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ANATOMY AND TOPOGRAPHY OF FURROWS AND BENDS, CYTOARCHITECTONICS OF THE AUDITORY CORTEX OF THE TEMPORAL LOBE OF THE HUMAN BRAIN IN POSTNATAL ONTOGENESIS

Resume: The ability to transmit, receive and process sound signals takes a special place in the development of the individual and the human collective. The ability to recognize and work with a complex sign system made a person not just a highly developed organism, but an entirely broadly functional personality. Initially exchanging simple sounds, society eventually learned to convey complexly constructed verbal sentences.

The temporal lobe is part of the telencephalon and is included in the structure of the cortex. It is located on both hemispheres of the brain on the sides from below, in close contact with neighboring areas - the frontal and parietal lobes. This section of the cortex has the most pronounced boundary lines. The upper part of the temple is slightly convex, and the lower part is concave.

The temporal lobe is separated from all the others by a groove called the lateral (lateral). The close location of the temporal and frontal lobes is not accidental: speech develops in parallel with thinking (frontal cortex), and these two functions are closely interconnected, since the ability to formulate and clearly express (speech) is provided by the degree of development of mental functions.

Key words: brain, temporal region, furrow, ontogenesis, postnatal period, temporal region functions.

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АНАТОМИЯ И ТОПОГРАФИЯ БОРОЗД И ИЗВИЛИН, ЦИТОАРХИТЕКТОНИКА СЛУХОВОЙ КОРЫ ВИСОЧНОЙ ДОЛИ ГОЛОВНОГО МОЗГА ЧЕЛОВЕКА В ПОСТНАТАЛЬНОМ ОНТОГЕНЕЗЕ

Резюме: Особое место в развитии индивида и человеческого коллектива занимает умение передавать, получать и обрабатывать звуковые сигналы. Способность распознавать и работать со сложной знаковой системой сделала человека не просто высокоразвитым организмом, а всецело широко функциональной личностью. Изначально обмениваясь простыми звуками, общество со временем научилось передавать сложно сконструированные словесные предложения.

Височная доля является частью конечного мозга и включается в структуру коры. Она располагается на обоих полушариях мозга по бокам снизу, тесно контактируя с соседними участками – лобной и теменной долей. Этот участок коры имеет самые выраженные граничные линии. Верхняя часть виска немного выпукла, а нижняя – вогнутая.

Височная доля отделяется от всех остальных бороздой, называющейся латеральной (боковой). Тесное расположение височной и лобной доли не случайно: речь развивается параллельно мышлению (лобная кора), и эти две функции плотно взаимосвязаны, так как умение формулировать и ясно излагаться (речь) обеспечивается степенью развития мыслительных функций.

Ключевые слова: головной мозг, височная область, борозда, онтогенез, постнатальном периоде, функции височной области.

Introductions. Emotional background, auditory perception, communication are defining moments in a person's behavior and life. The temporal lobe of the brain is largely responsible for the mood in which he is, feels happy or, on the contrary, is in a state of depression. It is she who processes sensory sound, auditory, visual information, then synchronizes it, gives emotional color.

The temporal lobe (lobus temporalis) occupies the lower lateral parts of the hemisphere and is separated from the frontal and parietal lobes by a deep lateral groove [4,7]. The edge of the temporal lobe that covers the insular lobe is called the temporal operculum (operculum temporale). The anterior part of the temporal lobe forms the temporal pole (polus temporalis). On the lateral surface of the temporal lobe, two grooves are visible - the upper and lower temporal (sulci temporales superior et inferior), almost parallel to the lateral groove.

The sinuses of the temporal lobe are oriented along the furrows. The superior temporal gyrus (gyrus temporalis superior) is located between the lateral groove above and the upper temporal below. On the upper surface of this gyrus, hidden deep in the lateral groove, there are two or three short transverse temporal gyri (gyri temporales transversi, Geschl's gyrus), separated by transverse temporal grooves (sulci temporales transversi) [1,3].

Between the superior and inferior temporal grooves is the middle temporal gyrus (gyrus temporalis medius). The lower lateral edge of the temporal lobe is occupied by the lower temporal gyrus (gyrus temporalis inferior), bounded from above by the groove of the same name. The posterior end of this gyrus continues into the occipital lobe [2,5].

