UDC 611.714.6:57.087.1: [572.54+572.73]

MORPHOMETRIC INDICATORS OF AN ORBIT AT ADULTS IN CONNECTION WITH TYPES OF CRANIUM

Dubyna S. O.
M. Gorky Donetsk National Medical University, Krasnyi Lyman, Ukraine

The norm of morphometric indicators of bone structures of an orbit for population of 96 people at the age of 48,6 ± 3,2 years without pathology of craniofacial area is established by method of a computer tomography. Means, confidence intervals (p = 0,05), correlation and reliability of distinctions in morphometric indicators of a skull and an orbit by groups on types of cranium are defined. In frequency distribution of the studied population by types of cranium brachiocephalic people are 63 %, dolichocephalic – 27% and mesocephalic – 10 %. In groups by types of cranium among linear indicators of an orbit length of a medial wall statistically reliable decreases from dolichocephals to brachiocephals, length of lateral wall, orbital floor and roof and also orbital breadth – from mesocephals to brachiocephals. Orbital height between groups' types of cranium reliable does not differ. An angle between medial and lateral walls of orbit statistically reliable increases from dolichocephalic persons to brachiocephalic. The interrelation of changes of an angle of orbital entrance inclination and types of cranium is not observed. The number of statistically significant correlations between morphometric indicators of an orbit increases from dolichocephals to brachiocephals at the absence of a reliable difference between them. Average degree correlation is noted only between orbital breadth and lengths of medial wall and orbital floor; orbital depth and lengths of the orbital floor and roof; between lengths of the orbital floor and roof – at brachiocephals, and also between lengths of the orbital floor and roof – at dolichocephals and mesocephals. The conclusion is drawn that when planning reconstructive operations at bone structures of an orbit it is necessary to consider the available distinctions in length of lateral wall, orbital roof and floor, height and breadth and value of an angle between medial and lateral walls by types of cranium.

KEY WORDS: orbit, morphometry, types of cranium, cranial index

МОРФОМЕТРИЧНІ ПОКАЗНИКИ ОЧНОЇ ЯМКИ ДОРОСЛИХ ЛЮДЕЙ У ЗВ'ЯЗКУ З КРАНІОТИПАМИ

Дубина С. О.
Донецький національний медичний університет імені М. Горького, Красний Лиман, Україна

Встановлена норма морфометричних показників кісткових структур очної ямки на вибірці з 96 чоловік у віці 48,6 ± 3,2 року без патології краніофаціальної області методом комп'ютерної томографії. Визначені середні значення, довірчі інтервали (p = 0,05), взаємозв'язок і вірогідність відмінностей в морфометричних показниках черепа і орбіти в групах за краніотипами. У частотному розподілі дослідженої вибірки за краніотипами брахіцефали складають 63 %, мезоцефали– 27 % і доліхоцефали – 10%. В групах краніотипів серед лінійних показників очної ямки довжина медіальної стінки статистично вірогідно зменшується від доліхоцефалів до брахіцефалів, довжина латеральної, верхньої і нижньої стінок, а також ширина входу в очну ямку – від мезоцефалів до брахіцефалів. Висота входу в очну ямку між групами краніотипів вірогідно не розрізняється. Кут між медіальною і латеральної стінками очної ямки вірогідно збільшується від доліхоцефалів до брахіцефалів. Взаємозв'язок змін кута нахилу входу в очну ямку і краніотипів не проявляється. Число статистично значущих взаємозв'язків між морфометричними показниками очної ямки збільшується від доліхоцефалів до брахіцефалів за відсутності вірогідної різниці між ними. Середня кореляція відзначається тільки між шириною входу і довжиною медіальної і нижньої стінок, глибиною і довжиною нижньої і верхньої стінок, довжиною верхньої і нижньої стінок очної ямки – у брахіцефалів, а також між довжиною нижньої і верхньої стінок – у доліхоцефалів і мезоцефалів. Зроблено висновок, що при плануванні реконструктивних операцій на кісткових структурах очної ямки слід враховувати наявні відмінності між краниотипами по довжині латеральної, верхньої і нижньої стінок, ширині і висоті входу в очну ямку і величині кута між медіальною і латеральною стінками.

