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Topography and dimensions of the auditory tube at the end of the fetal period

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Introduction. Otitis media in premature newborns and term newborns is a serious problem due to the immaturity of the organs and systems of these children and the difficulty of their adaptation. This often leads to the development of pathological changes in the hearing organ and the need for surgical intervention.

The aim — to find out the topographic and anatomical features of the auditory tube at the end of the fetal period to improve technologies and the adequacy of surgical treatment.

Material and methods. The study was performed on 35 human fetuses of 231.0–375.0 mm parietococcygeal length (PCL) and 11 neonatal cadavers. In the course of the study the following methods were used: thin dissection of the middle ear and adjacent areas under the control of a binocular loupe; macro- and microscopy; morphometry; macro photography with digital camera «OLIMPUS μ 1000 All-weather 10.0 MPix».

Results. It has been established that the size and shape of the auditory tube in premature babies do not have definitive dimensions and its location differs from that in term newborns. The pharyngeal openings of the auditory tubes are located at the level of the hard palate, and in term newborns — above the level of the hard palate. The tympanic openings from the lower part of the anterior wall of the tympanic cavity in fetuses of the seventh month of intrauterine growth completely move to its upper part and open into the supratympanic space in fetuses of the tenth month.

Conclusions. The defined features of the development of the auditory tube at the end of the fetal period are important for the improvement of technologies and the adequacy of surgical treatment and manipulations in premature babies and term newborns.

The research was carried out in accordance with the principles of the Declaration of Helsinki. The study protocol was approved by the Local Ethics Committee of the institution indicated in the work.

No conflict of interests was declared by the authors.

Keywords: anatomy, premature babies, auditory tube.

Топографія і розміри слухової труби наприкінці плодового періоду

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Вступ. Середній отит у недоношених новонароджених і в новонароджених у термін, є серйозною проблемою внаслідок незрілості органів і систем цих дітей та важкості їхньої адаптації. Це часто призводить до розвитку патологічних змін із боку органа слуху і необхідності хірургічного втручання.

Мета — з'ясувати топографо-анатомічні особливості слухової труби наприкінці плодового періоду для удосконалення технологій і адекватності хірургічного лікування.

Матеріал і методи. Дослідження виконано на 35 плодах людини 231,0–375,0 мм тім'яно-куприкової довжини та 11 трупах новонароджених. Під час дослідження використано методи тонкого препарування середнього вуха та прилеглих ділянок під контролем бінокулярної лупи; макро- та мікроскопії; морфометрії; макрофотографії цифровим фотоапаратом «OLIMPUS μ 1000 All- weather 10,0 MPix».

Результати. Встановлено, що розміри та форма слухової труби в передчасно народжених дітей не мають дефінітивних розмірів і її розташування відрізняється від такого, як у новонароджених у термін. Глоткові отвори слухових труб знаходяться на рівні твердого піднебіння, а в новонароджених у термін — вище рівня твердого піднебіння. Барабанні отвори з нижньої частини передньої стінки барабанної порожнини у плодів плодів сьомого місяця внутрішньоутробного розвитку повністю переміщуються у її верхню частину і відкриваються в надбарабанний простір у плодів десятого місяця.

Висновки. Визначені особливості розвитку слухової труби наприкінці плодового періоду мають важливе значення під час удосконалення технологій і адекватності хірургічного лікування та маніпуляцій у передчасно народжених дітей та в новонароджених у термін.

Дослідження виконано відповідно до принципів Гельсінської декларації. Протокол дослідження ухвалено Локальним етичним комітетом зазначеної в роботі установи.

Автори заявляють про відсутність конфлікту інтересів.

Ключові слова: анатомія, передчасно народжені діти, слухова труба.

Introduction

Full visualization of the structures of the tympanic cavity while using modern microsurgical technologies significantly increases the quality of operations and reduces the risk of possible complications [7,12]. Operations on these structures require knowledge of the anatomical and topographic features of the structure of the temporal bone, including in childhood [4,8–10,15], but only in rare works you can find data of the age-related features

of the anatomical structure of the tympanic cavity structures [3], which are of great importance during surgical manipulations on the middle ear at an early age.