The temporal lobe is separated from the frontal and parietal lobes by a lateral groove. On the outer surface of this lobe, the superior, middle and inferior temporal gyri are distinguished, separated from each other by the corresponding grooves. On the lower baeal surface of the temporal lobe, there is the lateral occipitotemporal gyrus, bordering the inferior temporal gyrus, and more medially, the hippocampal gyrus.

An insular lobe (Reil's islet) is located deep in the lateral groove. It is covered by areas of the frontal, parietal and temporal lobes, which make up the operculum frontale. The central groove of the islet divides it into two parts - anterior and posterior [1,4].

In the temporal lobes there are cortical sections (projection zones) of the auditory (superior temporal gyrus and transverse temporal gyrus), which are located under the lateral groove in the depths of the temporal lobe, statokinesthetic (on the border of the temporal, occipital and parietal lobes), gustatory (bark around the insular lobe) , olfactory (parahippocampal gyrus) analyzers [6]. Part of the conductors of the visual pathway passes deep in the temporal lobe. The efferent pathways from the temporal lobes go to the submucosal region, as well as to the brain bridge - the temporo-cerebellar pathway.

Purpose of the study. Study of age anatomy, topography and morphometry of the grooves and convolutions of the temporal lobe of the human brain, as well as the cyto-architectonics of the auditory cortex, in part, the volume of neurons, the sizes of pyramidal neurons in the left and right hemispheres from birth to 90 years.

Material and research methods. The material of the study was the frontal sections of the left and right upper temporal subregions of the brain of fifteen human fetuses of both sexes aged 16 to 40 weeks of gestation, 25 hemispheres in total.

Research results. These results are supported by recent literature data, according to which, as shown in model experiments on animals, the maturation of inhibitory interneurons in layer IV depends on the cells of the subplate. Failure to eliminate them alters the normal formation of inhibitory processes, influencing the modular organization of the cortex. Within the upper temporal subregion, using the developed criterion, it was also possible to establish a later maturation of field 37.

The development of cytoarchigectonic fields of the superior temporal subregion at 37-40 weeks of gestation was assessed using the following indicators: the percentage of neurons positive for two calcium-binding proteins (calbindin and par-valbumin) and the vertical ordering of cortical neurons, determined by the Org coefficient. On this segment of development within the boundaries of the upper temporal subregion, it is possible to differentiate: field 41 - primary auditory, field 22 - secondary auditory, field 37 - tertiary associative, which is part of Wernicke's zone.

Immunocytochemical research methods, widely used by neuromorphologists in recent years, can demonstrate new parameters of the structural and functional organization of the cortex. In particular, it was shown that the so-called "nuclear", phylo- and ontogeny more mature, thalamocortical relations are formed by neurons that are immunopositive to parvalbumin, and "supporting", less mature,

calbindin-positive cells. We found that the studied fields are heteromorphic in the distribution of neurons immunopositive to these two calcium-binding proteins. Calbindin-positive neurons are most abundantly represented in field 22, cells; expressing parvalbumin - in field 41; in field 37, both types of neurons were identified

The features of ontogenetic transformations of the neocortex, as the main formation that ensures the implementation of integrative processes in the central nervous system, are described by clear quantitative and qualitative criteria.

The period from the 20th to the 26th week is characterized by a gradual increase in the thickness of the cortex from 1300 to 1500 μm and stratification of the cortical plate. Its stratification at this time differs from the mature cortex and is characterized by the alternation of very dense and more rarefied layers. Pulmonary dense and, therefore, having a high optical density are: the outer border of the cortical plate - layer ell, layer elV and the upper zone of the subplate - spu.

The layers are comparatively rare-celled and with low optical density; these are the elll layer and the undifferentiated eV + eVI layer complex. At this age, the ell and elll layers consist mainly of neuroblasts, which differ from mature neurons in the fusiform body and long processes that extend from the apical and basal poles of the cell. The elV layer consists of large, densely packed pyramidal neurons, which at this time are the most differentiated cortical cells. The eV + eVI layer complex contains polymorphic cells.

