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UDC 616.831.9-053.81/.85**CRANIOTOPOGRAPHIC FEATURES OF THE TRANSVERSE SINUSES OF THE DURA MATER OF THE BRAIN OF THE CRANIAL VAULT OF MATURE PEOPLE**S.V. Bondarenko<sup>1</sup>, S.I. Serbin<sup>1</sup>, S.O. Dubyna<sup>1</sup>, V.V. Kalyuzhna<sup>1</sup>, V.P. Bilash<sup>2</sup>, N.L. Svintsyts'ka<sup>2</sup>,  
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**Abstract.** The goal of our research is the description of craniotopographic features of the transverse sinuses of the dura mater.

**The aim and the methods of research.** In order to achieve the goal, a set of methods for morphological studies was developed: macro- and micropreparation of anatomical objects of the brain; cranio- the morphometry of veins, sinuses, and the cervian structures of the cephalic brain; preparation of corrosive (acrylic) ulcerative preparations of veins, sinuses of the dura mater and periorbital lesions of the head; injection technique; variational and statistical analysis of morphometric data; computer-graphic analysis. This study was conducted on 70 preparations of veins and sinuses of the dura mater of the brain.

**Results of the study and their discussion.** Considering the above-mentioned facts, we established a craniotopographical projection of the transverse sinuses in relation to generally accepted craniotopographical planes and points. According to the data we have obtained, the venous collectors (transverse sinuses) studied by us have a certain projection analogy on the bones of the cranial vault and the corresponding correlations to the craniometric points, which can be used in medical craniology. In this regard, there is a natural range of individual anatomical variability in the parameters of the dura mater, which are described in people of mature age. The obtained data on the structure, shape, size and position of the venous collectors of the cranial vault (transverse sinuses) can be used in surgical interventions on the cerebrospinal fluid system, including the ventricles and cerebrospinal fluid pathways.

Transverse sinuses, located on both sides of the skull in the horizontal plane, are of important practical importance from a neurosurgical point of view. In adults, fully formed right and left transverse sinuses are always noted, which perform an important transport function of carrying venous blood from the drain of the sinuses into the sigmoid sinus and internal jugular veins.

The transverse sinuses of the posterolateral surface are adjacent to the inner surface of the parietal and occipital bones, which explains the frequent damage and injury to the collector in various skull injuries. In addition, these collectors must be taken into account during surgical access to various parts of the brain, including the lateral ventricles.

Taking into account the above, it is possible to distinguish different areas of the accumulation of veins that flow into the transverse sinuses. The densest location of tributaries, branches and anastomoses is observed in the initial part of the collectors, near the drainage of the sinuses, due to the surface veins of the occipital lobe and the veins of the cerebellar tent. The second place of accumulation of venous vessels is noted in the area of the transition of the transverse sinuses into the sigmoid sinuses, where the superficial temporal and parietal veins are concentrated.

**Conclusions.** The obtained results not only complement the known facts, but also more deeply reveal the principles of the craniotopographic structure of the transverse sinuses of the dura mater of the cranial vault of people of mature age.

On the basis of the actual data obtained, the position is substantiated, according to which a kind of "vascular zone" in the middle part of the transverse sinuses is topographically distinguished, where, in our opinion, it is better to perform surgical interventions in neurosurgical practice.

**Keywords:** craniotopographic method, dura mater, transverse sinuses, crypt and shape of the head (skull), people, mature age.

**Introduction.** Dura mater sinuses have a complex craniotopographic and morphometric structure of a closed intracranial vascular system of the brain, and the interest in these structures does not decrease every year, not only in relation to humans, but also to some species of animals, such as primates [1, 2].

According to the existing classifications, all the dura mater sinuses are divided into two large groups: the vault and the base of the skull. The first includes the upper sagittal sinus (USS), lower sagittal sinus (LS), straight sinus (SS), left and right transverse sinuses (LTS and RTS) and sinus drainage (SD). The above mentioned venous collectors of the dura mater of the brain have been the object of our research in recent years. The second group of the dura sinuses includes: cavernous, left and right, upper and lower petrosal sinuses, petrosal-squamosal, ethmoid-parietal and marginal sinuses [3, 4, 5].

