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DIAGNOSTICS OF THE FRONTAL SINUS DEVELOPMENT WITH ADJACENT STRUCTURES IN THE PRENATAL PERIOD OF HUMAN ONTOGENESIS

Abstract. *The article deals with the development of the frontal sinuses and adjacent structures in the prenatal period and childhood of human ontogenesis. By means of a comprehensive morphometry vertical, transverse, anterior-posterior sizes of the frontal sinuses and adjacent structures are detected; in the prenatal period the shape of the frontal sinuses is mostly slit-like (56%) and oval (44%), in childhood – pear-shaped (33%), oval (30%) and triangle (27%), that will promote better efficacy of diagnostics of congenital developmental defects.*

Key words: *frontal sinuses, fetus, childhood, ontogenesis, anatomy.*

Introduction. Diagnostics and treatment of the frontal sinuses are known to be one of the most complicated tasks as compared to diseases of other paranasal sinuses. It is stipulated by insufficient awareness of specialists with modern anatomical-physiological and instrumental methods of their examination and treatment [1]. Advanced methods of endoscopic intranasal surgery require a comprehensive spatial image concerning 3-D structure of the nasal cavity and paranasal sinuses [2, 3]. Numerous studies deal with anatomy of the frontal sinuses. However, the problem of topographic anatomy of the frontal-nasal junction and its surrounding structures remains one of the confusing and disputable issues concerning the structure of the paranasal sinuses [4]. A distinctive feature of the frontal sinuses is their absence at the moment of birth. They develop during the following eight years, and are completely formed only after puberty period. Considering the fact that the frontal sinuses are hollow structures covered with the mucous membrane, they can be afflicted with viral or bacterial infections. Harmful microbes penetrate together with the inhaled air [5]. In case of a low body resistance an inflammatory process may occur, therefore, it is important to follow the process of the frontal sinus development in the prenatal period and childhood.

Objective: to investigate development of the frontal sinuses with the adjacent structures in the

prenatal period and childhood of human ontogenesis.

Materials and methods. Dead fetuses, newborns and specimens of heads or separate complex of organs of different age human groups were fixed in formalin solution, and after external examination washed properly during 1-2 days under running water. Afterwards sagittal sections of the head and the complex of organs were performed so that the cut was passing close to the wall of the nasal septum. The place of the paranasal sinus opening was described on the anatomical specimens obtained. After that the frontal sinuses were opened, and their anterior-posterior, transverse and vertical sizes were measured, peculiarities of their walls were described.

For further microscopic examination of the frontal sinuses the specimens were fixed in 5-7 % formalin solution during 2-3 weeks. Afterwards the specimens were washed under the running water for 1-2 days depending on their sizes. Then the specimens were decalcified by means of their putting into 7% nitric acid solution for 1-3 days. To prevent swelling of the connective tissue the specimens were put into 5% sodium sulfate solution for 24 hours. The specimens were dehydrated by means of their processing through the battery of alcohols with an increasing concentration (from 30° up to absolute ethyl alcohol). The specimens were saturated with

paraffin. Chloroform was used as an intermediate medium between the absolute ethyl alcohol and paraffin. The series of histological sections 10-15 mcm thick were prepared from the paraffin blocks. Before processing in the battery of ethyl alcohol certain specimens were totally stained with boric carmine, and after histological sections were made they were additionally stained with hematoxylin-eosin, Lion blue or by Van Gieson method on the microscope slide which enables to obtain more differentiated staining of different tissues. After fixation in Canada balsam they were examined under the light microscope. The structures were measured with an ocular-micrometer and micrometric ruler.

Results and discussion. The rudiments of sinuses border on the cartilaginous capsule of the nasal cavity lateral walls. The shape of sinuses becomes close to oval. Their anterior-posterior size is $(0,3 \pm 0,02)$ mm, transverse size – $(0,05 \pm 0,02)$ mm and vertical – $(0,06 \pm 0,02)$ mm. At the end of the 5th month of development the anterior-posterior size of the sinuses increases to 1,1-1,3 mm, transverse – to 0,15-0,18 mm, vertical – 0,13-0,22 mm. Their shape is oval. The ossification islets of a semi-oval shape are seen near superior lateral borders of a pear-shaped opening on X-ray images. Therefore, the rudiment of the frontal sinuses is found on the 5th month of development. It is presented by a small oval-shaped cavity. Although radiographic clear anatomical signs of the sinus borders are absent.