Thus, the study of the formation of the upper temporal subregion of the neocortex in the brain of human fetuses from the 16th to the 36th week of gestation made it possible to establish the following: as the body develops, the cortex thickens, and in the period from the 16th to the 26th week, mainly due to its lower layers, ie, the "efferent" complex, and from the 27th to the 36th week - due to the upper layers, ie, the "associative" complex. During the studied period, a transition from embryonic cortical stratification to a typical one, characteristic of a mature brain, and differentiation of the superior temporal subregion into primary (41), secondary (22) and tertiary (37) cytoarchitectonic fields are observed.

For an objective assessment of ontogenetic transformations of the cortex, a quantitative criterion for the differentiation of the subplate in its composition was developed, namely, positively correlated indicators of changes in the cell density of the layer ell - the outer border of the cortical plate and spu - the upper zone of the subplate. In addition to the possibility of identifying the subplate, this criterion helps to establish the cause and timing of the advanced differentiation of the "efferent" complex of the cortex and the more active formation of the "associative" complex that replaces it. The maturation of the "efferent" complex occurs in the presence of the subplate and, apparently, slightly depends on its state. On the other hand, the interdependence of the rates of maturation of neurons in layers II and IV, the main component of the “associative” complex of the cortex, and the processes of elimination of the subplate is obvious. These layers begin to differentiate at an accelerated rate only after the beginning of the elimination of neurons in the subplate and outpace the formation of the "efferent" complex starting from the 27th week of gestation.

Thus, the data obtained indicate the ongoing heterochronous development of fields 41, 22, 37 of the upper temporal subregion. The maturity of the primary projection field 41 can be judged by the maximum content of parvalbumin-positive neurons, which is indirect evidence in favor of the fact that by the end of the fetal period thalamo-cortical projections of this field are organized tonotopically and mediated by the principal part of the medial geniculate type. The predominance of calbindin-positive cells in the secondary auditory field confirms the characteristic feature of its connections with the thalamus, which are classified as "supportive". The presence of two types of neurons in the field 37 can be regarded as evidence of the immaturity of its main thalamo-cortical projections, which in the mature brain are of the "nuclear" type.

The heterochronous formation of the fields of the superior temporal subregion in the last weeks of gestation is evidenced by another indicator - the vertical ordering of the neuronal complexes of the cortex. According to the data obtained, the value of the Org coefficient for fields 41, 22, and 37 of human fetuses at the age of 38–40 weeks of gestation differs (Fig. 6). During this period, the maximum value of the Org coefficient characterizes field 22, which is another fact indicating the advanced development of this secondary auditory zone. At the same time, for field 37, the Org coefficient is minimal, although in the adult brain the highest values of this indicator are characteristic of fields (including field 37) of Wernicke's speech zone. Interhemispheric asymmetry is a well-known fact. The quantitative indicator of the asymmetry of the human cerebral cortex, obtained from a comparative assessment of the vertical ordering of neural complexes, reaches maximum values for the speech zones [1,6]. In our study, interhemispheric asymmetry, assessed by the same indicator, was revealed only for field 37, which indicates that, despite immaturity, associative fields acquire characteristic structural and functional features even before birth.

Conclusion. In the period from the 16th to the 26th week of gestation, the structural and functional organization of the temporal cortex is determined by the dominance of the “efferent” complex of the cortex and the presence of a subplate, whose neurons mediate thalamo-cortical influences.

In the period from the 27th to the 36th week of gestation, there is a gradual elimination of neurons in the subplate and an increasing differentiation of the "associative" complex, which by the end of the period dominates over the "efferent" one. At the same time, there is a selection of fields of different functional orientation - primary (field 41), secondary (field 22) and tertiary (field 37).

From the 37th week of gestation to the end of the fetal period, these fields of the cortex develop heterochronously: structural and functional signs of advanced development characterize the secondary field 22; field 41 during this period has not yet reached structural maturity, field 37 has morphological features of the embryonic cortex, although it is the only field of the temporal region that shows signs of interhemispheric asymmetry.

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