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COMPARATIVE ANALYSIS OF THE PONS MORPHOMETRIC PARAMETERS ACCORDING TO THE DATA OF MRI IMAGES

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The pons is a component of the hindbrain, forms the bottom of the fourth ventricle, and contains nuclei of cranial nerves and a set of conducting pathways. The specificity of the anatomical structure in terms of age and gender is the basis of the lesion patterns of the different genesis of this brain part. Therefore, the work aimed to determine the patterns of differences in age transformation and gender dimorphism of the pons morphometric parameters. The work used 150 MRI images of the brain in two mutually perpendicular projections (sagittal and frontal) of men and women aged 4 to 35. Morphometric analysis was carried out using the RadiAnt Dicom Viewer software on MR-tomograms performed in the sagittal plane in T1 and T2 weighted image modes. Our study showed that a significant increase in the pons size occurs during the second childhood, acquiring a relatively stable state in adolescence. Furthermore, it was established that the longitudinal dimensions of the men's pons do not reliably differ from the similar indicators of the longitudinal dimensions of the women's pons, which indicates the absence of gender dimorphism. During the research, a wide range of distribution of morphometric indicators of the pons longitudinal dimensions within age groups was revealed.

Key words: *nervous system, brain, hindbrain, structure, age-related changes, sexual characteristics, anatomy, morphometric analysis.*

Connection of the publication with the planned scientific research.

The study is part of the scientific research work «Individual anatomical variability of craniotopographical features and spatial relationships of the human head areas in the post-embryonic period of ontogenesis», state registration number 0118U000954.

Introduction.

The pons formation takes place at 5-6 weeks of the prenatal period. At the time of birth, the pons is fully developed morphologically and is almost identical in its structure to the pons of an adult [1-3]. And if, according to some researchers, stabilization in the development of the human cerebrum occurs around the age of 21, then it is quite likely that stabilization in the pons development should be expected in a similar period.

The analysis of the literature devoted to the morphology and neurophysiology of the human cerebrum shows that the anatomical view of its structure has changed little in recent years. The same conservatism is observed concerning the pons structure. And even though the pons performs several vital functions, the number of works devoted to this brain structure is small. Studies in which gender differences in bridge parameters were studied, especially in children, are few [4]. Modern methods of magnetic resonance imaging make it possible to directly examine the structure of the brainstem and make it possible to determine the location of the main internal structures, which can be very important in the interpretation of MRI images [5-7].

The aim of the study.

To determine the patterns of differences in the age transformation and gender dimorphism of the pons morphometric parameters.

Object and methods of research.

The work used 150 MRI images of the brain in two mutually perpendicular projections (sagittal and frontal) of men and women aged 4 to 35 years, i.e., the following age periods: first childhood, second childhood, adolescence, young adulthood, and first period of mature age. To the pons metric characteristics that must be compared, we included its height, length (anterior-posterior dimension), and width.

When conducting morphometric studies, we inscribed the pons contour profile on the sagittal section within the boundaries of an equilateral rectangle, the long sides of which are equal to its height, and the short sides are comparable to the length (anterior-posterior dimension). We performed similar actions with the pons frontal projection while measuring its width.

The entire amount of necessary material in the form of MRI images of people's heads was provided thanks to the contract between Kharkiv National Medical University and MedService LLC. A Magnetom C magnetic resonance tomograph was used to obtain MRI images. Morphometric analysis was performed using the RadiAnt Dicom Viewer software on MR tomograms performed in the sagittal plane in T1 and T2 weighted image modes.

Research results and their discussion.

During the morphometric analysis, it was established that the height of boys' pons in first childhood ranges from 23.5 to 26.4 mm, from which it turns out that its arithmetic mean – is 24.7±0.8 mm. The minimum pons length (anterior-posterior dimension) is 19.3 mm, and the maximum is 21.5 mm (arithmetic mean – 20.9±0.5 mm). The pons width ranges from 22.7 to 32.1 mm (arithmetic mean – 26.3±2.1 mm).