One of the most common diagnoses among children in primary health care institutions is acute otitis media, and the most common risk factor for its occurrence is prematurity [1,6]. Hospitalization due to this disease occurs more often in premature babies (2.4–3.6%) and gradually reduces of full-term children (1.9%), that indicates a decrease of the number of patients with the increase of gestational age [5]. The frequency of otitis media of premature newborns is 72.9% [2].

The immaturity of the organs and systems of these children, the difficulty of their adaptation often lead to the development of pathological changes in the hearing organ, which may necessitate the surgical intervention [11,13,14].

That is why the study of embryological aspects of the development of the middle ear, its anatomy and topographic anatomy in fetuses remains relevant.

The aim of the research — to find out the topographic and anatomical features of the auditory tube at the end of the fetal period to improve technologies and adequacy of surgical treatment.

Material and methods of the research

The study was performed on 35 human fetuses of 231.0–375.0 mm parietococcygeal length (PCL) i.e. 7–10 months of intrauterine growth and 11 neonatal cadavers from the museum's collection of the Department of Human Anatomy of Bukovyna State Medical University. In the course of the study the following methods were used: thin dissection of the middle ear and adjacent areas under the control of a binocular loupe; macro- and microscopy; morphometry; macro photography with digital camera «OLIMPUS μ 1000 All-weather 10.0 MPix». During the macro-microscopic dissection, we paid attention to the shape and size of the auditory tubes, the shape and size of their tympanic and pharyngeal openings, the placement of the auditory tubes relative to the tympanic cavity and the hard palate. Statistical processing of the results was carried out using electronic spreadsheets of the program «Microsoft Excel» and the package of application programs «Statistica for Windows» v.6.0, Stat SoftInc. (USA), SPSS 13.0. The probability of differences in comparative indicators was determined using the Student's exact test (t) and nominal data using the Fisher's exact test, the differences were considered statistically significant at $p<0.05$.

The research was carried out in accordance with the principles of the Declaration of Helsinki. The study protocol was approved by the Local Ethics Committee of the institution indicated in the work.

Results of the research and discussion

In fetuses of the seventh month of intrauterine life, i.e. 231.0–270.0 mm PCL, we see that the auditory tube is straight, wide, and has a cylindrical shape. It does not have a bony section and an isthmus. The shape of the tympanic openings of the auditory tubes was irregular in eight cases, triangular in three cases, and rectangular in eleven cases. The pharyngeal openings of the auditory tubes are located at the level of the hard palate (Fig. 1). The tympanic openings of the auditory tubes are located in the lower part of the tympanic cavity (Fig. 2).

The length of the auditory tube is 11.52±0.37 mm, the diameter is 1.08±0.03 mm. The vertical size of the tympanic openings of the auditory tubes is 2.94±0.12 mm, horizontal — 2.12±0.06 mm. The anteroposterior size of the pharyngeal openings of the auditory tubes is 1.64 ± 0.08 mm, and the vertical — 2.12±0.09 mm.

During the macroscopic examination of fetuses of the eighth month, that is, 271.0–310.0 mm PCL,

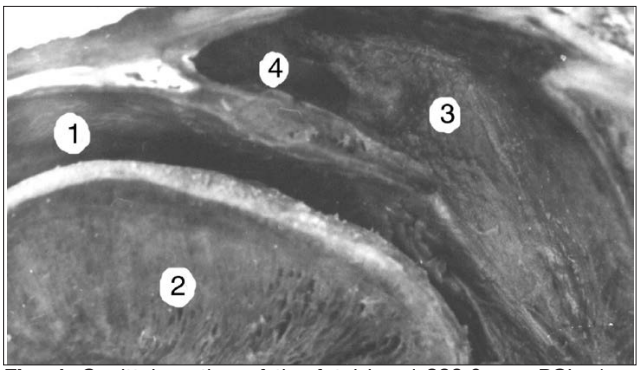

Fig. 1. Sagittal section of the fetal head 238.0 mm PCL: 1 — oral cavity, 2 — tongue, 3 — nasopharynx, 4 — pharyngeal opening of the auditory tube, 5 — hard palate. Magnification 1:3.2

