

Kuzniak Nataliya Bogdanivna,
Bukovyna State Medical University, Ukraine,
Professor, Chair of the Children's Dental Surgery Department

The anlage and development of the nasal section in the embryonic period of the human ontogenesis

Abstract: While investigating we carried out the sequential microscopic sections of 32 human embryos by fixing them in the 10-12% solution of the neutral formalin. The preparations had been dehydrated by keeping them in the bank of alcohol and the consequent filling up with the paraffin. With the help of the sliding microtome we carried out the sequential microscopic sections colored by hematoxylin and eosin or boron carmine during 1–3 days and investigated with the help of the ordinary microscope or binocular lens MBS–10. For investigation of the forms, positions and relief of the nasal septum structures we used classical means of the graphical and plastic reengineering. Morphometry was carried out with the help of the microruler. It was determined that at the beginning of the embryonic period nasal placodes develop, and in the middle of the embryonic period nasal fossae develop on their free surface. Nasal fossae are bounded by the horseshoe-shaped protuberances, which are shaped in the form of the rollers – the primary stage of the middle and side nasal processes formation. Later on, there is an intensive growth of the nasal fossae and adjacent structures, as a result of which they develop into the nasal chambers. At the end of the embryonic period there happens a break of the nasal chambers into the primary mouth cavity with the development of the primary choanae. The internasal septum develops with the help of the middle nasal processes coalescence. The primary nasal cavity from the primary mouth cavity is separated by the primary palate.

Keywords: nasal section, embryo, anatomy, ontogenesis, human.

Introduction. At present time there are no doubts in the necessity of the development of the medical aspects of the modern embryology, which makes it impossible to solve such important problems of the practical health care like the problems of sterility [1,2], cure of the inherited and inborn diseases, organ and tissues transplantation, etc. [3,4,5]. Due to the data of the World Health Organization annually out of 140 million

of the all newborn children in the world a big percent is born with the serious abnormalities. Without a well-grounded investigation of the different factors determining the normal and pathological processes of the embryonic development [6], the antenatal children health care cannot be possible [7]. The problem connected with the revelation of the critical periods in the structural transformations of the systems and organs is not developed and needs further investigation [8]. Numeral abnormalities which take place in the medical practice in most cases can be explained after investigation of their unusual topography and deep realization of the appropriate embryonic phenomena, in other words on the basis of investigation of the origin and interaction of the organs and structures, which with time gain the peculiar forms.

The human nasal cavity development has been investigated a lot [9], though practically not any investigation gives specific terms of the anlage and further differentiation of the embryos, which take part in its formation.

Thus, in the native and foreign literature the data of the normal anatomical development of the nasal cavity and namely its sides' development are not sufficient. Many researches are rather narrow, which doesn't allow talking of the available morphologico-theoretical framework in this area.

Tools and methods. For the investigation we carried out the sequential microscopic sections of 32 human embryos by fixing them in the 10-12% solution of the neutral formalin in the 15 days - period. After fixing the biological objects were irrigated in the running water, then they were dipped into the 35% alcohol solution for 24 days. Then they were coloured by hematoxylin and eosin or boron carmine during 1–3 days. The preparations were dehydrated by keeping them in the bank of alcohol and the consequent filling up with the paraffin. With the help of the sliding microtome we carried out the sequential microscopic sections colored by hematoxylin and eosin or boron carmine during 1–3 days and investigated with the help of the ordinary microscope or binocular lens MBS – 10. For investigation of the forms, positions and relief of the nasal septum structures we used classical means of the graphical and plastic reengineering. Morphometry was carried out with the help of the microruler.

Discussion of the investigation results. On the basis of the investigation of the series of the preparations of the 4th week of the embryonic development of the Vertex-coccyx length (VCL) 4,0 – 5,0 mm, the oral fossa was revealed, bounded by the frontal protuberance on top, below – by the cordiac protuberance, and from the sides by the mandibular processes, its back bound is formed by a maxillomandibular.