КЛЮЧОВІ СЛОВА: очна ямка, морфометрія, краніотипи, черепний індекс

МОРФОМЕТРИЧЕСКИЕ ПОКАЗАТЕЛИ ОРБИТЫ ВЗРОСЛЫХ ЛЮДЕЙ В СВЯЗИ С КРАНИОТИПАМИ

Дубина С. А.
Донецкий национальный медицинский университет имени М. Горького, Красный Лиман, Украина

Установлена норма морфометрических показателей костных структур орбиты на выборке из 96 человек в возрасте 48,6 ± 3,2 года без патологии краниофациальной области методом компьютерной томографии. Определены средние значения, доверительные интервалы (p = 0,05), взаимосвязь и достоверность различий в морфометрических показателях черепа и орбиты в группах по краниотипам. В частотном распределении исследованной выборки по краниотипам брахицефалы составляют 63 %, мезоцефалы – 27 % и мезоцефалы – 10 %. В группах краниотипов среди линейных показателей орбиты длина медиальной стенки орбиты статистически достоверно уменьшается от долихоцефалов к брахицефалам, длина латеральной, верхней и нижней стенок, а также ширина входа в орбиту – от мезоцефалов к брахицефалам. Высота входа в орбиту между группами краниотипов достоверно не различается. Угол между медиальной и латеральной стенками орбиты статистически достоверно увеличивается от долихоцефалов к брахицефалам. Взаимосвязь изменений угла наклона входа в орбиту и краниотипов не проявляется. Число статистически значимых взаимосвязей между морфометрическими показателями орбиты увеличивается от долихоцефалов к брахицефалам при отсутствии достоверной разницы между ними. Средней степени корреляция отмечается только между шириной входа и длинами медиальной и нижней стенок, глубиной и длиной нижней и верхней стенок, длиной верхней и нижней стенок орбиты – у брахицефалов, а также между длиной нижней и верхней стенок – у долихоцефалов и мезоцефалов. Сделан вывод, что при планировании реконструктивных операций на костных структурах орбиты следует учитывать имеющиеся различия в краниотипах по длине латеральной, верхней и нижней стенок, ширине и высоте входа в орбиту и величине угла между медиальной и латеральной стенками.

КЛЮЧЕВЫЕ СЛОВА: орбита, морфометрия, краниотипы, черепной индекс

INTRODUCTION

Type of person's cranium, along with age and sex, is one of the factors of variability of morphometric parameters of the skull and its anatomical structures, including orbit. That is why its definition serves an important prerequisite for the planning of surgical reconstructtive operations in the orbital zone. Available literature data [1, 2] mainly deal with sex-age aspects of individual variability of bone structures of the orbit. In [3] the assessment of orbital height and breadth is carried out, and in [4] linear indicators of orbits are investigated in connection with a shape of a face. The insufficient attention which is paid to influence of the main types of cranium on individual variability of the sizes of bone structures of an orbit causes necessity of this research.

OBJECTIVE

The objective of the study is to establish quantitative standards and reveal anatomical differences in the morphometric parameters of the orbital bone structures by types of cranium defined due to the cranial index.

MATERIALS AND METHODS

The object of study – 96 persons at the age of 21 to 74 years (mean age 48,6 ± 3,2 years) without pathology of craniofacial area investigated in Donetsk diagnostic center with their consent.

For morphometric studies multiscan computed tomography (CT) performed with use of Brilliance CT 64 (Philips) apparatus in the supine position with arms along the body. After selecting the baseline scan regime, scans were made with a thickness of 5 mm, followed by reconstruction up to 2 mm. As a post-processing of data the VRT (volume reconstruction) mode was used to improve visualization of bone structures.

