.*

*Kompüter-tomoqrafiya üsulu ilə aparılan tədqiqat sağ və sol göz yuvasının normal ölçülərini, onların girəcəyinin eninin və hündürlüyünün, dərinliyinin sağ və sol göz yuvasının girişlərinin meyllik dərəcəsini, medial və lateral divarların bucağını qiymətləndirməyə imkan vermişdir. Göz yuvasının morfometrik göstəricilərində cinsi dimorfizmin olmadığı ehtimalı irəli sürülmüşdür. Yaşlılıq dövrünün ikinci yaş qrupunda göz yuvasının dərinliyinin və aşağı divarının qalınlığının fərqli olmasının mümkünlüyü qeyd edilmişdir. Kranial indeksi fərqli olan müxtəlif kraniotipə mənsub insanlarda göz yuvasının müxtəlif morfometrik göstəriciləri arasında statistik etibarlı fərqlər aşkar edilmişdir.*

***Açar sözlər:*** *göz yuvası, morfometriya, kompüter-tomoqrafiya*
***Key words:*** *orbit, morphometry, computer tomography*
***Ключевые слова:*** *орбита, морфометрия, компьютерная томография*

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# MORPHOMETRIC CHARACTERISTICS OF THE ORBIT IN ADULTS

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***Summary.*** *The morphometric characteristics of the orbits of adults, in particular, left- and right-sided skewness, individual variability by age, gender and craniotypes were studied in order to obtain a morphometric standard of their anatomical norm.*

*The study was conducted with the involvement of 96 Caucasian people aged 22 to 74 years (48 men, 48 women, average age 48.6 ± 3.2 years) without pathology of the craniofacial area. Our study was performed using such methods as computed tomography, morphometric method, and mathematical methods (variation and correlation analyses).*

*According to the results of the study, it was found that there was no skewness of the orbits on the right and left, which made it possible to use the averaged indicators as a morphometric standard. The probable absence of gender dimorphism in the morphometric indicators of the orbits was noted. The presence of possible differences in the depth of the orbits and the length of the lower wall in the age group of the II period of mature age was established. Significant differences between individual morphometric indicators of the orbits in people with different craniotypes according to the cranial index were revealed.*

*A comprehensive evaluation of morphometric indicators was carried out, which made it possible to establish such parameters as the quantitative norm of the length of the walls, the width and height of the entrance to the orbit, their depth, the angle of inclination of the entrance to the orbit and the angle between medial and lateral walls in adults in groups according to the right and left orbits, age, gender, and craniotypes. The quantitative norms of morphometric indicators of bone structures of the orbit were determined.*

**Introduction.** In recent years, a number of studies in the field of craniometry have been carried out in the scientific literature. New information was obtained in the field of research of the skull, its channels and openings, the morphometric and topographic relationships of the surrounding soft tissues, as well as vessels and nerves, were studied [1]. To date there are gaps in the information field regarding the metric data of the orbit characteristics in adults according to such criteria as left- and right-sided skewness, individual variability by age, gender, and craniotypes. These data, in turn, are needed for standardizing the anatomical norm of the orbit.

At present, research on the human orbit does not stop. For example, with the help of 3-D technologies, gender anatomical differences regarding the orbit size and the configuration of the orbital aperture (more noticeable supraorbital rim in men) have been studied, which can affect the visual appearance of patients with endocrine orbitopathy and require therapeutic measures [2]. Computed tomography as a method of research and diagnostics in clinical medicine, in particular, the study of such an anatomical structure as the skull and its component – the orbit, is indispensable, for example, in such a pathology as Graves' orbitopathy [3].

In this regard, the morphometric characteristics of bone structures of the orbit according to tomographic imaging data is an actual and practically significant problem of normal anatomy together with clinical medicine.

**The purpose of the study** was to establish the morphometric characteristics of the orbits of adults, in particular, left- and right-sided skewness, individual variability by age, gender and craniotypes, in order to obtain a morphometric standard of their anatomical norm.

**Research materials.** The object of our study is the morphometric characteristics of the orbit of adults without pathology of the craniofacial region.

The subject of our study is the variability of linear, angular and calculated indicators of the orbit in the norm in adults of different age groups, sexes, and craniotypes. The study was conducted with the involvement of 96 Europoid people aged 22 to 74 years (48 men, 48 women, average age 48.6±3.2 years) without pathology of the craniofacial region in the Donetsk diagnostic center with their consent.