The rudiments of the frontal sinuses occur at the 5th month of the intrauterine development (fetuses 188,0-228,0 mm of PCL (parietal-coccygeal length) by means of the mucous membrane evagination of the middle nasal passage into the adjacent tissue. The rudiments of the frontal sinuses of 5th-month fetuses on the frontal sections are of an elongated oval shape. The inferior wall of the sinus is 1,0 mm higher from that of the supraorbital border. At this stage the gland of the mucous membrane of the sinuses begin to form by means of epithelium ingrowth into the adjacent mesenchyme. The mucous membrane becomes $0,2 \pm 0,01$ mm thick. The anterior X-ray projection presents additional ossification islets in the area of the lower portions of the medial wall of the eye sockets. They are located laterally and higher from the borders of the pear-shaped opening. On the border between the superior-lateral portion of the pear-shaped

opening and medial wall of the eye socket there is a lucid interval found that should be considered the place of origin for the frontal sinus formation.

In 5-month fetuses the anterior-posterior size of the right frontal sinus is 2,0-2,2 mm, transverse – 0,18-0,21 mm, vertical – 0,25-0,3 mm; and the left one: 1,8-2,0; 0,16-0,19; 0,23-0,25 mm respectively.

In 7-8-month fetuses the anterior-posterior size of the right frontal sinus is 5,4-5,9 mm, transverse – 0,8-1,0 mm, vertical – 2,0-2,5 mm, and the left one: 5,2-5,7; 0,7-0,9; 1,9-2,4 mm respectively. On the frontal sections the frontal sinuses are of the following shapes: in the right in 52 % cases an oval shape is found, in 32 % – spherical and in 16 % – spherical-oval. In the left a spherical shape of the sinus was found in 56 % cases, oval – in 34 %, spherical-oval – in 10 %. Radiological images in 7-8-month fetuses detect the areas of the frontal sinus localization in the anterior projection more distinctly than in fetuses of the previous age group.

On the basis of examination of 9-10-month fetuses from 311,0 to 375,0 mm of PCL it was found that the frontal sinuses are located higher from that of the supraorbital border. The sinuses are located at the distance of 2,0 mm from the upper and middle nasal passages. The anterior-posterior size of the right frontal sinus is 6,5-7,0 mm, transverse – 1,4-1,6 mm, vertical – 2,8-3,0 mm, and the left sinus: 6,4-6,9; 1,3-1,5; 2,6-2,8 mm respectively. On the frontal sections the sinus is of the following shapes: in the right in 54 % cases it is oval, in 35 % – spherical and in 11 % – spherical-oval. In the left a spherical shape of the frontal sinus is found in 57 % cases, oval – in 36 %, spherical-oval – in 7 %. Radiograms of heads of 9-10-month fetuses in the frontal projection present enlargement of ossification islets of the sinus walls as compared to 7-8-month fetuses. The sinus is connected with the nasal cavity in the place of the semilunar opening between the hamulus and ethmoidal bulla.

Variability of shapes of the frontal sinuses in newborns is found. The right sinus: oval (52 %), spherical (32 %), spherical-oval (16 %); the left sinus: oval (34 %), spherical (56 %), spherical-oval (10 %). It is of a slit-like shape on X-ray images.

In the period of early childhood (1-3 years) the frontal sinuses on all the specimens are detected higher from that of the supraorbital border. Its vertical size is 7,5-8,0 mm, transverse – 5,7-6,0

mm, anterior-posterior – 13,9-14,5 mm. The walls of sinuses are covered with the mucous membrane.

Frontal sinuses are characterized by age variability of radiological forms: in the prenatal period the shape of sinuses is more frequently slit-like (56%) and oval (44%), in childhood – pear-shaped (33%), oval (30%) and triangle (27%). Development of the frontal sinuses in childhood is accompanied by enlargement of the cavity volume. Formation and topographic-anatomical correlation of the nasal walls together with the adjacent structures during infancy (10 days – one year) demonstrated that the hamulus length was (8,0±0,13) mm, width – (2,0±0,1) mm. They are located obliquely in the anterior-posterior direction. Evagination of the frontal bundle on the examined specimens increased and was (2,6±0,05) mm.