Morphometric analysis of the pons longitudinal dimensions of girls in first childhood showed that the pons height ranges from 21.1 to 24.6 mm (arithmetic mean is

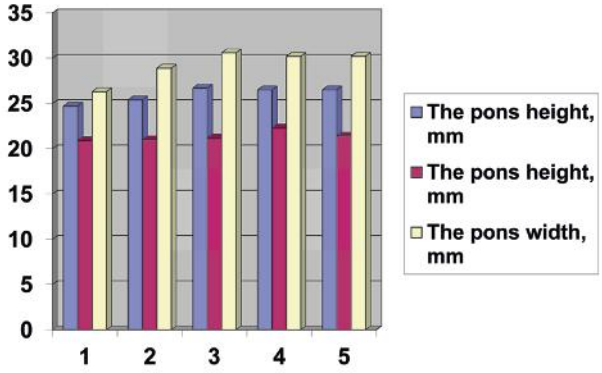

Figure 1 – Longitudinal dimensions of the men's pons.

Notes: the abscissa shows the age group (1 – the period of the first childhood, 2 – the period of the second childhood, 3 – the adolescence, 4 – the young adulthood, 5 – the first period of mature age), the ordinate – the arithmetic mean of the appearing metric values.

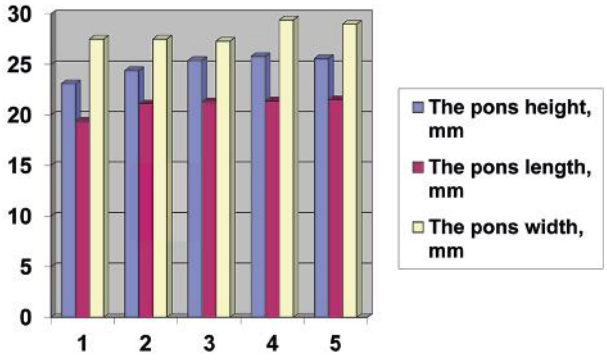

Figure 2 – Longitudinal dimensions of the women's pons.

Notes: the abscissa shows the age group (1 – the period of the first childhood, 2 – the period of the second childhood, 3 – the adolescence, 4 – the young adulthood, 5 – the first period of mature age), the ordinate – the arithmetic mean of the appearing metric values.

23.1±1.1 mm). At the same time, its minimum length is 17.6 mm, and the maximum reaches 22.6 mm (arithmetic mean – 19.4±1.4 mm). The pons width ranges from 24.1 to 30.3 mm (arithmetic mean – 27.5±1.6 mm).

By comparing the arithmetic mean values of the pons longitudinal dimensions of boys and girls in first childhood, it is possible to verify the absence of reliable signs of gender dimorphism in this age group.

As a result of metric measurements of the pons longitudinal dimensions of boys in the period of second childhood, it was established that its height is in the range from 22.0 to 28.7 mm; the arithmetic mean is 25.4±1.9 mm, the length (anterior-posterior dimension) varies from 17.2 to 22.7 mm, which in the arithmetic mean is 21.0±1.5 mm. The minimum pons width is 25.8 mm, and the maximum is 31.7 mm (arithmetic mean – 28.9±1.6 mm).

In girls, these indicators, as in the previous age group, also do not differ reliably from similar indicators of the pons longitudinal dimensions of boys. So, the pons height is individually distributed in the range from 22.4 to 26.5 mm; the arithmetic mean is 24.4±1.2 mm. The pons length values range from 19.1 to 22.6 mm (the arithmetic mean is 21.1±0.9 mm), and the indicators of the pons width are distributed in the range from 23.7 to 29.2 mm, which in the arithmetic mean is equal to 27.5±1.5 mm.

Let's consider the pons morphometric indicators of adolescent boys. The arithmetic mean of the height is 26.7±1.7 mm (with a minimum value of 25.1 mm, and a maximum value of 30.6 mm), the pons length is 21.2±1.6 mm (it ranges from 17.7 to 24 .0 mm), the pons width – 30.6±2.5 mm (from 26.3 to 35.7 mm).

As a result of pons metric measurements of girls of the same age group, it was established that the pons height is in the range from 21.8 to 30.9 mm (the arithmetic mean is 25.4±2.4 mm), the pons length is from 17.9 to 23 .5 mm (arithmetic mean – 21.3±2.3 mm), the pons width – from 23.5 to 33.4 mm (arithmetic mean – 27.3±2.2 mm). And although in this age group, the distribution range of individual indicators of the pons longitudinal dimensions is within more comprehensive limits, it is also not possible to talk about reliable signs of gender dimorphism.