In our study, we used the age distribution according to WHO recommendations: the first period of adulthood (men: 22–35 years, women: 21–35 years); the second period of adulthood (men: 36–60 years, women: 36–55 years); old age (men: 61–74 years, women: 56–74 years).

At the first stage of the study, an analysis of volunteers was carried out for the purpose of selection according to the developed inclusion and exclusion criteria. The study conforms to the Helsinki Declaration (1997), the Convention on Europe on Human Rights and Biomedicine (1997), the International Code of Medical Ethics (1983), ICHGSP (2002). All studied people voluntarily signed the “Informed Consent” regarding the participation in this project, which outlines the main purpose of the study, its duration and the patient's rights. Full information about the research method and their personal condition was also provided.

**Research methods.** Our research was performed using such methods as computed tomography (CT), morphometric method and mathematical methods (variation and correlation analyses).

For the morphometric study, a multi-slice CT scan of the skull was performed on a Brilliance CT 64 (Philips) machine in the supine position with arms along the body. After selecting the initial scan level, successive scans with a thickness of 5 mm and subsequent reconstruction of 2 mm were made. The VRT (volumetric reconstruction) mode was used during data processing to improve the visualization of bone structures in compliance with the principles of medical ethics regulated by the Council of Europe Convention on Human Rights and Biomedicine and the legislation of Ukraine.

Using the software built into the CT unit,

linear and angular indicators were determined on the obtained tomograms of the skull in accordance with the approaches of Hayvoronskyi I. (2012, 2013) [4, 5]; Ji Y. et al. (2010) [6], with the use of a number of craniometric points: basion (ba), bregma (br), ectoconchion (ec), eurion (eu), glabella (g), infraorbitale (oi), maxillofrontale (m-fr), supraorbitale (os), opistocranion (op) (**Figure 1**).

To estimate the length of the walls of the orbit, the approach of Ji Y. et al. (2010) [6] was used, according to which the opening of the optic nerve canal was taken as the reference point (**Figure 2**).

