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Craniotopographic Characteristics of Sinuous-Liquor Relationships in Mature People

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The purpose of the study was to determine the craniotopographic (craniometric) indicators of sinuous-liquor relationships in the horizontal plane in people of the first and second periods of mature age, based on the maximum permissible depth of its introduction.

Materials and methods. The object of the study was the dura mater of the brain with its sinuses, the ventricles of the brain and the vault of the skull of mature people.

The study was performed on 100 corpses of people of different ages and gender with the manufacturing of native preparations of the brain with membranes and liquor structures. Of the indicated number of morphological objects, 70 preparations of veins and sinuses of the dura mater of the brain and 30 preparations of the cerebrospinal fluid system of the brain of mature people were made.

The study used such research methods as: macro- and micropreparation of anatomical objects of the brain; cranio- and morphometry of veins, sinuses of the dura mater of the brain and liquor structures of the brain; manufacturing of corrosive (acrylic) casts – preparations of veins, sinuses of the dura mater of the brain and liquor formations of the brain; injection technique; variational-statistical analysis of morphometric data; computer-graphic analysis.

Results and discussion. As a result of the study, it was found that the puncture of the central part of the lateral ventricle is better to be performed at the level of the bregma point, or between this point and the vertex (**v**). The puncture needle penetrates to a depth of 6.0–7.0 cm through the milling hole, which is displaced by 3.0–4.0 cm from the arrow line at an angle of 70–75°.

The obtained data make it possible to determine the most optimal craniometric puncture points of the cerebrospinal fluid system of the brain. To penetrate into the cavity of the anterior horn of the lateral ventricle, the metopion point is proposed, which is located at the intersection of the median plane of the head with the line connecting the most convex areas of the frontal humps.

The upper puncture of the lateral ventricle is better to be performed by puncturing at the bregma point (the point of connection of the sagittal and coronal sutures) 2.0 cm from the midline (sagittal plane); the needle is directed down and backwards and at a depth of 5–6 cm (taking into account that it is enlarged and stretched) it enters the ventricular cavity.

The suboccipital puncture or a puncture of the cerebellar-cerebral cistern must be performed between the opisthocranion and lambda points. The puncture needle is inserted to a depth of 6.0–7.5 cm, and the end of the needle is gradually lowered to the base of the skull.

Conclusion. The most optimal puncture points of the constituent parts of the cerebrospinal fluid system of the brain – the cavity of the anterior horn and the central part of the lateral ventricle, the cavity of the cerebellar-cerebral cistern – were determined using craniometric analysis.

Keywords: craniotopographic method, dura mater of the brain, venous sinuses, ventricles of the brain, shape of the structure of the head (skull).

Introduction. The clinical anatomy of the sinuous-liquor relationships of the brain is the most difficult and important section of modern neurosurgery. It is aimed at developing rational and effective methods for treatment of various defects of the head, skull, vascular and nervous formations [1–3].

First of all, this concerns abnormal shapes and sizes of the head, skull, hydrocephalus and other pathological conditions, when radical surgical treatment is needed. In these cases, it is necessary to normalize the outflow of cerebrospinal fluid or drain the cerebrospinal fluid system and, thus, reduce intracerebral pressure [4, 5].

Neuromorphology with clinical craniology are important directions of modern medicine, requiring new objects to study craniotopographic and craniometric features of the relationship between the structures of the brain and its vascular system [6].

The brain and its formations are the object of study from the standpoint of individual anatomical variability and the establishment of gender-age and typical features [7].

Based on this, it can be concluded that the issues of craniotopographic features of venous-liquor relationships in different parts of the brain, primarily in the context of the structural shape of the head (skull), are relevant for modern neuromorphology and clinical medicine.

The purpose of the study was to determine the craniotopographic (craniometric) indicators of the sinuous-liquor relationships in people of the first and second periods of mature age in the horizontal plane, which can be used in the future to justify the insertion of a puncture needle into the cavities of the lateral ventricles (their parts) and the cerebellar-cerebral cistern, based on the maximum permissible depth of its introduction.

Materials and methods. The material of this study was the dura mater of the brain (DMB) with its sinuses, the ventricles of the brain and the vault of the skull in people of the first and second periods of mature age.

This study was performed on 100 corpses of people of different ages and genders with the manufacturing of native preparations of the brain with membranes and liquor structures (**Table 1**).

This study was carried out on 100 corpses of people of different ages and genders with the manufacturing of native preparations of the brain with membranes and liquor structures in the conditions of the patho-anatomical departments of the Donetsk region (oblast) of the Department of Health of the Donetsk Regional State Administration and the Department of Human Anatomy of the Donetsk National Medical University (Lyman) for the time period of 2015–2017 (obtaining material), and 2017–2020 – data processing and summarizing.