The pons height of young men in the period of youth is individually distributed from 23.1 to 28.4 mm, the arithmetic mean is 26.5±1.4 mm; fluctuations of the pons length indicators are in the range from 20.4 to 22.9 mm, the arithmetic mean is 22.3±1.3 mm; the pons width is 30.2±1.4 mm on average (with a minimum of 26.8 mm and a maximum of 32.4 mm).

In girls of the same age group, the pons height has an arithmetic mean of 25.8±1.5 mm (from 24.2 to 29.2 mm), the pons length is 21.4±1.1 mm (from 19.6 to 23.1 mm), and the width is 29.4±1.8 mm (from 25.6 to 32.4 mm). And as in the previous age groups, we do not have reliable data on the difference in the pons longitudinal dimensions of boys and girls.

And finally, we will consider the morphometric indicators of the pons longitudinal dimensions of men and women in the period of mature age, which is regarded as the most stable in ontogenesis. In men, the arithmetic mean of the pons height is 26.5±1.7 mm (from 23.6 to 30.2 mm), and in women – 25.6±1.3 (from 23.4 to 28.5 mm). The arithmetic mean of the pons length for men is 21.4±1.2 mm (ranging from 19.7 to

Table 1 – Results of the analysis of the longitudinal dimensions of the men's pons

Period	Pons height (mm)	Pons length (anterior-posterior dimension) (mm)	Pons width (mm)
The first childhood	24,7±0,8	20,9±0,5	26,3±2,1
The second childhood	25,4±1,9	21,0±1,5	28,9±1,6
The adolescence	26,7±1,7	21,2±1,6	30,6±2,5
The young adulthood	26,5±1,4	22,3±1,3	30,2±1,4
The first period of mature age	26,5±1,7	21,4±1,2	30,2±2,0

Table 2 – Results of the analysis of the longitudinal dimensions of the women's pons

Period	Pons height (mm)	Pons length (anterior-posterior dimension) (mm)	Pons width (mm)
The first childhood	23,1±1,1	19,4±1,4	27,5±1,6
The second childhood	24,4±1,2	21,1±0,9	27,5±1,6
The adolescence	25,4±2,4	21,3±2,3	27,3±2,2
The young adulthood	25,8±1,5	21,4±1,1	29,4±1,8
The first period of mature age	25,6±1,3	21,5±1,9	29,0±1,9

24.0 mm), and for women – 21.5±1.9 mm (from 18.1 to 25.1 mm). The pons width of men has an average value of 30.2±2.0 mm (minimum indicator – 26.8 mm, maximum – 34.1 mm), women – 29.0±1.9 mm (from 23.7 to 31, 4 mm). Therefore, despite the extensive distribution range of morphometric indicators of the pons longitudinal dimensions within the groups, it is impossible to assert gender dimorphism.

But if the sought-after metric indicators are displayed on the diagrams **(fig. 1, 2)**, their gradual increase with age becomes quite noticeable. First of all, the fact that the pons increases in size in the period of second childhood, reaching a more or less stable state in adolescence, and in the following two age periods (young adulthood and first period of mature age) is almost no different from the previous one, which is clearly shown by the data of the consolidated tables **(tables 1, 2)**.

Conclusions.

1. Our research showed that a significant increase in the pons size occurs during the second childhood, acquiring a relatively stable state in adolescence.

2. It was established that the indicators of the longitudinal dimensions of the men's pons do not reliably differ from the similar indicators of the longitudinal dimensions of the women's pons, which indicates the absence of gender dimorphism.

3. The research revealed a wide range of morphometric indicators of the pons longitudinal dimensions within age groups.

Prospects for further research.

Conduct a comparative analysis of the pons morphometric parameters of newborns and infants.

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ПОРІВНЯЛЬНИЙ АНАЛІЗ МОРФОМЕТРИЧНИХ ПАРАМЕТРІВ МОСТА ЗА ДАНИМИ МРТ-ЗОБРАЖЕНЬ

Боягіна О. Д., Попадинець О. Г., Коломійченко Ю. А., Литвиненко Н. В.

Резюме. Сучасні методи магнітно-резонансної томографії дозволяють безпосередньо розглянути будову стовбура мозку та дають змогу визначити місцезнаходження основних внутрішніх структур, які можуть бути дуже важливими при інтерпритації МРТ-зображень. Основною метою дослідження виступає визначення закономірності відмінностей вікового перетворення та статевого диморфізму морфометричних параметрів моста.