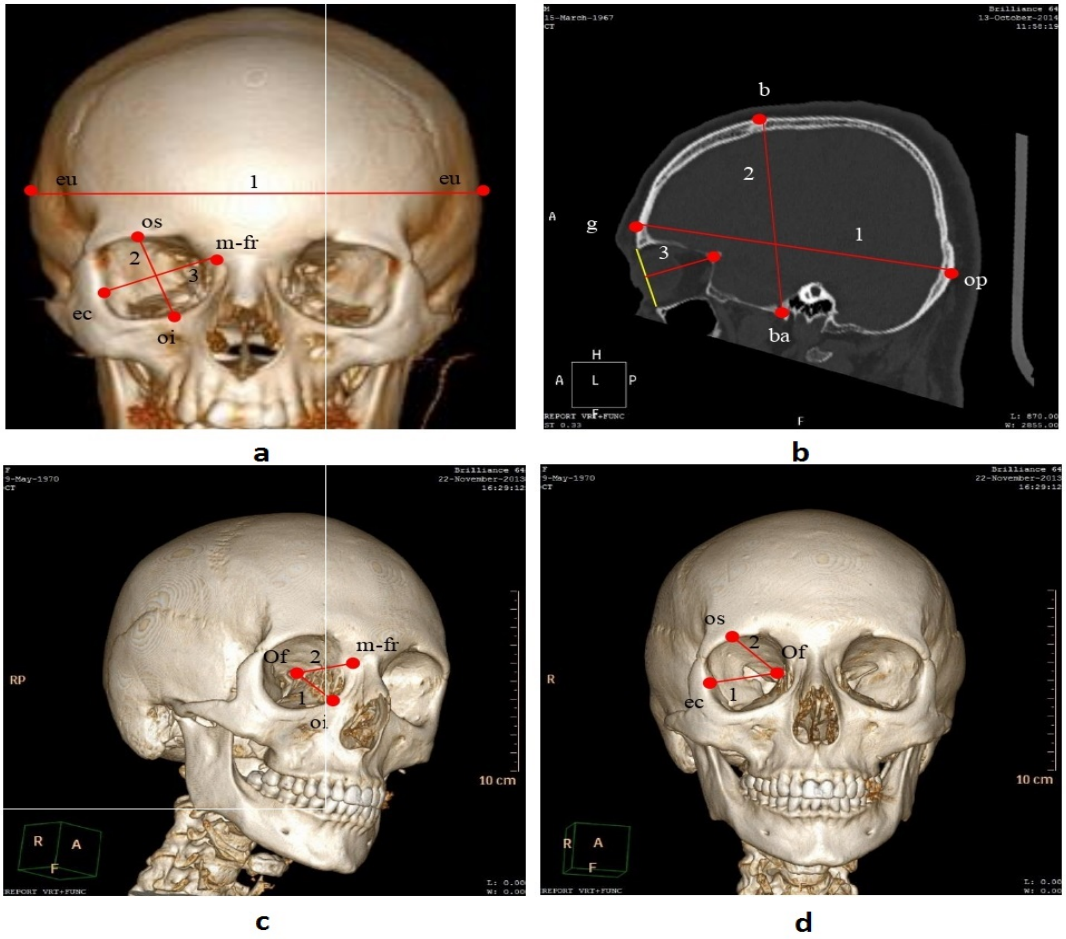


**Fig. 1. Linear and angular indicators of the skull and orbits: a)** 1 – the skull width, 2 – the height of the entrance to the orbit, 3 – the width of the entrance to the orbit; **b)** 1 – the skull length, 2 – the depth of the orbit, 3 – the skull height; **c)** the angle between the medial and lateral walls of the orbit; **d)** – the angle of inclination of the entrance to the orbit


**Fig. 2. The length of the walls of the orbit from the opening of the optic nerve canal *(Of):* a) 1 – the length of the lower wall; 2 – the length of the medial wall; b) 1 – the length of the lateral wall; 2 – the length of the upper wall**

Statistical processing of the obtained data was carried out using the Microsoft Excel 2010© licensed software package [7, 8].

Variation analysis was used to determine the parameters of descriptive statistics for each linear, angular and calculated parameter of the orbit, to assess the statistical significance of differences between groups formed by age, gender, mirror skewness of the right and left orbits, and craniotypes. Correlation analysis was used to identify interdependencies between the morphometric indicators of the orbits and to establish their significance.

**Research results and discussion**

It was determined that among the walls of the orbit, the medial wall is the longest 43.6 ± 0.4 mm, the lateral and upper walls occupy an intermediate position in size (40.8 ± 0.2 mm and 40.7 ± 0.2 mm, respectively), the smallest is the lower (39.7 ± 0.2 mm) wall of the orbit. The average values of the wall lengths, except for the length of the lateral and upper walls, have statistically significant differences. It was established that the width of the entrance to the orbit (39.2 ± 0.2 mm) is probably greater than its height (34.1 ± 0.2 mm).

The obtained results correspond to the data available in the work of Nikolayenko V. et al. [9] on the medial and lateral walls. The evaluation of the length of the lower wall is much higher (39.7 mm compared to 20 mm), however, this can be explained by the order of measurement – this indicator was defined as the distance from the infraorbitale point to the eye opening of the optic nerve canal, while Nikolayenko V. considers the lower orbital fissure as the inner border of the lower wall.

According to the length of the medial wall, the results of the study are similar to those obtained by Abed S. et al. on the materials of people of the Caucasian race in Great Britain, but somewhat differ from the data of other studies [10]. The existing difference can be explained by the different racial and ethnic affiliation of the research objects, the performance of measurements on skull preparations and the use of a less accurate research method (cranioscopy with a caliper), and in the study of Fetouh F. et al. [11] there are differences in the use of anatomical landmarks for measurements.

The data on the width and height of the entrance to the orbit correspond to the results of Kyrylova M. [12] and are lower than the data of Fetouh F. et al. [11].

It was determined that the angular indicators of the orbits have the following confidence intervals: the angle of inclination of the entrance to the orbit is {10.4 ± 0.4}, the angle between the medial and lateral walls is {51.9 ± 0.9}. The variability of the first of these indicators is medium-strong, while the variability of the second is weak. Based on the evaluation of the skewness and kurtosis of both indicators, it is possible to predict a predominance in the general set of values smaller than the average and a relatively low concentration around the defined average. The data on the value of the angle of inclination of the entrance to the orbit are less variable than those obtained by Kyrylova M. [12].

The linear and angular morphometric indicators of the orbits were evaluated in the context of groups of the first and second periods of mature and old age (table 1).