The work was carried out in accordance with the requirements of the «Instructions on the forensic medical examination» (Order of the Ministry of Health of Ukraine No. 6 of 01/17/1995), in accordance with the requirements and norms, a typical provision on ethics of the Ministry of Health of Ukraine No. 690 of 09/23/2009, «The procedure for the removal of biological objects from the dead, whose bodies are subject to forensic examination and pathological examination, for scientific purposes» (2018).

The following methods were used in the study: macro- and micropreparation of anatomical objects of the brain; cranio- and morphometry of veins, sinuses of the DMB and liquor structures of the brain; manufacturing of corrosive (acrylic) casts-preparations of veins, sinuses of the DMB and liquor formations of the brain; injection technique; variational-statistical analysis of morphometric data; computer-graphic analysis [7–18].

Results and discussion. Of the specified number of morphological objects, 70 preparations of veins and sinuses of the DMB and 30 preparations of the cerebrospinal fluid system of the brain of adults were made (**Table 1**).

Table 1 – Gender-age and quantitative composition of the research objects

Periods \ Gender	Male	Female
First mature	15	8
Second mature	45	32
Total	60	40

For each preparation, the head (cranial) index was calculated according to the formula:

$$\text{Ind} = \frac{\text{transverse dimension (width) of the skull (in cm)}}{\text{longitudinal dimension (length) of the skull (in cm)}} \times 100.$$

According to the teachings of V. M. Shevkunenko and his students, individual anatomical variability is a set of differences in the anatomical structure of the position of human organs, systems, and tissues [7].

On the basis of this teaching, according to his method (1935), at first the longitudinal size was determined using the craniocaliper from the glabella to the top of the external occipital protrusion – the inion, and the transverse size – between the distant points of the parietal humps (euryon). Thus, the head (cranial) index was obtained – that is, dolichocephals (dolichocranes), mesocephals (mesocranes), and brachycephals were determined.

Within the vault of the head (skull) there are transverse sinuses, which emerge from the drain of the sinuses and have a horizontal projection. Between the latitudinal parameters of these venous collectors and the lateral ventricles, there are appropriate ratios that have appropriate values for the rational puncture of their posterior horns (**Table 2**).

Table 2 – Craniometric characteristics of venous-liquor formations of the brain in mature people in the horizontal plane (cm)

Research parameters \ Head shape	Dolichocephals		Mesocephals		Brachycephals	
	Male	Female	Male	Female	Male	Female
Width of the upper wall of the transverse sinus	0.7-0.8	0.6-0.7	0.7-0.9	0.7-0.8	0.8-1.0	0.8-0.9
Width of half of the tent of the cerebellum	4.0-4.8	3.9-4.6	4.1-4.4	4.0-4.4	5.0-5.6	4.9-5.4
Width of the parietal lobe to the corpus callosum	3.2-3.6	3.0-3.3	3.3-3.7	3.2-3.5	3.7-4.2	3.6-4.1
Width of the posterior horn of the lateral ventricle	0.8-1.0	0.8-0.9	0.9-1.1	0.9-1.0	1.1-1.25	1.1-1.2

It was established that the width of the upper wall of the transverse sinus ranges from 0.7 to 1.0 cm in men and 0.6 to 0.9 cm in women. A change in one half of the tent of the cerebellum from 4.0 to 5.6 cm leads to the variability of the parietal lobe to the corpus callosum of 3.0–4.1 cm with a variation in the width of the posterior horn of the lateral ventricles from 0.8 to 1.2 cm.

It should be noted that the largest transverse parameters of the above-mentioned formations are typical for dolichocephals, and the smallest – for brachycephals (**Table 2**). This is explained by the predominance of the width of the head (skull), cranial cavity and brain structures in people with a brachymorphic physique, regardless of gender.

In parallel with this, the limits of variability of the distance between the left and right transverse sinuses and the posterior horn of the lateral ventricles were established (**Table 3**).

It was established that the distance between the anterior edge of the upper wall of the left and right transverse sinuses and the posterior horns of the lateral ventricles varies depending on the type of head structure. So, at the level of the craniological inion **(i)** point, in mature men with a dolichocephalic shape, this distance ranges from 3.3 to 3.8 cm, in women – from 3.4 to 3.7 cm. In representatives with a mesocephalic head shape it varies from 3.0 to 3.3 cm (men and women); with a brachycephalic head shape – from 2.8 to 3.2 cm (men) and from 2.7 to 3.1 (women).

