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INDIVIDUAL ANATOMICAL VARIABILITY OF THE EXTERNAL SURFACE CONFIGURATION OF THE CRANIAL VAULT BONES IN BRACHYCEPHALICS

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Abstract. *The scientific work is devoted to a comprehensive morphometric study of the individual anatomical variability of the configuration of the surface of the bones of the cranial vault of brachycephalics in relation to the coordinates of planar points on the outer and inner bone plates. The bones of the cranial vault have a different configuration of the outer surface, which is formed by parabolic curves and circles that determine the curvature of the surface of this area of the bone. The number, position, morphometric parameters and the nature of the distribution of planar coordinate points correlate with the shape of the human skull. The proposed method for describing the configuration of the surface of the bones of the cranial vault makes it possible to more accurately reproduce the craniotopography of the cranial vault in the applied aspect.*

In recent years, the study of craniotopography and morphometry of the bones of the cranial vault in the applied aspect has become of great importance. The cranial vault makes up the brain part of the cranium and is located in the only shaping bone structure with the base and facial section of the skull [1].

In connection with the active development of neurosurgery, vascular surgery, microsurgical technologies, the development and implementation of cranioplastic operations and diagnostic manipulations, the need for further study of the features of the individual structure of the shape, size, location and design of the cranial vault becomes obvious [2, 3].

Detailing of morphological data on the structure of the bones of the cranial vault is now also necessary for the problems of theoretical morphology, anthropology, forensic medicine and bioengineering [4, 5].

However, these studies do not reveal the relationship of craniotopography of the surface configuration and thickness of the calvarium bones with the shape of the skull.

The aim of the study is a comprehensive morphometric study of individual anatomical variability in the configuration of the surface of the bones of the cranial vault in relation to planar coordinate points on the outer and inner bone plates in brachycephalics.

The study was performed on 14 skull vaults taken from the corpses of people of both sexes aged 36 to 72 years, who did not have intracranial pathology during their lifetime. Distribution of anatomical material by sex: 10 - skulls of men, 4 - skulls of women.

The length and width of each skull were measured with a craniocaliper, followed by calculation of the cranial index. Each cranial vault was subjected to a complex craniometric study using a special device that allows determining planar coordinate points on the outer and inner surfaces of the cranial vault. The curvature of the bones of the cranial vault was studied by the method of contact combination of the bone profile with sections of patterned elements of arcs of chains of different radii and curves Y = X2 (square parabola), Y = X3 (cubic parabola) and Y = X2/2 (semisquare parabola).

