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INDIVIDUAL ANATOMICAL VARIABILITY OF ARTERIES OF DURA MATER OF HUMAN BRAIN

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Summary: The purpose of investigation is to study the individual peculiarities of arterial blood flow, dura mater of human brain, depending on the shape of the head.

Material and methods. The work is based on the results of the research of 100 preparations of the brain, taken from people of different age, sex and shape of the head during pathological autopsies.

Results. It has been studied the main sources of blood supply to surface membrane. It has been detected individual anatomical differences in the diameter and in the length of brainstems of main minengeal membrane arteries depending on the shape of the head.

Conclusion. Short headed persons have the biggest indexes of brainstem diameter of membrane arteries. Long headed persons have the biggest indexes of the main brainstem arteries.

Keywords: individual anatomical variability, dura mater of brain, arteries of dura mater of the brain

Dura mater of the brain (DMB) – is vital anatomical structure, which is a very strong connective tissue structure [1,2] lining the inner surface of the skull and covers the brain [3].

Dura mater of the brain performs the following important functions: maintenance of constant position and prevention from the displacement of the brain, providing the outflow of venous blood from the cranial cavity and protection of the brain from damage [4,5,6]. It is also known that DMB takes part in resorption of cerebrospinal fluid [9,10], in formation of routs of collateral blood circulation on the surface of the brain [7,8], in provision of the development of cranial bones of the skull in joints and fontanelles [1,4], is the reflexogenic zone of the brain and the place of headache occurrence [4].Furthermore, DMB can be used as a plastic material for closing of different defects of soft tissues [11].

Front minengeal artery (FMA), middle minengeal artery (MMA) and back minengeal artery (BMA) – are the main blood vessels of DMB. Front minengeal artery (FMA) is a process of the anterior ethmoid artery, which extends from the ophthalmic artery from the system of the internal carotid artery. Middle minengeal artery (MMA) extends from pterygoid part of maxillary artery from the system of the external carotid artery. Back minengeal artery (BMA), as a rule, extends from the ascending pharyngeal artery, and from the external carotid system [12,13,14]. There are additional sources of blood supply of DMB [12].

Detailed information about the features of the structure of DMB of the arteries is not available in specialized literature.

The conducted research is devoted to the study of individual peculiarities of arterial structure, which supply blood to the dura mater of the human brain, depending on the shape of the head.

Materials and Methods

The research was conducted on the basis of Lugansk regional bureau of forensic medical examination on 87 sites - 50 total

preparations of the brain with membranes, 37 isolated preparations of dura mater of brain of dead people of different age, sex and shape of the head, died without the pathology of the brain. During the forensic medical examination was conducted the allocation of these anatomical structures.

In addition, it was used 13 made corrosive preparations of DMB and its derivatives from the museum collection of the department of operative surgery and topographic anatomy of Lugansk State Medical University. Making corrosive preparations of vascular lesions of DMB was fulfilled with the help of polymer materials. The technique is based on giving the injection with special mass into the vessels and sinuses of DMB, consisting of a dry polymer powder and a liquid portion. After that, the injected preparation was left to solidify and then placed in a special bath with concentrated hydrochloric acid for several days. As a result, there occurred the melting of the soft tissue and received polymeric corrosion skeleton of vascular formed membrane.

We used the following methods of research: macro- and micro preparation of DMB, total and selective morphometrics of the membrane and its arterial structures, arterial injection.

We made the statistical analysis of the obtained data. We used the methods of descriptive statistics. We made the calculation of the average (M), standard deviation (σ), the standard error of the average (m).

Results and its discussion

In the given research, the emphasis is made on the existing range of variability of the diameter and length of the brainstem, the main sources of blood supply to the dura mater of the brain. It was revealed that the arteries of DMB are subjected to the individual anatomical variability depending on the shape of the head.

The part of front minengeal artery (FMA) has the diameter from 1,2 to 1.8 mm in men and from 1.0 to 1,6 in women (Table 1).

Table 1 – Variation of stem diameter of minengeal arteries in adults (mm)

№	Researched features / Shape of the head		Brachicephals		Mezocephals		Dolichocephals	
			men	women	men	women	men	women
1	Diameter of the front membrane minengeal artery	Left	1,3-1,7	1,2-1,5	1,5-1,7	1,2-1,6	1,3-1,7	1,0-1,6
		Right	1,4-1,8	1,2-1,8	1,4-1,6	1,2-1,5	1,2-1,6	1,0-1,6
2	Diameter of the middle minengeal artery	Left	2,0-2,4	1,8-2,2	1,8-2,1	1,7-2,1	1,5-1,9	1,5-2,0
		Right	2,0-2,4	1,8-2,1	1,7-2,2	1,6-2,2	1,5-1,9	1,4-1,9
3	Diameter of the back minengeal artery	Left	1,5-1,9	1,4-1,9	1,5-1,8	1,2-1,8	1,4-1,8	1,2-1,8
		right	1,5-2,0	1,3-1,9	1,4-1,9	1,1-1,9	1,5-1,8	1,1-1,7

The brainstem of the middle minengeal artery in adults has a diameter from 1.4 to 2.4mm. This index slightly prevails in men and ranges from 1.8 to 2.4 mm, for women - from

1.4 to 2,2mm.

