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CLINICAL ASPECTS OF AGE-RELATED SPHENOID BONE STRUCTURE VARIABILITY IN CHILDREN

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ABSTRACT — Aim of our study was to identify the morphometric variability of the parameters pertaining to the sphenoid bone body structures in children of different ages, in order to improve access to the skull internal base as well as to the adjacent structures during endoscopic interventions. The craniometry method was used to study 87 child skulls, age 1–21, without regard to gender (65 skulls from the fundamental Museum of the Department of Anatomy, the Saratov State Medical University, and 22 skulls from the Department of Normal Anatomy, Military Medical Academy (Saint Petersburg), broken into 6 age periods. The length of the sphenoidal yoke, as well as its width along with the front and back edges, and the length and width of the prechiasmatic sulcus, tuberculum sellae, its width and height, and the length and width of the sella turcica were identified.

The results of the study has revealed that most of the examined structures feature stable values until the age of 7 years (linear parameters of the sphenoidal yoke, the width of the prechiasmatic sulcus, the length and width of the saddle tubercle); these anatomical formations show intensive growth only at the age of 8–12. The height of the tuberculum sellae changes at the age of 4–7, reaching the final value; the length of the prechiasmatic sulcus grows at the ages of 4–7 and 13–16 and does not change in adolescence. The width of the Turkish saddle increases at the ages of 4–7 and 13–16; its length features the same values by the age of 12, increasing only within the period of 13–16, reaching stable values in adolescence.

KEYWORDS — sphenoidal yoke, prechiasmatic sulcus, tuberculum sellae, sella turcica, endoscopic interventions.

INTRODUCTION

The recent decades have witnessed much interest taken in the clinical anatomy of the head, which is based on morphometric studies of the skull deep structures [2–6, 10, 15, 17, 19, 23–26] employed in clinical practice to develop better access to hard-to-reach structures of the brain and neurovascular structures to be found at the skull base [7, 22]. Endoscopic endonasal approaches to the skull internal base in children with craniopharyngiomas, pituitary adenomas, and congenital encephalocele have already been proven to be highly effective and safe as treatment methods [12–14, 20]. The area of the sella turcica, which is located in the center of the skull base, is a relatively small anatomical structure that includes functionally meaningful neurovascular and endocrine formations. The complexity of this area, the depth of its location in the human skull, the availability of a single anatomical passage to it (transnasal-transsphenoidal) point at the value of studying its morphotopometric features and the adjacent structures of the internal cranial base through each period of childhood in order to develop the minimum invasive approaches to tumors and other pathologies occurring in this anatomical region [11]. The respective literature offers fairly sufficient anatomical data of the sphenoid bone in adults and only some works describe the variability of the sella turcica in childhood [8, 9, 18, 21]. Given the lack of knowledge regarding this issue in children, it appears relevant to study the anatomical age variability of the sphenoid bone structures within different childhood periods, which will serve the basis for planning and developing proper surgical access to the deep structures of the skull base in children [14].

Aim of study:

to identify the morphometric variability of the parameters pertaining to the sphenoid bone body structures in children of different ages, in order to improve access to the skull internal base as well as to the adjacent structures during endoscopic interventions.

MATERIALS AND METHODS

The object of study included 87 child skulls (age — 1 through 21, with no regard to gender; 65 skulls from the fundamental Museum of the Department of

Anatomy, the Saratov State Medical University, and 22 skulls from the Department of Normal Anatomy, Military Medical Academy (Saint Petersburg)), broken into 6 age periods. The entire material was divided into 6 age groups following the conventional age classification approved at the VII All-Union Congress of Anatomists, Histologists and Embryologists (1965): Period I — infancy (1–1.5 years old); Period II — early childhood (2–3 years old); Period III — first childhood (4–7 years old); Period IV — second childhood (8–12 years old); Period V — adolescence (13–16 years old); Period VI — youth (17–21 years old). Craniometry was performed subject to the method generally accepted in craniology: with a technical caliper and a metal ruler with a division step of 0.01 mm [1].