It is clear from the information sources that recently the interest in the sinuses of the dura mater, transverse in particular, is not decreasing [6, 7, 8].

Based on the important anatomical and physiological role in the outflow of blood, we have studied in detail the shape, size, position and relationship of the

transverse sinuses of the dura mater located within the cranial vault cavity.

**The aim of the study.** The aim of our study was to establish the craniotopographic features of the transverse sinuses of the dura mater of the brain vault of the head (skull) of adults.

**Object and research methods.** In the course of our research, we used the following research methods: macro- and microdissection of anatomical objects of the brain; cranio- and morphometry of veins, dura mater sinuses and cerebrospinal structures of the brain; production of corrosive (acrylic) casts-preparations of veins, sinuses of the dura mater and cerebrospinal fluid formations; injection technique; variational and statistical analysis of morphometric data; computer graphic analysis [9, 10, 11]. This study was conducted on 70 preparations of veins and sinuses of the dura mater of the brain (Table 1).

Table 1

The number of anatomical objects depending on the shape of the head						
Head Shape \ Periods	Dolichocephals		Mesocephals		Brachycephals	
	Male	Female	Male	Female	Male	Female
First mature	2	1	4	3	11	6
Second mature	2	1	6	5	18	11
Total	4	2	10	8	29	17

This study was carried in the conditions of the patho-anatomical departments of Donetsk region (oblast) of the Department of Health of the Donetsk Regional State Administration and the Department of Human Anatomy, physiology and pathological physiology of Donetsk National Medical University (Lyman, Kropyvnytskiy) with the assistance of the Department of Human Anatomy of Poltava State Medical University for the time period of 2015-2019 (obtaining material), and 2020-2022 – data processing and summarizing.

The work was carried out in accordance with the requirements of the “Instructions on conducting a forensic medical examination” (order of the Ministry of Health of Ukraine No. 6 dated from 17.01.1995), in accordance with the requirements and norms, the standard regulation on ethics of the Ministry of Health of Ukraine No. 690 dated from 23.09.2009, “The procedure for removing biological objects from the dead, whose bodies are subject to forensic medical examination and patho-anatomical examination, for scientific purposes” (2018).

Our research was performed using such methods as morphometric method and mathematical methods (variation and correlation analyses). Statistical processing of the obtained data was carried out using the Microsoft Excel 2010© licensed software package. Statistical data processing included two types of analysis, as indicated above – variation analysis and correlation analysis [12].

**Connection of the publication with planned research works.** This study is part of the research project “Morphofunctional study of human internal organs and laboratory animals in various aspects of experimental medicine”, state registration number 0121U108258.

**Research results.** Transverse sinuses, located on both sides of the skull in the horizontal plane, are of important practical importance from a neurosurgical point of view. In adults, fully formed right and left transverse sinuses are always noted, which perform an important transport function of carrying venous blood from the drain

of the sinuses into the sigmoid sinus and internal jugular veins. The classic position of the left and right transverse sinuses is given on Figure 1.

The transverse sinuses of the posterolateral surface are adjacent to the inner surface of the parietal and occipital bones, which explains the frequent damage and injury to the collector in various skull injuries. In addition, these collectors must be taken into account during surgical access to various parts of the brain, including the lateral ventricles.

Considering the above-mentioned facts, we established a craniotopographical projection of the transverse sinuses in relation to generally accepted craniotopographical planes and points. The inion, opisthocranium and asterion points are taken as a basis (Figure 2).

According to our data, the transverse sinuses are located between the points i – op at the level of the sagittal line, and then their axis is directed laterally to the asterion point (ast), which is located at the junction of the parietal, temporal and occipital bones. Morphometric data of the transverse sinuses are given in Table 2.