The brainstem of the back minengeal artery has a diameter from 1,1 to 2,0mm, but in men it ranges from 1.4 to 2.0 mm, in women – from 1,1 to 1,9.

observe the average indexes of brainstem diameter of front minengeal artery - M = 1,68mm in the left and M = 1,67mm in the

Table 2 – Variation-statistical indexes of brainstem diameter of membrane arteries in adults

№	Researched features / Shape of the head		Brachicephals			Mezocephals			Dolihocephals		
			M	σ	m	M	σ	m	M	σ	m
1	Diameter of the front minengeal artery	Left	1,69	0,11	0,08	1,68	0,11	0,09	1,49	0,12	0,10
		right	1,71	0,11	0,09	1,67	0,13	0,11	1,51	0,10	0,08
2	Diameter of the middle minengeal artery	Left	2,17	0,15	0,12	1,90	0,13	0,11	1,63	0,11	0,09
		Right	2,16	0,12	0,11	1,91	0,15	0,13	1,64	0,11	0,10
3	Diameter of the back minengeal artery	Left	1,93	0,10	0,09	1,74	0,12	0,09	1,60	0,08	0,07
		Right	1,94	0,12	0,10	1,73	0,11	0,09	1,60	0,09	0,08

The conducted variation-statistical analysis confirms the existing range of individual variability of brainstem diameter of minengeal arteries in adults without regard to gender differences (Table 2).

According to our data, the brainstem diameter of the front minengeal artery is slightly violated and is characterized by certain constancy in various forms of head. There is a slight predominance of the parameter in people with brachimorphic form of the head, and is evidenced by the arithmetic mean value

of M = 1,69mm in the left and M = 1,71mm in the right. In mezocephals, we can

(mm)right. The minimum index for this parameter is typical for dolichocephals - M = 1,49mm in the left and M = 1,51mm in the right.

Accordingly, the brainstem diameter of the middle minengeal artery in adults reaches maximum indexes in representatives with the brachicephalic shape of the head, M = 2,17mm in the left and l M = 2,16mm in the right, with gradual decrease of this statistic index in representatives with the mezo- and dolihocephalic forms.

№	Researched features / Shape of the head		Brachicephals		Mezocephals		Dolichocephals	
			men	women	men	women	men	women
1	Brainstem length of the front minengeal artery	left	8-15	9-13	8-17	8-16	10-21	10-18
		Right	7-14	8-14	9-16	9-15	12-20	12-18
2	Brainstem length of the middle minengeal artery	Left	10-17	9-16	9-19	9-18	11-24	11-20
		Right	9-17	9-16	10-19	9-19	12-23	12-22
3	Brainstem length of the back minengeal artery	Left	5-11	5-10	7-13	7-12	8-15	8-14
		Right	5-11	5-10	8-13	8-13	9-15	8-15

Table 3 – The variability of the brainstem length of membrane arteries in adults (mm).

The diameterof the back minengeal artery has a similar tendency to change with a certain decreasing from brachicephals (M = 1,93mm in the left and M = 1,94mm in the right) to the meso- and dolichocephals (M = 1,60mm in the left and in the right).

The length of front minengeal artery varies between 8-21mm in the left and 7-20mm in the right, with some increasing in men (Table. 3). In women, there is fluctuation of parameter from 8 to 18mm. The length of brainstem of the middle minengeal artery in men varies from 9 to 24 mm, in women from 9 to 22 mm.

Accordingly, the length of brainstem of the back minengeal artery is in the first and in the second in the range between 5 to 15 mm.

The obtained data were analyzed variation-statistically and are presented in the Table 4.

It was defined that the length of the brainstem of the front minengeal artery in adult, having brahicephalic head shape, has a minimal quantity. Index of the arithmetic mean of the brachycephalic head shape is M = 9,8mm in the left, M = 10,0mm in the right, with a

№	Shape of the head / Researched features		Brachicephals			Mezocephals			Dolichocephals		
			M	Σ	m	M	σ	m	M	σ	m
1	Brainstem length of front minengeal artery	Left	9,8	2,50	2,21	11,85	3,06	2,58	14,62	3,80	3,40
			10,0	2,60	2,27	11,92	3,05	2,53	14,77	2,10	3,60
2	Brainstem of middle minengeal artery	Left	11,36	3,08	2,25	13,25	3,17	2,66	17,26	3,03	3,00
		right	11,77	2,86	2,41	13,38	3,06	2,55	17,38	3,60	3,08
3	Brainstem of back minengeal artery	Left	8,06	2,10	1,83	9,80	1,76	1,44	12,00	2,56	2,00
		right	8,18	1,98	1,70	9,87	1,63	1,34	12,07	2,60	2,07

Table 4 – Variation-statistically indexes of the length of the brainstem of minengeal arteries in adults (mm)

standard deviation σ = 2, 50 and σ = 2, 60, and also the average error m = 2, 21 and m = 2, 27 respectively.