At the level of the opistion **(op)** point, the posterior horn of the lateral ventricle is located at a distance of 2.5–2.8 cm in dolichocephalic males and 2.3–2.6 cm in females; respectively, in mesocephals – 2.3–2.5 cm, regardless of gender; in brachycephals – 2.2–2.4 (men) and 2.1–2.3 cm (women).

The obtained data make it possible to determine the most optimal craniometric puncture points of the cerebrospinal fluid system of the brain. To penetrate the cavity of the anterior horn of the lateral ventricle, the metopion point is proposed, which is located at the intersection of the median plane of the head with the line connecting the most convex parts of the frontal humps [1, 2]. In this case, the puncture needle passes at an angle of 45° to a depth of 6.5 to 8.0 cm, on average 7.0–7.5 cm, penetrating into the anterior necessary section of this ventricle (**Fig. 1**).

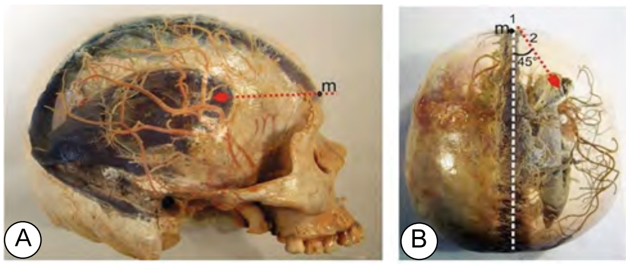

Fig. 1 – Puncture of the anterior horn of the lateral ventricle:
A – in the sagittal plane; **B** – in the horizontal plane;
1 – arrow line; 2 – the direction of the puncture needle

It is necessary to move from the arrow line to the right or left by a distance of 1.0–2.0 cm in order not to damage the upper arrow sinus.

In this place, it is better to impose a trepanation hole, taking into account the projection anatomy of the anterior horn of the lateral ventricle.

It is better to puncture the central part of the lateral ventricle at the level of the bregma point or between this point and the vertex **(v)**. The puncture needle penetrates to a depth of 6.0–7.0 cm through the milling hole, which is displaced by 3.0–4.0 cm from the arrow line at an angle of 70–75° (**Fig. 2**).

Given the variability of the location and size of the central part of the lateral ventricle, such a puncture is much more difficult to perform [3]. Taking into account

Table 3 – Individual variability of the distance between the transverse sinus and the posterior horn of the lateral ventricle in mature people

Research parameters \ Head shape	Dolichocephals		Mesocephals		Brachycephals	
	Male	Fem.	Male	Fem.	Male	Fem.
At the level of the inion point	3.3-3.8	3.4-3.7	3.0-3.3	3.1-3.3	2.8-3.2	2.7-3.1
At the level of the opistion point	2.5-2.8	2.3-2.6	2.3-2.5	2.3-2.5	2.2-2.4	2.1-2.3

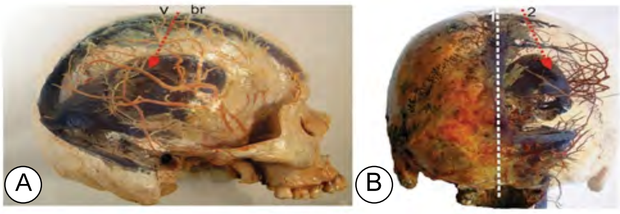

Fig. 2 – Puncture of the central part of the lateral ventricle:
A – lateral projection; **B** – rear projection; 1 – arrow line; 2 – the direction of the puncture needle

the established parameters of this part, it is necessary to perform a puncture at the inion point with moving a puncture needle to a depth of 3.0 to 5.0 cm. The milling hole is performed 1.0–2.0 cm from the midline (left and right), moreover, the needle is directed almost parallel to the arrow line.

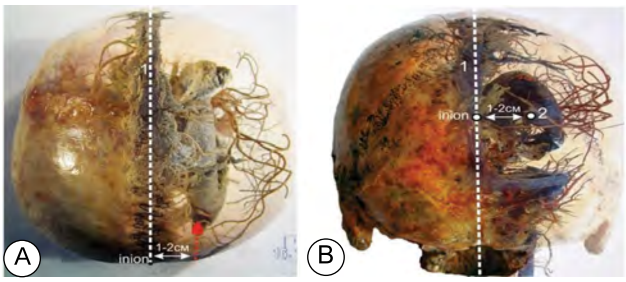

Fig. 3 – Puncture of the posterior horn of the lateral ventricle:
A – side view; **B** – rear projection; 1 – arrow line; 2 – puncture site; red arrow of the direction of the puncture needle

Kocher recommended to puncture the lateral ventricles with a puncture both from the side (lateral puncture) and from above (upper puncture).