It has been revealed that the length of the transverse sinuses in adults ranges from 4.5 to 8.1 cm. Taking into account the individual structure of the head, it varies from 6.5 to 8.1 cm in dolichocephals, from 5.1 to 6.1 in mesocephals cm, in brachycephals - from 4.5 to 6.3 cm. Accordingly, the width of the sinus walls on both sides has characteristic parameters depending on the type of structure and shape of the head and skull. Therefore, the upper wall of the transverse sinuses has a range of variability from 0.9 to 1.5 cm with a constant increase in representatives of the meso- and brachymorphic statures (Table 2). The back wall of the collector varies from 0.8 to 1.3 cm with a similar trend of morphometric indicators.

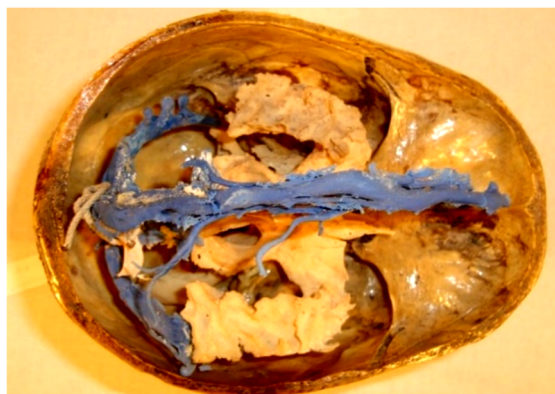


Fig. 1. Topographic and anatomical positions of the transverse sinuses of an adult

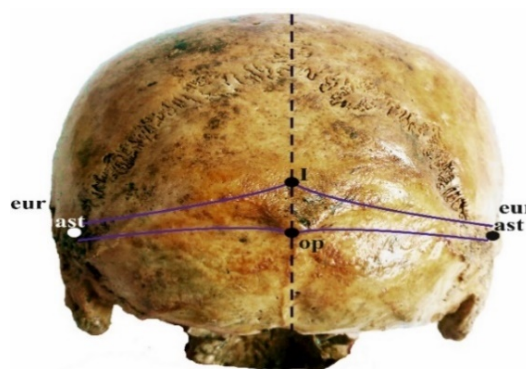


Fig. 2. Craniotopographic projection of the transverse sinuses along the generally accepted craniometric points of the skull

Table 2

Individual anatomical variability of the transverse sinuses of a person of mature age (sm)

Shape of the head Research of sign	Dolichocephals		Mesocephals		Brachycephals	
	Length	6,5-8,0	6,7-8,1	5,2-6,1	5,1-6,0	4,5-6,2
Width of the upper wall	0,9-1,0	0,9-1,1	1,0-1,1	1,0-1,2	1,2-1,5	1,2-1,5
Width of the back wall	0,8-1,0	0,8-1,0	0,9-1,1	0,9-1,1	1,0-1,2	1,1-1,3
Width of the lower wall	0,9-1,0	0,9-1,0	1,0-1,1	0,9-1,0	1,1-1,2	1,0-1,2
Height of the Lumen	1,2-1,3	1,2-1,3	1,0-1,1	0,9-1,0	1,0-1,1	1,0-1,1

The width of the lower wall of the transverse sinuses ranges from 0.9 to 1.2 cm with a slight expansion in brachycephals.

The height of the lumen of the left and right transverse sinuses, which varies from 0.9 to 1.3 cm, is interrelated with these parameters (Table 2). It should be taken into consideration that this size is slightly increased in people with a dolichomorphic head structure.

The greatest width of the three walls of the transverse sinus is noted in the initial (middle) section at the point of exit from the drainage of the sinuses. In some cases, it could reach 1.6-1.7 cm. In the middle part of the venous collector, the average width of the walls is from 1.0 to 1.3 cm, and in the end (side) - from 0.8 to 1.0 cm.

The narrowest section of the transverse sinuses is the transition to the sigmoid sinuses, where a peculiar bend is noted at the level of the upper edge of the temporal bone. The degree of narrowing does not exceed 0.7-0.8 cm and, to a significant extent, depends on the caliber of the mastoid emissary vein. The larger it is, the smaller the diameter of the indicated axillary fold.

Transverse sinuses are characterized by a triangular shape throughout the structure of the sinus, with the exception of the terminal section, where it takes on an oval shape with smooth and streamlined sinus walls. It is a well-known that the upper and lower walls of this collector are formed due to the splitting of the leaves of the tent of the cerebellum, and the back - a leaf of the convexity part of the dura mater.