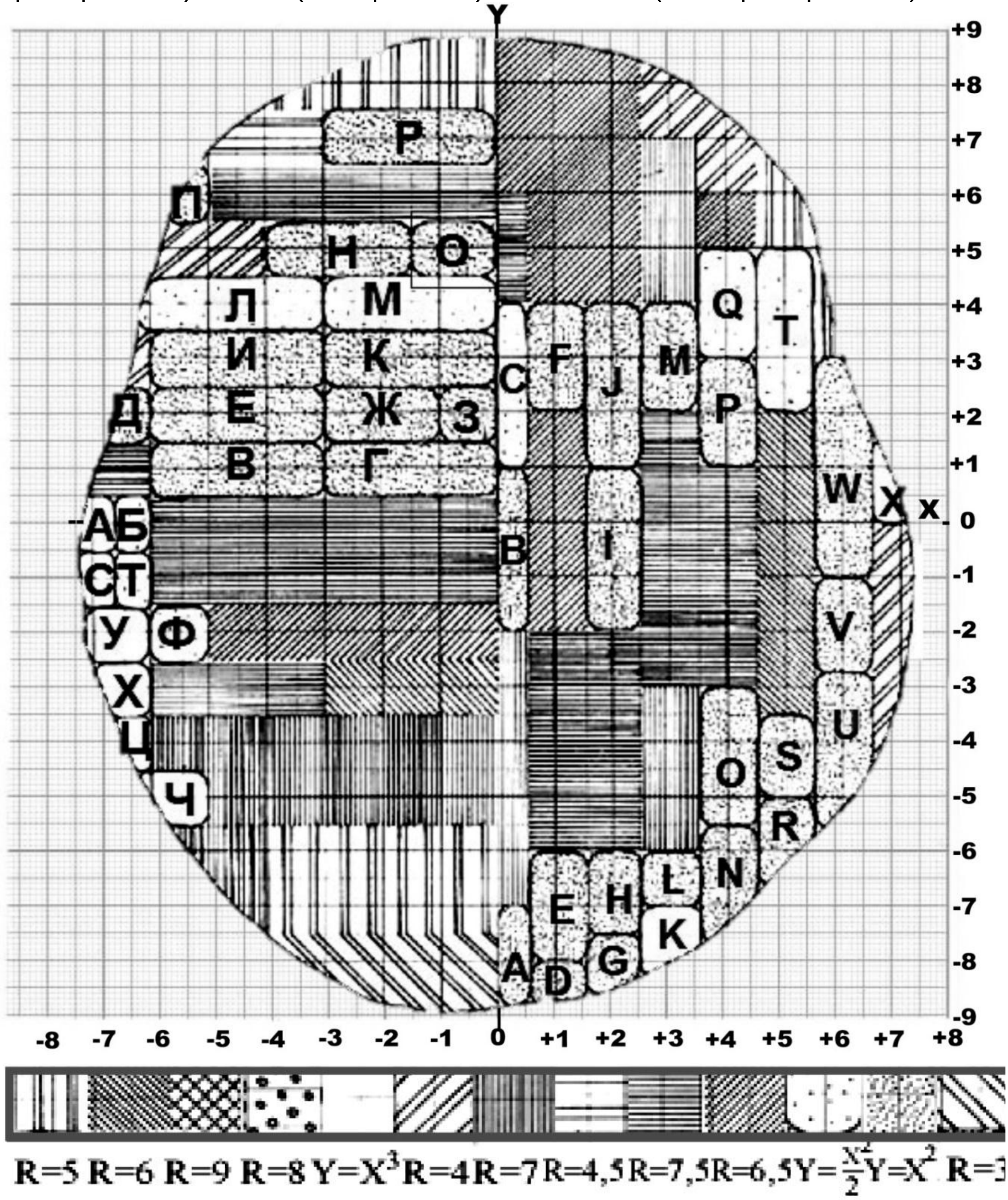

Fig. 1. **Distribution of areas corresponding to the configuration of parabolas and circles on the vaulted skulls of brachycephals. Frontal sections are described from left to right on the left half of the cranial vault (from the lateral parts of the bone to the midline of the skull). Sagittal sections are described on the right half of the skull in the direction from the occipital bone to the frontal**

Study of frontal sections. The occipital bone of brachycephalics (the part of the occipital scales related to the cranial vault) in the frontal sections y = -9 and y = -8 is described by a circle with a radius R = 3 (Fig. 1).

The parietal bone in brachycephalics has a more complex configuration. In the frontal sections y = –7 and y = –6, the lateral sections of the bone to the line passing through the middle of the parietal hump (x = –4) can be described by a circle with a radius R = 7. Medially from this line (in the same sections to the sagittal seam) the chain radius is reduced to R = 5.

At intersections y = -5 and y = -4, the configuration of the parietal bone corresponds to a circle with radius R = 7. The only exception is the lateral parts of these intersections: at the intersection y = -5, the surface configuration corresponds to a section of a cubic parabola Y = X3 with coordinates Y $\in$ (1; 4) at x $\in$ (-6.5; -6) (Fig. 1, section Ч). At the intersection y = 4, the configuration of the bone is also described by a section of the parabola Y = X3 with coordinates Y $\in$ (1; 4) at x $\in$ (-6.5; -6) (Fig. 1, section Ц).

The intersection y = -3 in brachycephalics has 3 departments of different configurations. On the section X, where x$\in$ (-7; -6), the configuration is described by a section of the parabola Y = X3 with coordinates Y$\in$ (0.7; 3.7). Section x$\in$ (-6; -3) corresponds to a circle with radius R = 7.5. The other part of the bone in this intersection corresponds to a circle with radius R=6 (Fig. 1).

At the intersection y = -2 in the section Y, where x $\in$(-7; -6.2), the configuration of the bone is described by the parabola $Y = X^3$ with coordinates Y $\in$(1.0; 4.0). Section F, where x $\in$(-6.2; -5), corresponds to the configuration of a semi-square parabola $Y = X^2/2$ with coordinates Y $\in$(0.5; 2.7). The section from x = -5 to x = 0 in this intersection is described by a circle with a radius of R = 6.5.