In the received CT-scans according to [5-7] length of orbital walls from an opening of the optic nerve channel, orbital height and breadth, angle of orbital entrance inclination and angle between medial and lateral walls were measured. For definition of types of cranium due to [8] width and length of a skull were measured and the cranial index as a width divided by length expressed as a percentage was calculated. Thus a row of craniometrical points was used: ectoconchion (ec), eurion (eu), glabella (g), infraorbitale (oi), maxillo-

frontale (mf), supraorbitale (os), opistocranion (op), point on the optic foramen (Of) (fig. 1).

According to value of the index each case belonged to one of three types of cranium: dolichocephalic (a cranial index is less than 74,9 %); mesocephalic (value of index is from 75,0 % to 79,9 %) and brachiocephalic (a cranial index exceeds 80,0 %). In defined groups by types of cranium statistical parameters of linear and angular morphometric indicators of orbits were estimated.

Statistical processing of the obtained data was carried out with use of the license software package of Microsoft Excel 2010© according to recommendations [9-10] in the following sequence: verification of data of each selection on a normality by means of criterion χ^2; calculation of a mean, maximum and minimum values, skewness, kurtosis, variation coefficient Cv, standard errors of means and variation coefficients; definition of a confidence intervals of mean and variation coefficient. An assessment of the statistical significance of differences of means was done with use of t-criterion in case of a normal distribution of populations or Mann-Whitney's criterion – otherwise. Variability of values admitted weak if Cv did not exceed 10 %, average – if Cv was 11-25 %, considerable – at Cv > 25 %.