People with mezocephalic head shape has a gradual increase in the length of brainstem of the front minengeal artery to M = 11,85mm in the left and M = 11,92mm in the right.

Correspondingly, in representatives of the dolihocephalic head shape we can observe a further increase in the parameter to M = 14, 62 mm in the left and M = 14, 77 mm in the right.

A similar trend is observed and for the length of the brainstem the middle minengeal artery: brachicephalic arithmetic mean does not exceed M = 11, 36 mm in the left and M = 11, 77 mm in the right; in mezocephalics - M = 13 ,25 mm and 13, 38 mm; in dolichocephals - M = 17, 25 mm and 17, 38 mm respectively. The last is explained by the increase of the external longitudinal and altitudinal size of the head, which are characteristic features for mezzo- and dolichocephals.

Accordingly to our data, the length of the brainstem of the back minengeal artery is subjected to the individual differences depending on the head shape (Table 4). The length of the initial section of the given artery in brochicephals doesn't exceed M=8, 06 mm in the left and M=8, 18 mm in the right. In mezecephals, correspondingly, the length of the brainstem of the back minengeal artery is approximately M=9, 80 mm in the left and M=9, 87 mm in the right. For dolichocephals the given parameter has the arithmetic mean M=12, 00 mm in the left, M=12, 07 mm in the right. This testifies to the correctness of our

assertion that people with narrow head shape have an increase of the brainstem of the back minengeal artery.

Conclusions

The biggest diameter of the brainstems of main arteries, blood supplying the dura mater of human brain, is characteristic feature for brachicephals.

People with dolichcephalic head shape have the biggest indexes of brainstem length of the main minengeal arteries.

Significant sex differences between diameter and the brainstem length of the studied arteries have not been found among all shapes of the head.

REFERENCES

1. Журавлева Ю.П. Достижения и перспективы в изучении твёрдой оболочки головного мозга человека / Ю.П. Журавлева // Перспективи медицини та біології. — 2009. — Т. 1, № 1. — С. 31—37.
2. Круцяк О.В. Морфо- и антропометрические особенности синусов твёрдой мозговой оболочки свода черепа / О.В. Круцяк // Буковинський медичний вісник. — 2006. — Т. 10, № 2. — С. 93-95.
3. The cranial dura mater: a review of its history, embryology, and anatomy / N. Adeeb [et al.] // Childs. Nerv. Syst. — 2012. —Vol. 28. — P. 827-837.
4. Вовк Ю.М. Порівняльна анатомія пазух твердої оболони головного мозку / Ю.М. Вовк, В.С. Черно. — Миколаїв: Іліон, 2014. — 389с.
5. Вовк Ю.М. Пазухи твердої оболони в ранньому онтогенезі людини / Ю.М. Вовк, В.П. Пішак, О.П. Антонюк. — Чернівці, 2006. — 186 с.
6. Чалый В.А. Клинико-морфологическая характеристика синусов твердой оболочки головного мозга человека и собаки / В.А. Чалый // Український журнал клінічної та лабораторної медицини. — 2009. — Т. 4, №1. — С. 84—87.
7. A rare variation of the posterior cranial fossa: duplicated falx cerebelli, occipital venous sinus, and internal occipital crest / Shoja, M.M. [et al.] // Folia Morphologyca. — 2006. — Vol. 65, № 2. — P. 171—173.
8. The evolution of the meningeal vascular system in the human genus: from brain shape to thermoregulation / E. Bruner [et al.] // Am. J. Hum. Biol. — 2011. — Vol. 23. — P. 35—43.
9. Органоспецифічність мікроваскуляризаційної системи твердої оболонки головного мозку людини / А.А. Архипович [и др.] // Таврический медико-биологический вестник. — 2006. — Т. 9, № 3. — Ч. II. — С. 11—13.
10. Калаев А. А. Микроциркуляторное русло твердой оболочки головного мозга в условиях алкогольной интоксикации / А. А. Калаев, А. А. Молдавская // Морфология. — 2006. — Т. 129, № 4. — С. 57.
11. Журавлева Ю.П. Нові методики та пристрої для вивчення твердої оболони головного мозку людини / Ю.П. Журавлева // Український морфологічний альманах. — 2009. — Т. 7, № 4. — С. 37—39.
12. Черно В.С. Гістотопографія артеріальних судин твердої оболонки головного мозку та її похідних – стінок синусів / В.С. Черно, Ю.К. Хилько // Вісник проблем біології та медицини. — 2010. — № 4. — С. 185—188.
13. Bruner E. The middle meningeal artery: from clinic to fossils / E. Bruner, S. Sherkat // Childs. Nerv. Syst. — 2008. — Vol. 24. — P. 1289—1298.
14. Morphometric analysis of the middle meningeal artery organization in humans – embryological considerations // T.H. da Silva [et al.] // J. Neurol. Surg. — 2013. — Vol. 74. — P. 108—112