Intersections y = -1 and y = 0 in brachycephalics have approximately the same configuration. In the lateral sections in sections A and C, where x $\in$(-7.3; -6.6), the surface configuration corresponds to the section of the parabola $Y = X^3$ with coordinates Y $\in$(1; 4). Adjacent areas B and T, where x $\in$(-6.6; -6), have a curvature described by the parabola $Y = X^2/2$ with coordinates Y $\in$(0.3; 2.7). The surface of the parietal bone in the section x $\in$(-6; 0) in these sections corresponds to a circle with a radius of R=7.5.

At the intersection y = 1 in brachycephalics, the lateral section x $\in$(-7; -6) is described by a circle with a radius of R = 7.5. The other part of this intersection can be described with the help of a quadratic parabola $Y = X^2$. Section B, where x $\in$(-6; -3), corresponds to the section of this parabola with coordinates Y $\in$(0.3; 3.6); and section Г, where x $\in$(-3; 0), is a section of a parabola with coordinates Y $\in$(1; 4) (Fig. 1).

The intersection y = 2 is represented by four sections of the parabola $Y = X^2$. Intersection Д, where x $\in$(-6.6; -6), corresponds to the curvature of the parabola section with coordinates Y $\in$(3.7; 0.1); section E, where x $\in$(-6; -3), - with coordinates Y $\in$(0.4; 3.8); section Ж, where x $\in$(-3; -1), - with coordinates Y $\in$(2,3; 4,5); section З, where x $\in$(-1; 0), - with coordinates Y $\in$(2; 2,9) (Fig. 1).

The intersection y = 3 has 3 sections. The lateral section, where x $\in$(-6,3; -6), is described by a circle with a radius of R = 4. Section I, where x $\in$(-6, -Z), is similar to section B, because it has the same coordinates of the parabola $Y = X^2$: Y $\in$(0.3; 3.6). Section K, where x $\in$(-3; 0), is described by the section of the parabola $Y = X^2$ with coordinates Y $\in$(3; 0,2) (Fig. 1).

Intersection y = 4 in brachycephalics corresponds to the frontal suture and is represented by two sections of the semi-square parabola $Y = X^2/2$. Section Л, where

$x \in$(-6,2; -3), corresponds to the configuration of the branch of this parabola with coordinates $Y \in$(0, 3,2). Section M, where $X \in$(-3; 0), corresponds to the configuration of its branch with coordinates $Y \in$(2.8; 0.2).

In the intersection y = 5, we selected 3 parts. The lateral section, where $x \in$**(** -6; -4), is described by a circle with a radius of R = 4. Section H, where $x \in$(-4; - 1.5), corresponds to the configuration of the section of the parabola $Y = X^2$ with coordinates $Y \in$(1, 5; 4,7). Section O, where $x \in$**(**-1.5; 0), corresponds to the section of the same parabola with coordinates $Y \in$(0.3; 1.6) (Fig. 1).

At the intersection y = 6, the lateral section П, where $x \in$**(**-5.7; -5), is described by the section of the parabola $Y = X^2$ with coordinates $Y \in$(0.5; 3). The other part of the section corresponds to the arc of a circle with a radius of R = 7.5.

The intersection y = 7 is represented by two sections. The lateral section, where $x \in$(-5.1; -3), can be described by a circle with a radius of R = 4.5. The medial part of P, where $x \in$(-3; 0), corresponds to the section of the parabola $Y = X^2$ with coordinates $Y \in$(3.2; 0.4) (Fig. 1).

The rest of the frontal bone, corresponding in the used coordinate grid to the frontal intersections y = 8 and y = 9, in brachycephalics is described by a circle with a radius of R = 5 (Fig. 1).