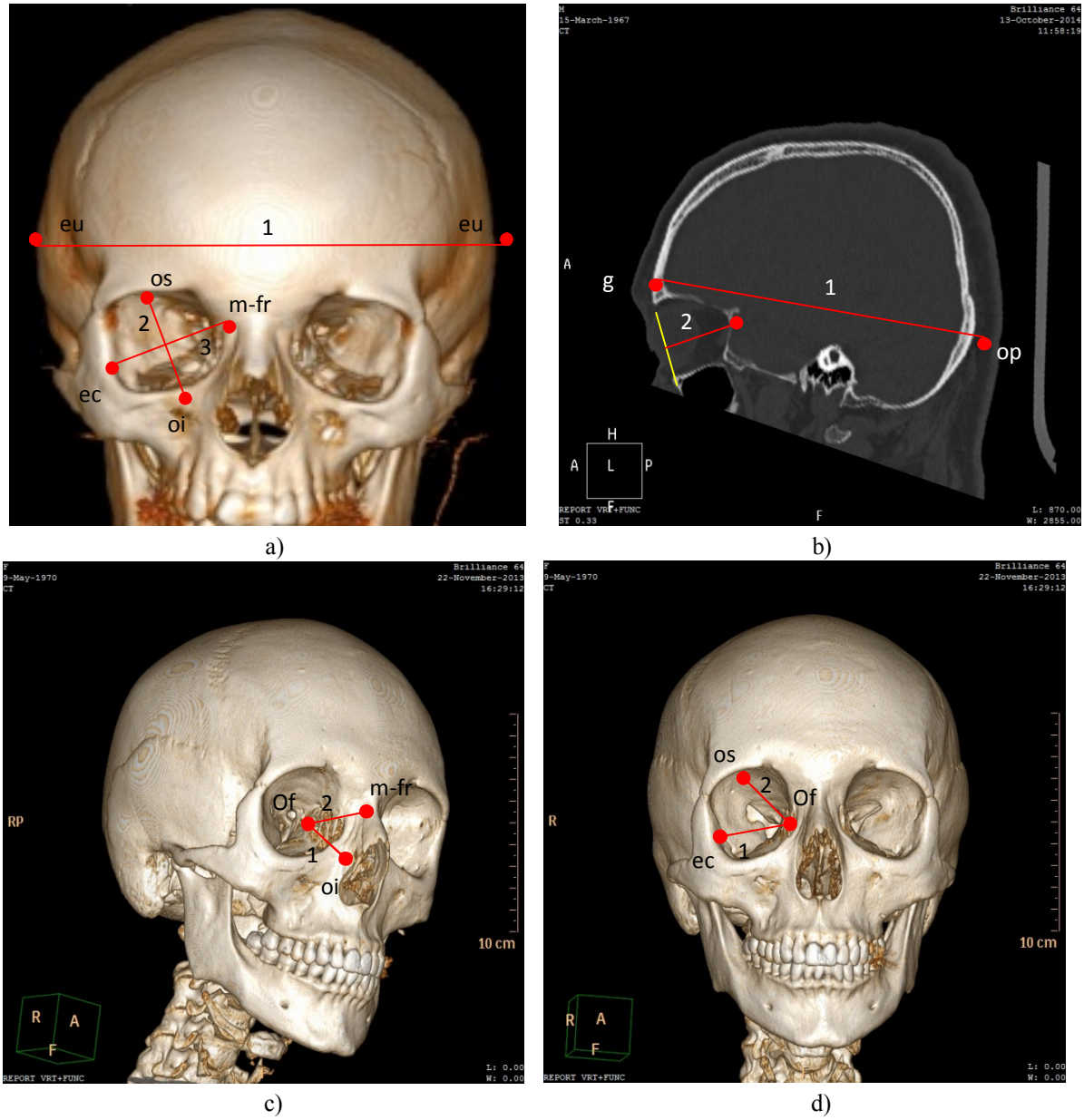

Fig. 1. Linear indices of a skull and an orbit:

a) 1 – skull width; 2 – orbital height, 3 – orbital breadth; b) 1 – skull length; 2 – orbital depth; c) 1 – orbital floor length; 2 – medial wall length; d) 1 – lateral wall length; 2 – orbital roof length.

The correlation analysis was carried out on the basis of calculation of Pearson's coefficient of correlation and the subsequent assessment of the reliability of difference of received coefficients from zero, calculation of a confidence interval of their average values, assessment of reliability of difference between statistically significant coefficients of correlation. Differences of means and correlation coefficients admitted reliable at $p \leq 0,05$.

RESULTS AND DISCUSSION

The frequency distribution of the studied population into groups by types of cranium is shown at fig. 2.

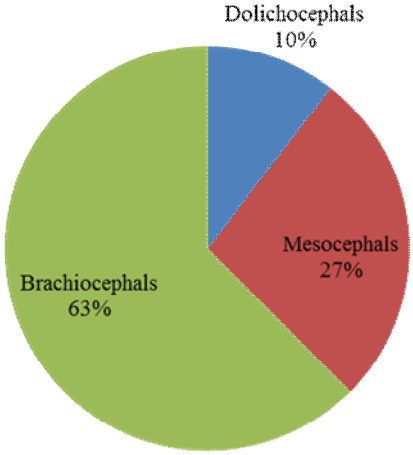

Fig. 2. Population distribution by types of cranium

The main groups are brachycephals which 6 times exceed the number of dolichocephals and 2.3 times – mesocephals.

In tab. 1 statistical parameters of linear indicators are specified by groups due to the cranial index.