The nasal cavity as such doesn't still exist. Though at the bottom and from the sides of the frontal protuberance closely fitting cells of the ectoderm form two thickened plates, presented by the 4-5 row cylindrical epithelium. On the periphery the epithelium cells slightly stand out the ectoderm level developing the horseshoe-shaped protuberance, open to the oral fossa.

In the area of the middle part of the mentioned thickening of the epithelium in the embryos of the VCL 6,0 there develops a slight deepening of the epithelium in the liable mesenchyme - it's the primary stage of the anlage of the nasal placodes. They are placed in the craniocaudal direction, and their size is no more than 120 mcm, width - 66 mcm. Depth of the nasal placodes epithelium is 18 mcm, sometimes 22 mcm, and maximal distance between their medial ends - 1080 mcm.

While investigating the series of the histological sections of the embryos VCL 7,0 - 7,5 mcm it is determined that the ingrowths of the nasal placodes epithelium is slightly expressed, and on the free surface of the placodes there forms a deepening - the primary stage of the nasal fossae formation, sides of which are covered with 4-6 raw cylindrical epithelium 34 - 38 mcm, and the depth is no more than 62 mcm. Cranio caudal size of the fossae anlage is no more than 176 mcm, and width - 86 mcm. Their linear axis lies vertically. Caudal ends of the fossae lie closer to each other - in the distance 1340 mcm. Distance between the cranial ends is 1394 mcm.

The horseshoe-shaped protuberances which bound the edges of the nasal fossae thicken in the form of the rollers. The open ends of the nasal fossae are directed to the corners of the primary mouth cavity. The mentioned rollers present the primary stage of the middle and side nasal processes formation, which bound the nasal fossae. Horizontal size of the middle nasal process is no more than 216 mcm, and vertical - 110 mcm. Horizontal size of the side nasal process is no more than 190 mcm. Distance between medial ends of the middle nasal processes is 1130 mcm.

While investigating the series of the histological sections and plastic reengineering of the nasal area of the embryos with VCL 8,0-8,8 mm, we found out that the epithelium which covers the nasal fossae continues invaginating in the liable mesenchyme in the dorsal direction. Also the size of the nasal processes grows; the nasal processes develop in the caudal direction and hang over the primary mouth cavity.

Nasal fossae are covered with the cylindrical epithelium with the depth 34-42 mcm, its cell nuclei place in 4-6 rows. Depth of the nasal fossae is 98 mcm, height - 186 mcm, length - 98 mcm, and the distance between them is 1300 mcm.

Horizontal size of the middle nasal processes in the embryos of VCL 8,8 mm is 260 mcm, and vertical 280 mcm, side nasal processes - 226 and 224 mcm.

There develops a gradual convergence of the middle nasal processes, which grow medially and somewhat forward. They approach to the side nasal processes, though on this development stage there is no integration between them. They are divided by a small slit connected with the anlage of the eye.

In the embryos of the VCL 9,5 – 10,0 mm there happens an intensive growth of the nasal fossae and adjacent structures. While investigating the plastic reconstruction of the nasal area of the embryos VCL 10, 0 mm, we found out that the nasal fossae as a result of the intensive growth and invagination of the epithelium in the liable mesenchyme develops into the blindly edged caps (nasal chambers), which grow in the dorsal direction and somewhat caudally and there is no joining between them. Nasal chambers are covered with the high multi-row cylindrical epithelium. On the histological sections the nasal chambers have a form of a crescent slit, open to the opposite side of the second chamber, their caudal ends are placed closer than the cranial ones. The depth of the nasal chambers is 546 mcm, they are placed in the distance 158 mcm from the primary mouth cavity, though separated from it by a mesenchyme 112 mcm, which is placed between the epithelium covering the nasal chambers and epithelium covering the primary mouth cavity. The size of the nasal chambers almost doesn't change: height – 212 mcm, width – 108 mcm. The inner surface of the nasal chambers is smooth.