A puncture can be made 3.0 cm above and 3.0 cm back from the external auditory meatus, with the needle directed obliquely upwards to the upper end of the auricle of the opposite side. If the puncture is performed above the temporal line (linea temporalis), we prevent damage to the transverse sinus, and usually at a depth of 4.0 cm we reach the lower horn of the lateral ventricle (**Fig. 3**).

The upper puncture of the lateral ventricle is performed by a puncture at the bregma point (the point of connection of the sagittal and coronal sutures) 2.0 cm from the midline (the sagittal plane); the needle is directed downwards and backwards and enters the ventricular cavity at a depth of 5.0–6.0 cm, given that it is enlarged and stretched [1].

A suboccipital puncture or a puncture of the cerebellar-cerebral cistern must be performed between the opistion point and the lambda point (**Fig. 4**). The puncture needle is inserted to a depth of 6.0–7.5 cm, with the gradual lowering of the end part of the needle to the base of the skull.

The milling hole is applied along the middle line of the skull, taking into account the above.

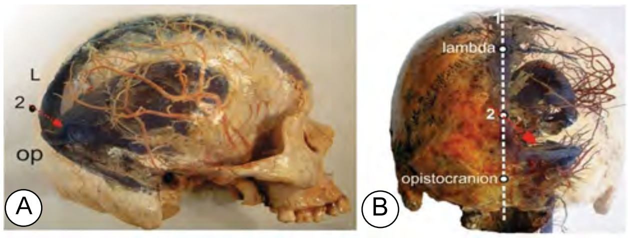

Fig. 4 – Puncture of the cerebellar-cerebral cistern:
A – lateral projection; **B** – rear projection; 1 – arrow line; 2 – puncture site; red arrow – the direction of the puncture needle

Conclusion. The most optimal craniometric puncture points of the constituent parts of the cerebrospinal fluid system of the brain were determined: the cavities of the anterior horn and the central part of the lateral ventricle, the cavities of the cerebellar-cerebral cistern.

Perspectives of further research. The obtained results confirm the expediency of conducting further experimental and morphological studies on the use of the craniotopographic method to determine the peculiarities of the structure of the components of the cerebrospinal fluid system in the context of the application of the obtained data in clinical medicine, in particular in neurosurgery.

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КРАНІОТОПОГРАФІЧНА ХАРАКТЕРИСТИКА ПАЗУШНО-ЛІКВОРНИХ ВЗАЄМОВІДНОШЕНЬ У ЛЮДЕЙ ЗРІЛОГО ВІКУ

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Резюме. *Метою дослідження* було визначення у людей першого і другого періодів зрілого віку краніотопографічних (краніометричних) показників пазушно-ліквoрних взаємовідношень у горизонтальній площині.

Матеріал та методи. Об'єктом дослідження були тверда оболона головного мозку з її пазухами, шлуночки головного мозку та склепіння черепа людей зрілого віку.

У дослідженні застосовані методи макро- та мікропрепарування анатомічних об'єктів головного мозку; краніо- та морфометрія вен, пазух твердої оболони головного мозку та ліквoрних структур головного мозку; виготовлення корозійних (акрилових) зліпків – препаратів вен, пазух твердої оболони головного мозку та лікворних утворень головного мозку; ін'єкційна методика; варіаційно-статистичний аналіз морфометричних даних; комп'ютерно-графічний аналіз.

Результати дослідження. У результаті дослідження встановлено, що пункцію центральної частини бічного шлуночка краще проводити на рівні точки брегма, чи між цією точкою та вертексом **(v)**. Пункційна голка проникає на глибину 6,0–7,0 см через фрезовий отвір, який зміщений на 3,0–4,0 см від стрілової лінії під кутом 70-75°.

Верхню пункцію бічного шлуночка краще здійснювати проколом у точці bregma (точка з'єднання стрілового та вінцевого швів) на 2,0 см від серединної лінії (стрілової площини); голку спрямовують донизу та дозаду і на глибині 5–6 см потрапляють у порожнину шлуночка (враховуючи, що вона збільшена та розтягнута).

Субокципітальну пункцію або пункцію мозочково-мозкової цистерни необхідно проводити між точками опістокраніон та точкою ламбда. Пункційна голка проводиться на глибину 6,0-7,5 см, причому, з поступовим опусканням кінцевої частини голки до основи черепа.

Висновок. Визначені за допомогою краніометричного аналізу найбільш оптимальні точки пункції складових частин ліквориної системи головного мозку – порожнини переднього рогу і центральної частини бічного шлуночка, порожнини мозочково-мозкової цистерни.

Ключові слова: краніотопографічний метод, тверда оболона головного мозку, венозні пазухи, шлуночки головного мозку, форма будови голови (черепа).

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