Table 1

Linear morphometric indicators of an orbit in groups by types of cranium according to a cranial index*

Indicator, measurement unit	Type of cranium **	Descriptive statistics					
		M ± σt	Min	Max	As	E	Cv, %
Medial wall length, mm	D	46,1 ± 1,0	43,3	48,3	-0,4	0,9	3,0
	M	44,4 ± 0,7	41,6	46,7	-0,4	-1,1	3,7
	B	42,8 ± 0,5	38,6	47,6	0,3	0,3	4,4
Lateral wall length, mm	D	41,0 ± 0,6	39,4	42,4	-0,3	0,1	2,1
	M	41,4 ± 0,4	39,1	42,7	-0,9	0,5	2,2
	B	40,6 ± 0,2	38,7	43,2	0,3	0,1	2,3
Orbital floor length, mm	D	40,6 ± 0,5	39,9	41,5	0,5	-1,8	1,5
	M	40,3 ± 0,3	38,8	41,6	-0,1	0,6	1,6
	B	39,3 ± 0,3	36,1	41,4	-0,5	0,2	2,8
Orbital roof length, mm	D	41,1 ± 0,6	40,1	42,6	0,7	-0,4	2,1
	M	41,2 ± 0,4	39,4	43,0	0,0	-0,7	2,3
	B	40,4 ± 0,2	38,0	42,2	-0,4	-0,1	2,4
Orbital breadth, mm	D	39,7 ± 0,4	38,1	44,0	-1,3	-1,1	1,6
	M	39,7 ± 0,4	37,8	41,3	-0,2	-0,9	2,4
	B	38,9 ± 0,2	36,5	41,2	-0,3	0,4	2,5
Orbital height, mm	D	34,4 ± 0,5	33,6	35,9	1,2	1,1	2,0
	M	34,2 ± 0,3	33,1	36,0	0,8	-0,4	2,4
	B	34,0 ± 0,3	32,3	36,5	0,3	-0,6	3,0
Orbital depth, mm	D	45,1 ± 1,1	42,5	47,9	0,3	0,3	3,4
	M	43,2 ± 0,7	40,2	47,5	0,6	0,3	4,0
	B	41,7 ± 0,6	36,9	46,7	0,4	-0,2	5,6

* hereinafter in tables – M – mean, σ – standard deviation, t – rate of t-distribution for 95% two-sided critical region and for the corresponding number of degrees of freedom; M ± σt – confidence interval; Min and Max – minimum and maximum value of indicators in a population, As – skewness, E – kurtosis, Cv – variation coefficient;

** – D – dolichocephalic group; M – mesocephalic group, B –brachiocephalic group.

Variability of linear indicators of orbit is low and demonstrates an increase tendency from group of dolichocephalic persons to group of brachiocephalic. Differences between all groups are insignificant for orbital height. There are significant distinctions between groups of mesocephals and brachiocephals in length of lateral wall, orbital roof and floor and orbital breadth – these indicators are higher in group of mesocephals (fig. 3).