***Table 1.*** **Morphometric indicators of the orbits in mature and old age people**

| Measured parameters | First periods of mature | Second periods of mature | Old age |
|---|---|---|---|
| medial wall | 43,7 ± 0,7 mm | 43,0 ± 0,6 mm | 44,0 ± 0,9 mm |
| lateral wall | 41,0 ± 0,4 mm | 40,9 ± 0,3 mm | 40,6 ± 0,4 mm |
| upper wall | 41,0 ± 0,3 mm | 40,4 ± 0,4 mm | 40,9 ± 0,4 mm |
| lower wall | 40,1 ± 0,4 mm | 39,2 ± 0,4 mm | 40,2 ± 0,4 mm |
| width of the entrance to orbit | 39,4 ± 0,3 mm | 38,9 ± 0,4 mm | 39,3 ± 0,3 mm |
| height of the entrance to orbit | 34,2 ± 0,4 mm | 33,9 ± 0,3 mm | 34,7 ± 0,7 mm |
| depth of the orbit | 42,7 ± 0,8 mm | 41,5 ± 0,7 mm | 42,5 ± 1,0 mm |
| angle of inclination of the entrance to the orbit, (°) | 9,7 ± 0,7 | 10,5 ± 0,7 | 10,6 ± 0,6 |
| angle between the medial and lateral walls, (°) | 52,3 ± 1,3 | 51,9 ± 1,4 | 52,1 ± 1,9 |

The obtained average values of linear morphometric indicators of the orbit are in general relatively lower than those available in the work of Ji Y. et al. (2010) [6], except for the height of the entrance to the orbit, which can be explained by the fact that he conducted the study on individuals of the Mongoloid race.

No explicit relationships between the values of linear morphometric indicators and age were established. The comparison of the values of indicators among each other within each of the age groups gives a picture similar to the general sample. A common feature of the first and second periods of mature age is a relatively lower variability of linear indicators compared to old age. Statistically significant differences between age groups were found in the length of the lower wall in the people of old age and in the depth of the orbit in individuals of the second period of mature age. These indicators, in our opinion, are indicative and probable parameters for distinguishing age groups in the adult period of life.

The correlation analysis conducted for the first time made it possible to establish that age groups differ in the number of statistically significant relationships between the studied indicators. In the first period of mature age, a relationship of medium strength exists between the length of the medial wall and the length of the lower wall, the depth of the orbit, and the width of the entrance to it; between the length of the lower wall and the length of the upper wall and the width of the entrance to the orbit. In the second period of mature age, an average correlation is noted between the length of the medial wall and the length of the lateral, upper and lower walls, the depth of the orbit, the width of the entrance to it; between the depth of the orbit and the length of the lateral, upper and lower walls; between the length of the lower and upper walls. In the group of old age, the average strength of the relationship is observed between the length of the medial wall and the length of the lateral and lower walls, the depth of the orbit; between the length of the upper wall and the length of the lateral and lower walls; between the width of the entrance to the orbit and the length of the lateral, upper and lower walls. Other statistically significant relationships are weak. A common feature of the correlations in all age periods is the significance of the length of the medial wall in the formation of statistically probable relationships between morphometric indicators. Differences between correlation indicators in different age groups are insignificant.

The absence of statistically significant differences between morphometric indicators and correlation indicators between them in different age groups of the mature period of life is consistent with the data available in the literature on the patterns of age-related dynamic of changes of bone structures of the orbit [13].

The variability of linear indicators of the orbit in terms of gender characteristics (table 2) is low (up to 5.6%), there are no differences in groups by gender, and it corresponds to the picture of the general sample. In the variability of angular indicators, the gender factor is significant: the coefficient of variation of the sample in the angle of inclination of the entrance to the orbit in men (18.6%) is higher than in women (16.6%), the coefficient of variation of the angle between the medial and lateral walls of the orbit is, on the opposite, higher in women (8.8%) than in men (7.7%).

***Table 2.*** **Morphometric indicators of the orbit in terms of gender characteristics**

| Measured parameters | Male (n=48) | Female (n=48) |
|---|---|---|
| medial wall | 43.7 ± 0.7 mm | 43.5 ± 0.6 mm |
| lateral wall | 40.9 ± 0.3 mm | 40.8 ± 0.3 mm |
| upper wall | 40.9 ± 0.3 mm | 40.4 ± 0.3 mm |
| lower wall | 39.8 ± 0.3 mm | 39.7 ± 0.3 mm |
| width of the entrance to orbit | 39.3 ± 0.3 mm | 39.2 ± 0.3 mm |
| height of the entrance to orbit | 34.2 ± 0.3 mm | 34.1 ± 0.3 mm |
| depth of the orbit | 42.5 ± 0.7 mm | 42.5 ± 0.7 mm |
| angle of inclination of entrance to the orbit, (°) | 10.5 ± 0.6 | 10.2 ± 0.5 |
| angle between the medial and lateral walls, (°) | 52.6 ± 1.2 | 51.2 ± 1.3 |