Taking into account the above, it is advisable to distinguish several craniotopographical forms of the

structure of the transverse sinuses: expanded symmetrical; extended asymmetric; tapered symmetrical and tapered asymmetric. These forms are explained by the different level of departure from the drainage of the sinuses on the left and right in relation to the sagittal and horizontal planes. Classical symmetry of the position of these venous collectors is very rare.

Throughout its structure, the transverse sinuses collect blood from different parts of the brain, the dura mater, tent and cerebellar tissues. Their number depends on the severity of the anastomotic branches and the presence of main vessels. Among them, there are large, medium and small veins that form the venous pool of these collectors (Figure 3).

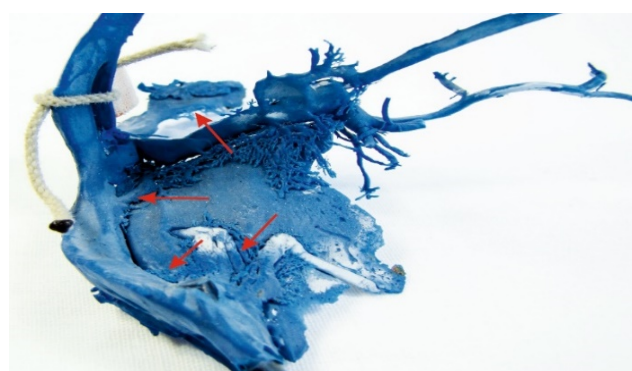


Fig. 3. Presence of venous tributaries and anastomoses throughout its transverse sinus structure (indicated by arrows). Corrosive preparation



Taking into account the above, it is possible to distinguish different areas of the accumulation of veins that flow into the transverse sinuses. The densest location of tributaries, branches and anastomoses is observed in the initial part of the collectors, near the drainage of the sinuses, due to the surface veins of the occipital lobe and the veins of the cerebellar tent. The second place of accumulation of venous vessels is noted in the area of the transition of the transverse sinuses into the sigmoid sinuses, where the superficial temporal and parietal veins are concentrated. Based on the detected topography, a kind of “vascular zone” should be identified in the middle part of the transverse sinuses and it is better to perform surgical intervention here.

**Discussion.** The specialized literature contains quite a bit of information about such a significant issue of modern neurosurgery and neuromorphology as the craniotopographical structure of the transverse sinuses of the dura mater (DMB) of the cranial vault of adults. Only in some fairly outdated works there is little information about the specifics of the indicated DMB sinuses.

H. Browning (1953) described several main types of confluens sinuum: symmetric, when there is a general fusion of the superior sagittal sinus (SSS) and straight sinus from which the left and right transverse sinuses depart. The aforementioned DMB sinuses have a similar location, however, a demarcated ridge of membrane tissue may be located in the drainage lumen. Split type, in which there is a bifurcation of the straight sinus, when the SSS passes into the right or left transverse sinus. Bifurcated type of SSS, when the straight sinus passes into the right or left transverse sinus [13].

According to D.B. Bekov, S.S. Mikhailov (1979), the transverse sinus often has the form of a trihedral prism, and its posterior wall is adjacent to the lamina interna of the occipital bone, and the superior and inferior walls are derivatives of the cerebellar tent (Yu.N. Vovk, 1977) [14,15].

Research by M.A. Sreseli, O.P. Bolshakov (1977) showed that the projection of the transverse sinuses on the lamina interna of the occipital bone, depending on the extreme forms of the skull structure, is symmetrical in 93% of cases; the right sinus is higher than the left in 6%; left higher than right - 1% of cases. The projection line of the transverse sinuses is preferably 0.5-1 mm above the horizontal plane drawn through the center of the protuberantia occipitalis externa. Despite this, the transverse sinuses can begin with two trunks from the VSP, when the projection is 0.5-2 cm above the horizontal drawn through the center of the external occipital protrusion [16].