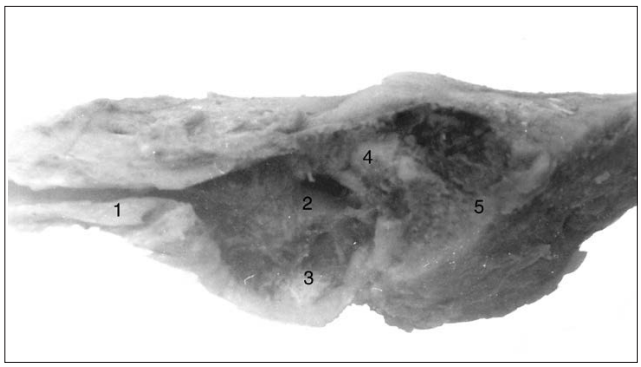

Fig. 2. Sagittal section of the temporal bone of the fetus 240.0 mm PCL: 1 — auditory tube, 2 — oval window, 3 — round window, 4 — channel of the facial nerve, 5 — antrum. Magnification 1:3.2

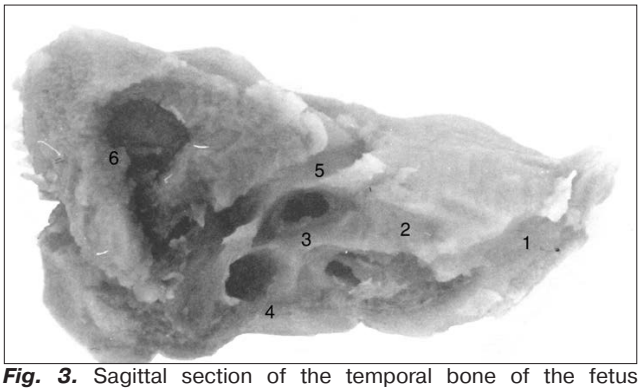

Fig. 3. Sagittal section of the temporal bone of the fetus 280.0 mm PCL: 1 — internal carotid artery canal, 2 — auditory tube, 3 — oval window, 4 — round window, 5 — facial nerve canal, 6 — antrum. Magnification 1:3.2

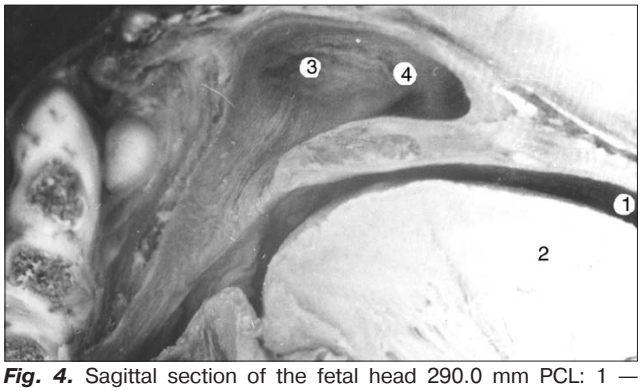

Fig. 4. Sagittal section of the fetal head 290.0 mm PCL: 1 — oral cavity, 2 — tongue, 3 - nasopharynx, 4 — pharyngeal opening of the auditory tube, 5 — hard palate. Magnification 1:3.2

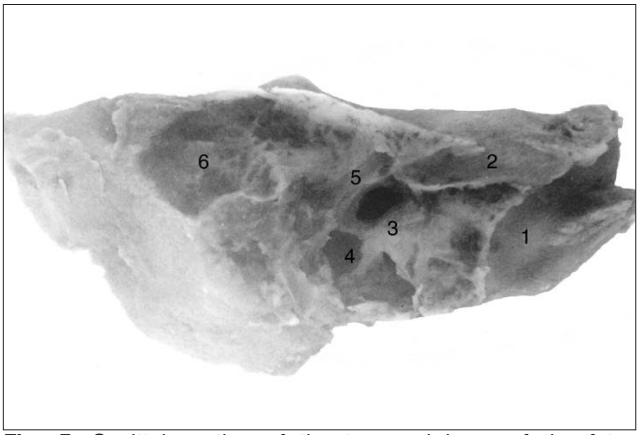

Fig. 5. Sagittal section of the temporal bone of the fetus 340.0 mm PCL: 1 — internal carotid artery canal, 2 — auditory tube, 3 — oval window, 4 — round window, 5 — facial nerve canal, 6 — antrum. Magnification 1:3.2