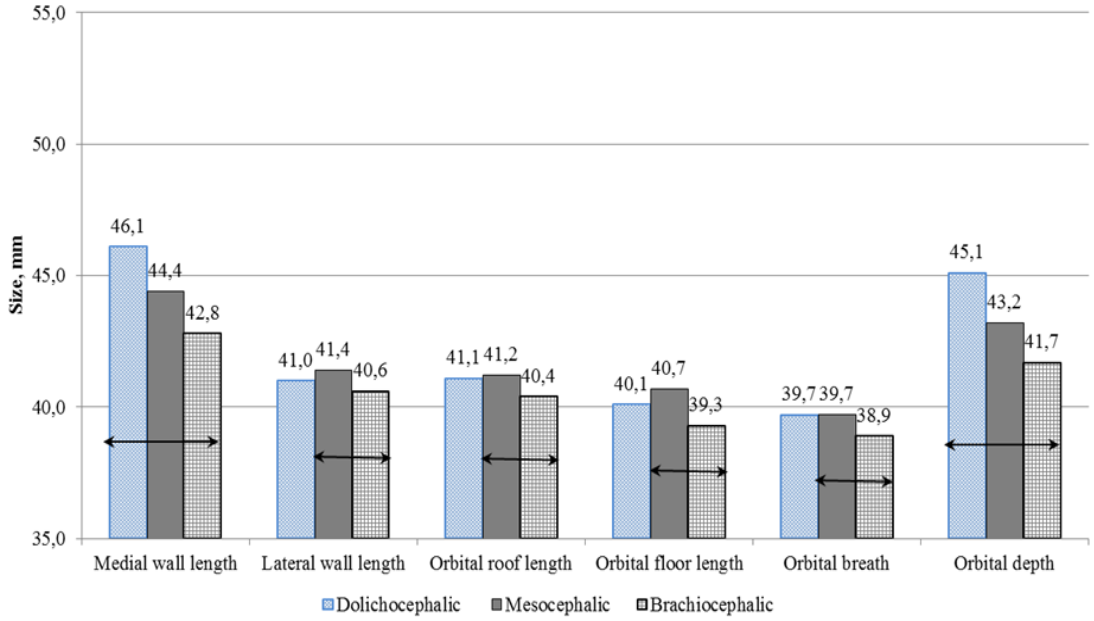

Fig. 3. Linear indicators with reliable differences between groups by a cranial index

In tab. 2 statistical parameters of angular indicators of an orbit are given by groups according to the types of cranium.

Table 2

Angular morphometric indicators of an orbit in groups by types of cranium according to a cranial index

Indicator, measurement unit	Type of cranium	Descriptive statistics					
		M ± σt	Min	Max	As	E	Cv, %
Angle of orbital entrance inclination,	D	10,6 ± 1,3	7,8	13,1	0,0	-1,1	17,0
	M	10,6 ± 0,7	7,6	13,2	-0,3	-1,1	16,6
	B	10,2 ± 0,5	6,8	13,7	-0,1	-1,1	18,4
Angle between medial and lateral walls,	D	48,1 ± 2,4	43,9	54,0	0,6	-0,8	7,1
	M	51,0 ± 2,0	41,5	61,1	-0,1	-0,5	9,8
	B	53,0 ± 1,0	41,4	58,9	-0,8	0,6	7,0

Variability of angular indicators unlike linear is higher. Statistically reliable distinctions between groups by types of cranium are noted only in values of the angle between medial and lateral walls of an orbit (fig. 4).

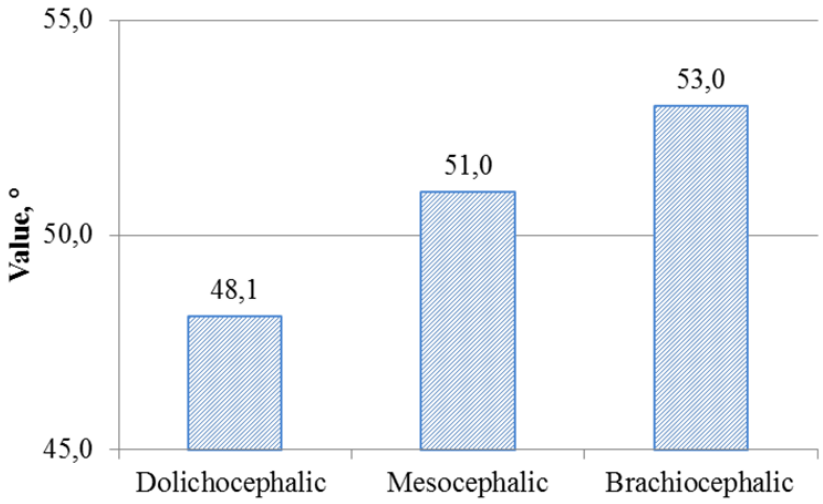

Fig. 4. Values of angle between medial and lateral walls in groups by a cranial index

Correlation coefficients between morphometric indicators of an orbit in groups by types of cranium are presented in tab. 3. Average degree correlation is observed only between orbital breadth and lengths of medial wall and orbital floor; orbital depth and lengths of the orbital floor and roof; between lengths of the orbital floor and roof – at brachiocephals, and also between lengths of the orbital floor and roof – at dolichocephals and mesocephals. Correlations between the rests of the indicators combinations are absent.