The anatomical material was used to study the following parameters of the middle cranial fossa: the sphenoidal yoke length (SYL) — the distance between the elevation front and rear points located in the sagittal plane; the width of its front edge (FEW) — the distance between the front side points of the elevation and width of its rear edge (REW) — the distance between the rear side points of the elevation in the frontal plane; the prechiasmatic sulcus length (PSL) — the distance between the front and rear edges in the sagittal plane and its width (PSW) — the distance between the medial points of the visual channels; the length of the saddle tubercle (STL) — the distance between the two most distant points of the tubercle in the sagittal plane, its width (STW) — the distance between the most distant points of the tubercle in the frontal plane and the height (STH) — the perpendicular from a line passing through the most prominent point of the tubercle to the bottom of the sella turcica; length of the sella turcica (LTS) — the distance from the front and rear of the remotest points of the saddle in the sagittal plane and its width (TSW) — the distance between the lateral points of the carotid groove in the frontal plane. The obtained data was processed employing the STATISTICA 7.0 application software package and the Excel MO table editor. The major variational and statistical features were identified: the arithmetic mean, the mean square deviation, the variation coefficient, the average sampling error, as well as the relative growth rate of the average values of indicators through the transition from one age group to another (%). Since the distribution in the sample did not differ from normal, parametric confidence criteria (Student's criterion) were used to assess the reliability of the differences between the data series. The differences were considered statistically significant at $p<0.05$.

RESULTS AND DISCUSSION

The length of the sphenoidal yoke at the age of 1–1.5 is 8.8±0.5 mm, keeping the values through the age of 2–7 within the range of 8.8–9.8 mm. At the age of 8–12, the length increases by 1.7 mm (10.6±0.4 mm; $p<0.05$), and at 13–16 — by 2.9 mm, compared to the age of 2–3; the relative increase over the indicated age periods was 19.1% and 32.6%, respectively. At the age of 17–21, the parameter values were stable. Over the period from 1–1.5 through 17–21, the length of the sphenoid platform went up 1.2 times.

The width of the sphenoid yoke along the front edge at the age of 1–1.5 is 10.8±0.6 mm and does not change through the age period of 2 to 7 years revealing fluctuations in the values from 10.2 to 10.7 mm. At the age of 8–12, the area expands by 2.0 mm (12.7±0.8 mm; $p<0.05$) with a relative increase of 18.7%, maintaining stable values with minor fluctuations in older ages (12.3–13.4 mm). Within the period of 1–1.5 to 17–21, the width of the elevation in the front increased 1.2 times.

The width of the sphenoid yoke along the posterior edge at the age of 1–1.5 is 14.2±0.7 mm, retaining the values through the age of 2 to 7 within the range of 14.0–14.8 mm. At the age of 8–12, the site expands by 2.1 mm (16.9 ± 0.5 mm; $p<0.05$), whereas the relative increase is 14.2%. At 13–16 and 17–21 years, the values remain stable and fluctuate from 15.6 mm to 17.9 mm. For the age period of 1–1.5 through 17–21, the width of the yoke at the posterior part increased 1.1 times.

The length of the prechiasmatic sulcus at the age of 1–1.5 is 3.0 ± 0.2 mm. At the age of 4–7, there is an increase of 0.7 mm (3.7±0.2 mm; $p <0.05$) and then, at 13–16 – an increase by 0.6 mm (4.3±0.1 mm; $p<0.05$), while the relative increase over these age periods is 19.4% and 16.2%, respectively. After the age of 16, the values remain stable. For the age period of 1–1.5 through 17–21, the width of the visual intersection increased 1.5 times.

The width of the sulcus at the age of 1–1.5 years is 16.5±0.8 mm, and it features no change through the period of 2 to 7, the values remaining at 16.8 mm. At the age of 8–12, the length increases significantly by 1.7 mm (18.5 ± 0.4 mm; $p<0.05$), and at age of 13–16 — by another 2.0 mm (20.5 ± 0.5 mm; $p<0.05$) with a relative increase of 10.1 and 10.8% over the indicated age periods. After the age of 16, the values remain stable. Over the age period of 1–1.5 to 17–21, the length of the chiasma opticum increased by 1.2 times.