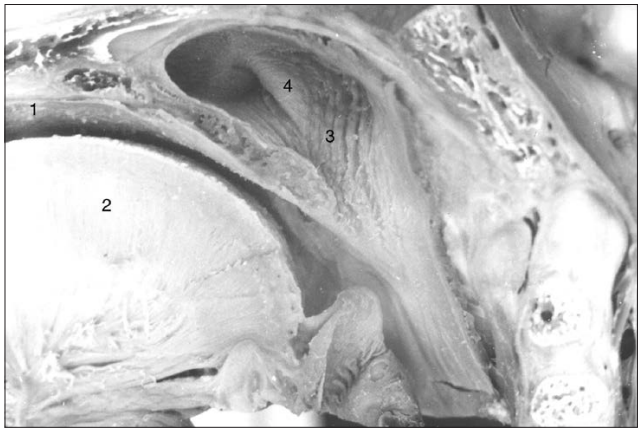

Fig. 6. Sagittal section of the fetal head 310.0 mm PCL: 1 — oral cavity, 2 — tongue, 3 — nasopharynx, 4 — pharyngeal opening of the auditory tube, 5 — hard palate. Magnification 1:3.2

it was defined that the auditory tube is straight, wide, and has a cylindrical shape. It has no bony part and isthmus (Fig. 3).

The shape of the tympanic openings of the auditory tubes was irregular in eleven cases, triangular in two cases, and rectangular in three cases. The pharyngeal openings of the auditory tubes are located at the level of the hard palate (Fig. 4). The tympanic openings begin to shift upwards due to the growth of the anterior wall of the tympanic cavity below its junction with the auditory tube.

The length of the auditory tube is 14.52±0.31 mm, its diameter is 1.32±0.04 mm. The tympanic openings of the auditory tube have the such dimensions: horizontal — 2.55±0.09 mm, vertical — 3.25±0.15 mm. The anteroposterior size of the pharyngeal openings is: 2.04±0.07 mm, the vertical size is 2.75±0.12 mm.

During the ninth month of intrauterine growth that is in fetuses 311.0–345.0 mm PCL the auditory tube is straight, wide, and has a cylindrical shape. It has no bony part and isthmus (Fig. 5).

The pharyngeal openings are located at the level of the hard palate (Fig. 6). The anteroposterior size of the pharyngeal openings increases significantly. The tympanic openings are shifted more to the top. They had an irregular shape in nine cases, and a rectangular shape in five cases.

The length of the auditory tube is 16.88±0.32 mm, its diameter is 1.77±0.02 mm. The tympanic openings of the auditory tube have such dimensions: horizontal — 3.48±0.11 mm, vertical — 4.52±0.16 mm. The anteroposterior size of the pharyngeal openings is: 2.25±0.09 mm, the vertical size is 2.94±0.08 mm.

Within the tenth month of intrauterine growth, that is, in fetuses 346.0–375.0 mm PCL, the auditory tube is straight, wide, and has a cylindrical shape. It has no bony part and isthmus (Fig. 7).

The anteroposterior size of the pharyngeal openings increases significantly, they are located at the level of the hard palate. The tympanic openings of the auditory tubes move to the upper part of the anterior wall of the tympanic cavity and open into the supratympanic space. They had an irregular shape in ten cases, and in six cases we observed their rectangular shape.

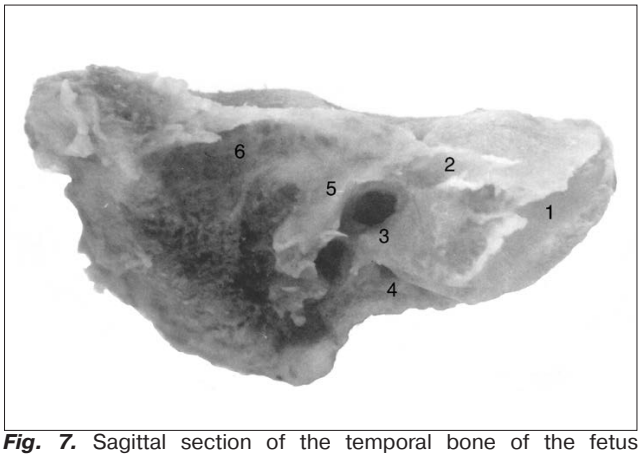

Fig. 7. Sagittal section of the temporal bone of the fetus 355.0 mm PCL: 1 — internal carotid artery canal, 2 — auditory tube, 3 — oval window, 4 — round window, 5 — facial nerve canal, 6 — antrum. Magnification 1:3.2