***Table 3.*** **The morphometric indicators of the orbits in the context of craniotypes**

| Measured parameters | Dolichocephals (n=10) | Mesocephals (n=26) | Brachycephals (n=60) |
|---|---|---|---|
| medial wall | 46.1 ± 1.0 mm | 44.4 ± 0.7 mm | 42.8 ± 0.5 mm |
| lateral wall | 41.0 ± 0.6 mm | 41.4 ± 0.4 mm | 40.6 ± 0.2 mm |
| lower wall | 40.6 ± 0.5 mm | 40.3 ± 0.3 mm | 39.3 ± 0.3 mm |
| upper wall | 41.1 ± 0.6 mm | 41.2 ± 0.4 mm | 40.4 ± 0.2 mm |
| the width of the entrance to the orbit | 39.7 ± 0.4 mm | 39.7 ± 0.4 mm | 38.9 ± 0.2 mm |
| the height of the entrance to the orbit | 34.4 ± 0.5 mm | 34.2 ± 0.3 mm | 34.0 ± 0.3 mm |
| the depth of the orbit | 45.1 ± 1.1 mm | 43.2 ± 0.7 mm | 41.7 ± 0.6 mm |
| the angle of inclination of the entrance to the orbit, (°) | 10.6 ± 1.3 | 10.6 ± 0.7 | 10.2 ± 0.5 |
| the angle between the medial and lateral walls, (°) | 48.1 ± 2.4 | 51.0 ± 2.0 | 53.0 ± 1.0 |

The analysis proved the absence of statistically significant differences between the morphometric indicators in the male and female series, which allows to neglect the gender factor in the quantitative characteristics of the orbit. The number of statistically significant correlations in the samples of men and women is the same.

The number of statistically significant relationships between the morphometric indicators of the orbit increases from dolichocephals to brachycephals in the absence of a probable difference (table 3).

The average correlation is noted only between the width of the entrance and the length of the medial and lower walls; between the depth of the orbit and the length of the lower and upper walls; between the length of the upper and lower walls of the orbit – in brachycephals; between the length of the lower and upper walls – in dolicho- and mesocephals [14]. The results of evaluating the width and height of the entrance to the orbit for craniotypes according to the cranial index are approximately similar in terms of the value given by Khudyakova O., Vynogradov A. [15], but do not demonstrate an increase in the width of the entrance as the values of the cranial index increase.

**Conclusion.** Summarizing our study, we can say with confidence that a comprehensive evaluation of morphometric indicators was carried out, which made it possible to establish such parameters as the quantitative norm of the length of the walls, the width and height of the entrance to the orbit, their depth, the angle of inclination of the entrance to the orbit and the angle between medial and lateral walls in adults in groups according to the right and left orbits, age, gender, and craniotypes. The data obtained in our study should become an element in the planning of reconstructive operations in the craniofacial area.

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## МОРФОМЕТРИЧЕСКАЯ ХАРАКТЕРИСТИКА ОРБИТЫ ВЗРОСЛЫХ ЛЮДЕЙ

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***Резюме.*** Изучены морфометрические особенности орбит взрослых людей, в частности лево- и правосторонней асимметрии, индивидуальная изменчивость по возрасту, полу и краниотипам, с целью получения морфометрического эталона их анатомической нормы.

Исследование проведено с участием 96 лиц европеоидной расы в возрасте от 22 до 74 лет (48 мужчин, 48 женщин, средний возраст 48,6 ± 3,2 года) без патологии краниофациальной области. В нашем исследовании использовались такие методы, как компьютерная томография, морфометрический метод и математические методы (вариационный и корреляционный анализы).

По результатам исследования установлено отсутствие перекоса глазниц справа и слева, что позволило использовать усредненные показатели в качестве морфометрического эталона. Отмечено вероятное отсутствие полового диморфизма в морфометрических показателях орбит. Установлено наличие возможных различий глубины глазниц и длины нижней стенки в возрастной группе II периода зрелого возраста. Выявлены достоверные различия между отдельными морфометрическими показателями орбит у людей с разными краниотипами по краниальному индексу.

Проведенная комплексная оценка морфометрических показателей, позволило установить такие параметры, как количественная норма длины стенок, ширина и высота входа в глазницу, их глубина, угол наклона входа в глазницу и угол между медиальной и латеральной стенками у взрослых в группах по правой и левой орбитам, возрасту, полу и краниотипам. Определены количественные нормы морфометрических показателей костных структур орбиты.

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