У роботі використано 150 МРТ-зображень головного мозку в двох взаємно перпендикулярних проекціях (сагітальній та фронтальній) чоловіків і жінок віком від 4 до 35 років. Морфометричний аналіз здійснено за допомогою програмного забезпечення RadiAnt Dicom Viewer на МР-томограмах, виконаних в сагітальній площині, в режимах Т1 і Т2 зважених зображень.

Отримавши результати та порівнявши середньоарифметичні значення поздовжніх розмірів мосту хлопчиків та дівчаток періоду першого дитинства, можна переконатися у відсутності достовірних ознак статевого диморфізму у даній віковій групі. Результати значення поздовжніх розмірів мосту хлопчиків та дівчаток періоду другого дитинства, як і в попередній віковій групі, також достовірно не відрізняються від аналогічних показників. При розгляді морфометричних показників мосту хлопчиків та дівчат підліткового віку. діапазон розподілу індивідуальних показників поздовжніх розмірів моста знаходиться в більш широких межах, але говорити про достовірні ознаки статевого диморфізму також не уявляється можливим. Висота моста юнаків та дівчат періоду юнацького віку, як і в попередніх вікових групах ми не маємо достовірних даних щодо відмінності поздовжніх розмірів мосту юнаків і дівчат. При розгляді поздовжніх розмірів мосту чоловіків і жінок І періоду зрілого віку, який вважається найбільш стабільним в онтогенезі, але не зважаючи на великий діапазон розподілу морфометричних показників поздовжніх розмірів мосту всередині груп, стверджувати про наявність статевого диморфізму не уявляється можливим.

Отже, встановлено, що показники поздовжніх розмірів моста чоловіків достовірно не відрізняються від аналогічних показників поздовжніх розмірів моста жінок, що вказує на відсутність статевого диморфізму також у процесі дослідження було виявлено великий діапазон розподілу морфометричних показників поздовжніх розмірів моста всередині вікових груп.

Ключові слова: нервова система, головний мозок, задній мозок, структура, вікові зміни, статеві особливості, анатомія, морфометричний аналіз.

COMPARATIVE ANALYSIS OF THE PONS MORPHOMETRIC PARAMETERS ACCORDING TO THE DATA OF MRI IMAGES

Boiagina O. D., Popadynets O. H., Kolomiichenko Yu. A., Lytvynenko N. V.

Abstract. Modern methods of magnetic resonance imaging make it possible to directly examine the brainstem structure and make it possible to determine the location of the main internal structures, which can be very impor-

tant in the interpretation of MRI images. The study's primary goal is to determine the pattern of differences in age transformation and gender dimorphism of the pons morphometric parameters.

The work used 150 MRI images of the brain in two mutually perpendicular projections (sagittal and frontal) of men and women aged 4 to 35. Morphometric analysis was carried out using the RadiAnt Dicom Viewer software on MR-tomograms performed in the sagittal plane in T1 and T2 weighted image modes.

After obtaining the results and comparing the arithmetic mean of the pons longitudinal dimensions of boys and girls in the period of the first childhood, it is possible to make sure that there are no reliable signs of gender dimorphism in this age group. Furthermore, the value results of the pons longitudinal dimensions of boys and girls in the period of second childhood, as in the previous age group, are also not significantly different from similar indicators. When considering the pons morphometric indicators of adolescent boys and girls, the distribution range of individual indicators of the pons longitudinal dimensions is within wider limits. Still, it is also not possible to talk about reliable signs of gender dimorphism. Regarding the pons height of boys and girls in young adulthood, as in the previous age groups, we do not have reliable data on the difference in the pons longitudinal dimensions of boys and girls. When considering the pons longitudinal dimensions of men and women of the first period of mature age, which is regarded as the most stable in ontogenesis, but despite the extensive distribution range of morphometric indicators of the pons longitudinal dimensions within the groups, it is not possible to assert the presence of gender dimorphism.

Therefore, it was established that the indicators of the pons longitudinal dimensions of men do not reliably differ from the similar indicators of the pons longitudinal dimensions of women, which indicates the absence of gender dimorphism, also during the research, an extensive distribution range of morphometric indicators of the pons longitudinal dimensions within age groups was revealed.

Key words: nervous system, brain, hindbrain, structure, age-related changes, sexual characteristics, anatomy, morphometric analysis.

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Conflict of interest:
There is no conflict of interest between the authors of this article.

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