Table 3

Correlation coefficients between morphometric indicators of an orbit in groups by types of cranium *

Indices	Type of cranium	Medial wall length, mm	Lateral wall length, mm	Orbital floor length, mm	Orbital roof length, mm	Orbital breadth, mm	Orbital height, mm	Orbital depth, mm	Angle of orbital entrance inclination, °	Angle between medial and lateral walls, °
Medial wall length, mm	D	1,00								
	M	1,00								
	B	1,00								
Lateral wall length, mm	D	0,23	1,00							
	M	0,26	1,00							
	B	0,44	1,00							
Orbital floor length, mm	D	0,48	0,22	1,00						
	M	0,24	0,25	1,00						
	B	0,47	0,17	1,00						
Orbital roof length, mm	D	0,39	0,57	0,79	1,00					
	M	-0,09	0,28	0,49	1,00					
	B	0,31	0,33	0,57	1,00					
Orbital breadth, mm	D	-0,48	0,34	-0,48	-0,14	1,00				
	M	0,43	0,22	0,31	0,23	1,00				
	B	0,52	0,13	0,51	0,31	1,00				
Orbital height, mm	D	-0,32	-0,66	-0,05	-0,09	-0,32	1,00			
	M	-0,09	0,23	0,19	0,26	0,08	1,00			
	B	0,08	-0,02	-0,08	-0,04	0,16	1,00			
Orbital depth, mm	D	0,31	-0,21	-0,32	-0,38	-0,32	0,10	1,00		
	M	0,39	-0,41	-0,13	-0,38	0,05	-0,19	1,00		
	B	0,40	0,32	0,52	0,59	0,38	0,01	1,00		
Angle of orbital entrance inclination, °	D	0,54	0,21	0,67	0,53	-0,68	0,10	0,35	1,00	
	M	0,08	0,27	-0,05	0,25	0,02	0,35	-0,39	1,00	
	B	0,11	0,05	0,04	0,13	0,14	0,13	0,14	1,00	
Angle between medial and lateral walls,	D	-0,61	-0,08	-0,35	-0,08	0,29	0,28	-0,40	-0,39	1,00
	M	-0,29	0,24	-0,02	0,38	0,48	0,07	-0,24	-0,13	1,00
	B	-0,32	-0,21	-0,19	-0,01	-0,23	0,16	-0,38	-0,12	1,00

* - table cells with gray color show coefficients of correlation which reliable ($p \leq 0,05$) differ from zero

In the literature the number of publications and analyzed orbital morphometric indicators especially as regards types of cranium is limited. All of them relate exclusively to the linear indicators. Our data on orbital height and breadth in groups by types of cranium are consistent with [3] and are below than mentioned in [2]. As for other linear indicators they were studied only in [4], and out of connection with types of cranium. Correlation between morphometric indicators are not covered in references.

During planning reconstructive surgery at orbital bone structures differences between types of cranium in orbital height and breadth, lengths of lateral wall, orbital roof and floor and values of angle between medial and lateral walls should be considered.

CONCLUSIONS

1. Brachiocephals constitute 63 %, dolichocephals – 27 % and mesocephals – 10 % of the frequency distribution of the investigated population.

2. In groups by types of cranium length of medial wall reliable decreases from dolichocephalic persons to brachiocephalic; length of lateral wall, orbital roof and floor as well as orbital breadth – from mesocephalic persons to brachiocephalic. There are no reliable distinctions between types of cranium in orbital height. The angle between medial and lateral walls of orbit reliable increases from dolichocephals to brachiocephals. The interrelation of changes of an angle of orbital entrance inclination and types of cranium is not observed.