An intensive development of the frontal sinuses occurs in the period of the second childhood (8-12 years) and teen age (13-16 years).

Conclusion. The vertical, transverse, anterior-posterior sizes of the frontal sinuses and adjacent structures are detected by means of a comprehensive morphometry; in the prenatal period the shape of the frontal sinuses is more often slit-like (56%) and oval (44%), in childhood – pear-shaped (33%), oval (30%) and triangle (27%), promoting better efficacy of diagnostics of congenital developmental defects.

Prospects of further studies. Further investigation of blood supply and innervation of the mucous membrane of the frontal sinuses in other age periods is being planned.

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CONTENT:

Yasnikovska S.M. Peculiarities of pregnancy progress in women with corrected isthmic-cervical incompetence	3
Shkolnikov V.S., Zalevskiy L.L., Zalevska I.V. Structural organization of the cerebellum of 17-18 week human fetuses during intrauterine development	5
Khmara T.V., Okrim I.I., Biriuk I.G., Komar T.V., Khmara A.B. The specialization degree of wood-destroying basidial fungi on trees in samur-davachi lowland forests of azerbaijan	10
Tkachenko P.V. Clinical-morphological prognostic characteristics of prostate cancer	14
Sasina O.S. Psychohygienic aspects of training of disabled adolescents with pathology of the vision (literature review)	19
Banul B.Yu. Development of paramesonephric ducts and their derivatives at the end of embryonic period of human ontogenesis	23
Niankovskiy S.L., Gorodylovska M.I. Heterogeneity of esophagitis in schoolchildren	26
Yevtushenko I.Y, Padalitsa M.A, Goryainova G.V. Age features of cervical arch and height of human renal calyces in mature and elderly ages	32
Vepruk Y., Rohovyy Y., Tovkach Y., Rykhlo I. Characteristic of aluminum salts influence on indexes of ion regulative renal function in mature and immature rats against the background of the pineal gland hyperfunction	35
Zakharchuk O.I., Kryvchanska M.I. Chronoregulating and rhythm-stabilizing role of melatonin in seasonal structure of circadian rhythms of non-specific immunity indices with aging	38
Kachko G.O., Omelchenko E.M., Pedan L.R., Polka O.O. Characteristics of congenital pathology with inherited and multifactorial nature in children of Kyiv region	41
Kosilova S.Y. Metabolic disorders in women depending on menopause duration	44
Kotelban A.V., Godovanets O.I., Burdeniuk I.P. Peculiarities of administration of antiseptic drugs in children suffering from chronic catarrhal gingivitis under conditions of diabetes mellitus	47
Reshetilova N.B., Navarchuk N.M., Popeliuk O.-M.V., Glubochenko O.V., Kulish N.M. Topographic peculiarities of the anterior cerebral vesicle on the 4th week of the embryonic period	51
Fik V.B., Paltov Y.V., Lohash M.V., Kryvko Y.Y. Peculiarities of morphological manifestation of the periodontal tissue in experimental animals against the ground of a short-term effect of opioid analgesic	54
Khomenko V.G. Renal tissue fibrinolysis against the ground of stress and xenobiotics	59
Dudenko V.G., Vdovychenko V.Yu., Kurinnoy V.V. Spatial topography of the diaphragm in the sagittal plane in women	61
Avdieyev Oleksandr, Dziubak Sergii Epidemiological analysis of dental diseases among individuals exposed to unfavourable psychoemotional surroundings	65
Andriets M. M., Andriets V.I. Psychological aspects of physical culture and sport	68
Malanchuk L.M., Kryvytska G.O. Renal tissue fibrinolysis against the ground of stress and xenobiotics	71
Bambuliak A.V., Galagdina A.A., Boychuk O.M. Diagnostics of the frontal sinus development with adjacent structures in the prenatal period of human ontogenesis	73
Kryvetskiy V.V., Narsiya V.I., Kryvetskiy I.V. Blood supply of the cervical region of the vertebral column during the fetal period and in newborns	76
Pavlovych L.B., Bilous I.I. The indicators of stimulation electroneuromyography in patients with diabetic polyneuropathy	80



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