At the age of 1–1.5 the length of tuberculum sellae is 3.0 ± 0.2 mm; within the period of 2 to 7, it increases slowly with 3.3–3.4 mm fluctuations in the values. At the age of 8–12, it expands significantly — by 0.6 mm (4.0 ± 0.2 mm; p<0.05); the relative increase was 17.6%. At the age of 13–16, the parameter is stable. At 17–21, there is an increase in the average width by 0.5 mm with a relative increase of 12.5% (4.5 ± 0.3 mm; p>0.05), which, however, is not reliable. For the period from 1–1.5 to 17–21, the width of the sella turcica revealed a 1.5-times increase.

The width of the sella turcica at the age of 1–1.5 features values of 12.7±0.7 mm, and from 2 to 7 it retains the values of 12.8–13.1 mm. At the age of 8–12, the length shows a significant increase by 1.0 mm (14.1±0.3 mm; p<0.05) with a relative increase of 7.6%, and reaches stable values in the said age period. During the period from 1–1.5 to 17–21, the length of tuberculum sellae increased by 1.1 times.

The height of sella turcica at the age of 1–1.5 has a value of 5.4 ± 0.4 mm. At the age of 4–7, it goes up significantly by 1.0 mm (6.6±0.2 mm; p<0.05) with a relative increase of 17.9%, the values were stable within the following age groups (6.0–6.8 mm). Within the age period between 1–1.5 and 17–21, the height of sella turcica increased by 1.3 times.

The length of sella turcica at the age of 1–1.5 is 7.6 ± 0.4 mm. Within the age range of 2 to 12, the values vary slightly between 7.5–8.2 mm. At 13–16, the length increases by 0.8 mm (9.2±0.3 mm; p<0.05) compared to the period of 8–12 years and the relative increase is 15.0%. At the period of 17–21, the sella turcica continues to grow by 0.7 mm with a slight relative increase of 7.6% (9.9 ± 0.5 mm; p>0.05), yet this is not reliable. Within the period from 1–1.5 to 17–21, the length of sella turcica increased by 1.3 times.

The width of the sella turcica at the age of 1–1.5 years is 15.2±0.9 mm. With the age of 4–7 it increases by 1.3 mm (17.5±0.4 mm; p<0.05), and at 13–16 — by another 2.4 mm (19.9±0.4 mm; p<0.05), the relative increase over these age periods being 8.0% and 11.8%. After the age of 16, the values remain stable. For the period between 1–1.5 and 17–21, the width of the sella turcica increased by 1.3 times.

The study outcomes show that at the age of 1.5, the width of the sella turcica prevails over its length by 2 times. In further age groups, the linear dimensions gradually increase until the age of 16, maintaining a similar ratio. The literature also describes the predominance of the sagittal size of the sella turcica over its vertical size, starting from the newborn period up until the age of 16, while the mismatch in the size features does not allow making a comparative analysis [16]. According to V. S. Maykova-Stroganova and D. G. Rokhlin (1955) the length of the sella turcica in children aged 4–18 is 10–14 mm, whereas the transverse size is 9–18 mm [16]. Fluctuations in the average values of the sella turcica parameters that were to be observed on our material are less variable compared to the data mentioned in the respective literature, and range as follows: width — from 15.2 mm to 19.9 mm; length — from 7.6 mm to 9.9 mm, which can be explained by different measurement approaches.

CONCLUSION

In view of the above, most structures of the sphenoid bone body feature stable values up to the age of 7, namely, the linear parameters of the sphenoid yoke like the width of the prechiasmatic sulcus, the length and width of sella turcica. Growth of these anatomical formations occurs only at the age of 8–12, while the values remain stable in older age groups. At the same time, the height of the sella turcica changes within the age of 4–7, reaching the final value in the same age group, whereas the prechiasmatic sulcus length increases at the age period of 4–7 and 13–16, remaining stable in adolescence. The width of the sella turcica increases at the age period of 4–7 and 13–16, while its length does not feature much of age-related change, and retains the same values up until the age of 12, increasing only within the age period of 13–16. The sella turcica parameters reach stable values by adolescence.

The obtained data can be useful for practitioners who perform surgeries on the skull basis in children. The choice of the surgical access and the diameter of tools instruments will depend on the knowledge regarding age-related variability in the size features of anatomical formations in the area of sella turcica in children.

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