Study of sagittal sections. In the intersection x = 0, we have highlighted several areas in brachycephalics. The occipital bone corresponds to area A (Fig. 1, right half), where $y \in$(-9; -7), and is described by the area of the quadratic parabola $Y = X^2$ with coordinates $Y \in$(0.5; 4.5). The area where $y \in$(-7; -2) corresponds to the arc of a circle with a radius of R = 7. The area B where $y \in$(-2; 1) corresponds to a part of the quadratic parabola $Y = X^2$ with coordinates $Y \in$(0,2 ; 3). Section C, where $y \in$(1; 4), corresponds to part of the semi-square parabola $Y = X^2 / 2$ with coordinates $Y \in$(4; 7). The area where $y \in$(4; 6) is described by an arc of a circle with a radius of R = 7.5. The area where $y \in$(6; 9) is described by an arc of a circle with a radius of R = 6.5 (Fig. 1).

At the intersection x = 1, brachycephalics have a section D, where $y \in$(-9; -8), which is described by part of the parabola $Y = X^2$ with coordinates $Y \in$(1; 3). The section E adjacent to it, where $y \in$(-8; -6), corresponds to a part of the same parabola with coordinates $Y \in$(1,3; 5). The section where $y \in$(-6; -2) at the intersection of x = 1 and x = 2 corresponds to the arc of a circle with a radius of R = 7.5. The section where $y \in$(-2; 2) at the intersection of x = 1 is described by an arc of a circle with a radius of R = 6.5. Section F, where $y \in$(2; 4), corresponds to part of the parabola $Y = X^2$ with coordinates $Y \in$(5; 3). Part of the scale of the frontal bone at the intersections x = 1 and x = 2, where $y \in$(4; 9), is described by the arc of a circle with a radius of R = 6.5 (Fig. 1).

At the intersection x = 2, the section G, where $y \in$(-8.7; -7.5), corresponds to the part of the parabola $Y = X^2$ with coordinates $Y \in$(0.5; 3.0). Section H, where $y \in$(7.5; -6), is described by part of the same parabola with coordinates $Y \in$(1.5; 4.2). Section I, where $y \in$(-2; 1), corresponds to the part of this parabola with coordinates $Y \in$(0,3; 3). Section J, where $y \in$(1; 4), is described by part of the same parabola with coordinates $Y \in$(7; 3,8) (Fig. 1).

The intersection of x = 3 in brachycephalics is similar to the intersection of x = 1 in terms of the location of the areas described by parabolas and circles. Section K, where $y \in$(-8.2; -7.5), corresponds to part of the cubic parabola $Y = X^3$ with coordinates $Y \in$(0.8; 2.0). Section L, where $y \in$(-7.5; -6), corresponds to part of the quadratic parabola $Y = X^2$ with coordinates Y ∈(1.5; 4.7). The area where y ∈(-6; -3) is described by the arc of a circle with radius R = 7, and the area where y ∈(-3; 2) is described by the arc of a circle with radius R = 7.5. Section M, where y ∈(2; 4), corresponds to part of the parabola $Y = X^2$ with coordinates Y ∈(4; 6).

The scale of the frontal bone in the area where y ∈(4; 7) is described by an arc of a circle with a radius of R = 7, and in the area where y ∈(7; 8,4) is described by an arc of a circle with a radius of R = 4 (Fig. 1) .

At the intersection of x = 4 in brachycephalics, we selected the following sections: section N, where y ∈(-7.6; -5.5), is described by a part of the parabola $Y = X^2$ with coordinates Y ∈(0.7; 4.3); section O, where y ∈(-5.5; -3.0), is described by part of the same parabola with coordinates Y ∈(0.2; 3.0); the section where y ∈(-3; 1), as well as in the intersection x = 3, corresponds to the arc of a circle with a radius of R = 7.5; section P, where y ∈(1; 3), is described by part of the parabola $Y = X^2$ with coordinates Y ∈(9.0; 7.0); section Q, where y ∈(3.0; 5.0), is described by part of the parabola $Y = X^2 / 2$ with coordinates Y ∈(5.0; 3.0); the section where y ∈(5; 6) corresponds to the arc of a circle with a radius of R = 6.5, and the section where y ∈(6.0; 7.9) corresponds to the arc of a circle with a radius of R = 4 (Fig. 1).