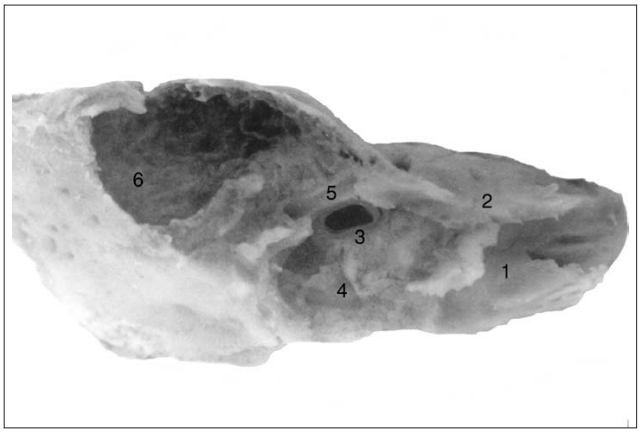

Fig. 8. Sagittal section of the temporal bone of a newborn: 1 — internal carotid artery canal, 2 — auditory tube, 3 — oval window, 4 — round window, 5 — facial nerve canal, 6 — antrum. Magnification 1:3.2

The auditory tube reaches the length of 19.67±0.39 mm, its diameter is 1.93±0.03 mm. The pharyngeal openings of the auditory tube have a height of 3.04±0.11 mm, their width is 2.37±0.05 mm. The drum openings of the auditory tube have the height of 4.74±0.12 mm, a width of 3.74±0.10 mm.

The auditory tube of newborns is cylindrical, straight, short and wide. It has no bony part and an isthmus (Fig. 8).

The length of the auditory tube is 21.94±0.82 mm, its diameter is 2.04±0.07 mm. The anteroposterior size of the pharyngeal openings is 2.54±0.11 mm, vertical — 3.12±0.05 mm. They are located above the hard palate at a height of 2.30±0.07 mm and have a cartilaginous ring, which leads to their constant gaping (Fig. 9). The tympanic openings of the auditory tubes are located in the upper part of the anterior wall of the tympanic cavity and open into the supratympanic space. They had an irregular shape in ten cases, a rectangular shape in nine cases, and a triangular shape in three cases. The tympanic openings of the ear tubes have such dimensions: horizontal — 4.12±0.17 mm, vertical — 4.97±0.15 mm.

It has been established that the size and shape of the auditory tube in premature babies do not have definitive dimensions and its location differs from that in term newborns. The pharyngeal openings of the auditory tubes are at the level of the hard palate, and in term newborns — above the level of the hard palate. The tympanic openings from the lower part of the anterior wall of the tympanic cavity in fetuses of the seventh month of intrauterine growth are completely moved to its

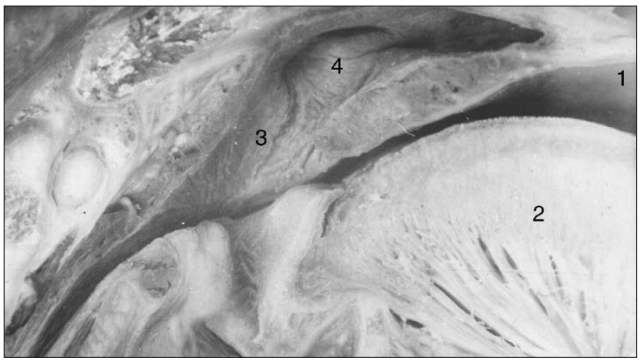

Fig. 9. Sagittal section of the head of a newborn: 1 — oral cavity, 2 — tongue, 3 — nasopharynx, 4 — pharyngeal opening of the auditory tube, 5 — hard palate. Magnification 1:3.2

upper part and open into the supratympanic space in fetuses of the tenth month.

Conclusion

According to the results of this study, the peculiarities of the development of the auditory tube at the end of the fetal period are determined. It is important for the improvement of technologies and the adequacy of surgical treatment and manipulations in premature babies and term newborns.

Prospects for further research. The results of the study of the topographic and anatomical features of the structure of the auditory tube at the end of the fetal period can be the basis for improving of the technology and adequacy of surgical treatment and manipulations of premature children and term newborns.

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No conflict of interests was declared by the authors.

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