Based on the above facts, we can confidently assert the theoretical and practical significance of our research for modern neuromorphology and neurosurgery.

**Conclusions.** Summarizing our research, we can draw the following conclusions:

1. Transverse sinuses are located between points i – op at the level of the sagittal line, and then their axis is directed laterally to the point asterion (ast), which is located at the junction of the parietal, temporal and occipital bones.

2. The length of the transverse sinuses in adults ranges from 4.5 to 8.1 cm. Taking into account the individual structure of the head, it varies from 6.5 to 8.1

cm in dolichocephals, from 5.1 to 6.1 cm in mesocephals, in brachycephals - from 4.5 to 6.3 cm.

3. The upper wall of the transverse sinuses has a range of variability from 0.9 to 1.5 cm with a constant increase in representatives of the meso- and brachymorphic stature. The back wall of the collector varies from 0.8 to 1.3 cm with a similar trend of morphometric indicators. The width of the lower wall of the transverse sinuses ranges from 0.9 to 1.2 cm with a slight expansion in brachycephals.

4. The height of the lumen of the left and right transverse sinuses varies from 0.9 to 1.3 cm. It should be noted that this size is slightly increased in people with a dolichomorph head structure.

5. Topographically, a peculiar “vascular zone” is highlighted in the middle part of the transverse sinuses, where, in our opinion, it is better to perform surgical interventions.

**Prospects for further research.** The obtained data on the established craniotopographic features of the transverse sinuses of the dura mater of the cranial vault of mature people can be used in practical health care (neurosurgery) to optimize surgical interventions on the veins and sinuses of the dura mater and the cerebrospinal fluid system of the brain of adults.

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#### КРАНІОТОПОГРАФІЧНІ ОСОБЛИВОСТІ ПОПЕРЕЧНИХ ПАЗУХ ТВЕРДОЇ ОБОЛОНИ ГОЛОВНОГО МОЗКУ СКЛЕПІННЯ ЧЕРЕПА ЛЮДЕЙ ЗРІЛОГО ВІКУ

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**Резюме.** Метою дослідження було встановлення краніотопографічних особливостей поперечних пазух твердої оболони головного мозку склепіння голови (черепа) людей зрілого віку.

**Матеріал та методи.** Дослідження проведено на 70 препаратах вен і пазух твердої оболони головного мозку. За результатами аналізу уточнено топографо-анатомічні положення поперечних пазух дорослої людини; встановлено краніотопографічну проекцію поперечних пазух стосовно загальноприйнятих краніотопографічних площин і точок; з'ясовано індивідуальну анатомічну мінливість поперечних пазух людини зрілого віку з різними типами будови голови (черепа) за такими досліджуваними ознаками, як: довжина, ширина верхньої стінки, ширина задньої стінки, ширина нижньої стінки та висота просвіту; уточнена відома наявність венозних притоків й анастомозів упродовж поперечних пазух.

**Результати.** Встановлено, що вищеперелічені венозні колектори мають певну проекційну аналогію на кістки склепіння черепа та відповідні співвідношення до краніометричних точок, які можуть бути використані в медичній краніології з урахуванням природного діапазону індивідуальної анатомічної мінливості параметрів твердої оболони головного мозку, котрі описано в людей зрілого віку.

**Висновки.** Встановлено різні ділянки скупчення вен, які впадають у поперечні пазухи. Найбільш густе розташування притоків, гілок і анастомозів можна спостерігати в початковому відділі колекторів, поблизу стоку пазух завдяки поверхневим венам потиличної частки та венам намету мозочка. Друге місце скупчення венозних судин відзначаємо в ділянці переходу поперечних пазух у сигмоподібні, де сконцентровані поверхневі скроневи та тим'яні вени. Тож коли ґрунтуємося на встановленій топографії виділяємо своєрідну «безсудинну зону» в середній частині поперечних пазух, яка є благодатною при виконанні оперативних втручань на венах і синусах твердої мозкової оболони й лікворній системі головного мозку.

**Ключові слова:** краніотопографічний метод, тверда оболонка головного мозку, поперечні пазухи, склепіння та форма будови голови (черепа), людина, зрілий вік.

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