3. The number of statistically significant correlations between morphometric indicators of an orbit increases from dolichocephals to brachiocephals at the absence of a reliable difference between them. Average degree correlation is noted only between orbital breadth and lengths of medial wall and orbital floor; orbital depth and lengths of the orbital floor and roof; between lengths of the orbital floor and roof – at brachiocephals, and also between lengths of the orbital floor and roof – at dolichocephals and mesocephals.

4. During planning reconstructive surgery at orbital bone structures differences between types of cranium in orbital height and breadth, lengths of lateral wall, orbital roof and floor and values of angle between medial and lateral walls should be considered.

PROSPECTS FOR FUTURE STUDIES

Deepening of ideas of quantitative anatomic norm of orbital bone structures by analysis of combinations of a sex, age and type of cranium factors is promising.

REFERENCES

1. Mihaylyukov V. M. Bezramnaya navigatsiya v hirurgicheskom lechenii posttravmaticheskih defektov i deformatsiy orbityi: diss. … k.med.n.: 14.01.17 «Hirurgiya», 14.01.18 «Neyrohirurgiya» / V. M. Mihaylyukov; Mosk. gos. med.-stomat. un-t im. A. I. Evdokimova; NII skoroy pomoschi im. N. V. Sklifosovskogo. – M., 2014. – 178 s.
2. Shut V.V. Vozrastnyie i individualnyie razlichiya v stroenii glaznitsyi po dannyim morfometrii i luchevoy diagnostiki: avtoref. dis. … kandidata meditsinskih nauk … spetsialnost: 14.00.02 «Anatomiya cheloveka», 14.00.08 «Glaznyie bolezni» / V.V. Shut; Ros. un-t druzhdyi narodov. – M., 2008. – 21 s.
3. Hudyakova O. V. Variantyi stroeniya orbityi cheloveka / O. V. Hudyakova, A. A. Vinogradov // Ukraiyinskiy morfologichniy almanah. – 2012. – T. 10, № 2. – S. 161–164.
4. Tsipyaschuk A. F. Morfologiya glaznichnyih scheley u vzroslyih lyudey pri razlichnyih kraniotipah: dis. ... kandidata meditsinskih nauk … spetsialnost: 14.00.02 «Anatomiya cheloveka» / A.F. Tsipyaschuk; Sarat. gos. med. un–t. – Saratov, 2008 – 158 s.
5. Ji Y. Quantitative morphometry of the orbit in Chinese adults based on a three–dimensional reconstruction method / Y. Ji, Z. Qian,Y. Dong [et al.] // J Anat. 2010 Nov; 217(5) : 501–506.
6. Gayvoronskiy I. V. Metodika opredeleniya naklona vhoda v orbitu / I. V. Gayvoronskiy, M. P. Dolzhenkova // Usovershenstvovanie sposobov i apparaturyi, primenyaemyih v uch. protsesse, mediko–biologicheskih issledovaniyah i klinicheskoy praktike : sb. izobret. i rats. predlozheniy Voen.–med. akad. – SPb.: VMA, 2012. – Vyip. 43. – S. 43.
7. Chan L. L. Graves ophthalmopathy : the bony orbit in optic neuropathy, its apical angular capacity, and impact on prediction of risk / L. L. Chan, H. E. Tan, S. Fook–Chong [et al.] // AJNR Am J Neuroradiol. 2009, Mar ; 30(3) : 597–602.

8. Vovk Yu. N. Klinicheskaya anatomiya golovyi: uch. posob. Ch. 1 / Yu. N. Vovk. – Lugansk, Elton–2, 2010. – 196 s.
9. Bondarchuk S. S. Osnovyi prakticheskoy biostatistiki: ucheb. posob. dlya vuzov /S. S. Bondarchuk, I. G. Godovannaya, V. P. Perevozkin. – Tomsk: izdatelstvo TGPU, 2009. – 130 s.
10. Glantz S. Primer of biostatistics. New York: McGraw-Hill Medical Pub, 2012. – 320 p.