At the intersection of x = 5 in brachycephalics, the section R, where y ∈(-6.7; -5), is described by part of the parabola $Y = X^2$ with coordinates Y ∈(0.5; 4). Section S, where y ∈(-5.0; - 3.5), is described by part of the same parabola with coordinates Y ∈(0.5; 2.5). The section where y ∈(-3.5; 2.0) corresponds to an arc of a circle with a radius of R = 6. The section T where y ∈(2.0; 5.0) corresponds to a part of the parabola $Y = X^2 / 2$ with coordinates Y ∈(5.5; 2.5). The area where y ∈(5.0; 6.8) is described by an arc of a circle with a radius of R = 5 (Fig. 1).

At the intersection of x = 6, the following 4 sections are distinguished in brachycephalics: section U, where y ∈(-5.5; -2.7), corresponds to the part of the parabola $Y = X^2$ with coordinates Y ∈(0.5; 4); section V, where Y ∈(-2,7; -1), corresponds to a part of the same parabola with coordinates Y ∈(0; 2); section W, where Y ∈(-1; 3), - with coordinates Y ∈(0; 3,5). The area where U ∈(3; 4,7) is described by an arc of a circle with a radius of R = 5.

Brachycephalics have 2 sections in the intersection of x = 7. The area where Y ∈(-4.5; 0) is described by an arc of a circle with radius R = 4. The area X where Y ∈(0; 1.5) corresponds to the part of the parabola $Y = X^3$ with coordinates Y ∈(0, 2; 1.5) (Fig. 1).

Thus, when analyzing the frontal sections, it was found that the configuration of the scales of the occipital bone in all the studied skulls is practically the same. The configuration of the parietal bone in frontal sections in brachycephalics is characterized by the predominance of parabolic functions in the area from the frontal suture in front to the middle of the distance from the glabella to the opistocranion.

The scale of the temporal bone and the adjacent parts of the parietal bone in all the studied skulls are described by the sections of the parabolas $Y = X^2$, $Y = X^3$ and $Y = X^2 /2$. In brachycephalics, the line of inflection of the more vertically placed scales of the temporal bone and part of the parietal bone into its spherical part is located at the intersection x = 6. The other part of the parietal bone is described mainly by arcs of circles with different radii in the frontal direction.

The configuration of the scales of the frontal bone in frontal sections has its own characteristics. Thus, the part of the frontal scale up to the limit of hair growth in all studied skulls corresponds to a circle with a radius of R = 5. The area of the frontal hump is described in brachycephalic skulls by an arc of a circle with a radius of

R = 4.5. Which indicates a greater width of the frontal bone in brachycephals. The other part of the frontal bone in brachycephalics has a complex configuration, which is described by circles and parabolas.

When studying the configuration of the surface of the skull in sagittal sections, it was established that the area of the occipital bone and the lambda-like suture have a complex configuration. The area of the parietal humps corresponds mainly to the shape of parabolas. The parasagittal section in the sagittal sections of brachycephalics is described by a circle with a radius of R = 7 and the parabolas $Y = X^2$ and $Y = X^2/2$. The scales of the temporal bone and the adjacent parts of the parietal bone correspond mainly to parts of various parabolas.

The central part of the parietal bone in all studied turtles is most often described by arcs of circles in sagittal sections.

The area of the frontal suture in these sections in brachycephalics is described by parabolic functions.

When comparing the frontal and sagittal cross-sections, areas of connection were found, which are described by the arcs of circles. The surface of the bones has a constant configuration in the area of the frontal bone from the cutting line of the skull from below to the border of hair growth above and to the medial edge of the frontal humps from the lateral side. It is described by the intersection of arcs of circles with a radius of R = 5 in the frontal plane in all studied turtles and has a radius of R = 6.5 in the sagittal plane.

The area of the frontal humps in brachycephalics is represented by a group of areas of connecting circles. In the frontal plane, at a distance of 2 cm from the frontal suture, a section with a spherical surface with a radius of R = 7 – 7.5 was found in brachycephalics.

In the central part of the parietal bone, brachycephalics have a large area with a spherical surface with a radius of R = 6.5 – 7. The studied skulls also have a small spherical area with a radius of R = 6.5 – 7. At a distance of 3 – 4 cm in front of the site the crossing of the sagittal and lambda sutures of brachycephalics has a spherical bone area with a radius of R = 7 – 7.5.

Other parts of the frontal, parietal, temporal and occipital bones in the studied brachycephalic skulls have an even more complex configuration, which is described by parabolic functions and their connection with arcs of circles.

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