The frontal back axis of the nasal chambers is placed obliquely. Their primary parts are placed in the distance of 1284 mcm from each other and back ends – 1126 mcm.

On the described stage of development the nasal sections become bigger, especially the middle, the horizontal size of which is 664 mcm, vertical – 754 mcm, the size of the horizontal and vertical side nasal processes – 446 and 420 mcm. Nasal processes are presented by a mesenchyme covered by a layer of the epithelium cells, nuclei of which are placed in 1-2 rows.

On the medial processes of every of the middle nasal sections there is a well-marked exuberance which provides the gradual joining of the middle nasal processes. The distance between them is quite big – 856– 884 mcm. By the surfaces connected with each other the middle and side nasal processes bound the primary nasals which stay below open-ended as the maxillary processes grow to the middle line and forward,

but they do not join the nasal processes yet. Medial edges of the maxillary processes are placed on the level of the free low ends of the middle nasal processes.

In the embryos VCL 11,0–12,0 mm there happens the further growth of the nasal chambers back and somewhat caudally in the direction of the primary mouth cavity, but there isn't a joining between them.

The distance between the nasal chambers and primary mouth cavity is 86 mcm, depth of the nasal chambers - 548 mcm, and height – 224 mcm.

The upper, the lower and the side walls of the nasal chambers are smooth and on the medial side in the middle part of it there appears a deepening – the anlage of the Jacobson's organ.

The middle nasal processes are down and laterally directed. Its horizontal size of the embryos is 12,0 mm, VCL – 926 mcm, and width – 788 mcm. The side nasal processes are 854 mcm long, and 608 mcm – wide, they are down and medially directed. The distance of the joined edges of the middle nasal processes is 858 mcm.

The maxillary processes continue to grow; their back frontal size enlarges to 1524 mcm, and height – to 758 mcm. On this stage of development they join with the side nasal processes. Their free edge is placed at the lower edge of the middle nasal process.

At the end of the embryonic period (embryos VCL 13,014,0 mm) there happens a break of the nasal chambers in the primary mouth cavity, as a result of which there forms a link between the primary nasal cavity, primary mouth cavity and the gullet.

Both parts of the primary nasal cavity have a curved form – directed dorsally at first and then somewhat caudally, to the primary mouth cavity. The front back size of the primary nasal cavity is 692 mcm. The distance between the upper edges is 1328 mcm, and lower – 996 mcm. The height of the primary nasal cavity is no more than 664 mcm, and the width – 184 mcm. Every part of the primary nasal cavity begins with an opening – the primary nasal. It is limited laterally by the side nasal process which is 772 mcm long, and 558 mcm wide, and medially by the front edge of the nasal septum which develops in the result of the middle nasal processes joining. Vertical size of the nasal septum is 668 mcm, horizontal – 882 mcm, and the front back – 486 mcm.

At the back the vertical size of the primary nasal cavity gradually becomes smaller; and in the places of the break in the primary mouth cavity the primary round shaped choanae develops. The distance between the primary choanae is no more than 890 mcm.

The primary nasal cavity from the primary mouth cavity is separated by a primary palate which is 288 mcm thick, 1136 mcm wide, and 278 mcm – long.

On this stage of development on the back side of the primary mouth cavity there develops a small exuberance – the anlage of the palatal process. This exuberance is presented by a mesenchyme of the maxillar process covered by the 3-4 row of epithelium. On the frontal sections it has a form of a cone, directed by its top to the tongue, and placed on the level of the low edge. The height of the palatal process is 210 mcm, the front back size is no more than 426 mcm, and its free edge stands out in the primary mouth cavity for 108 mcm. All the sides of the primary nasal cavity are smooth. The maxillar processes are already joined to the side nasal processes.

Thus, the carried out morphological investigation of the primary stages of the human nasal area development proves that the anlage and development of the nasal cavity is a complicated process closely connected to the adjacent components' formations.

Of big importance here is the anlage and development of the nasal maxillar processes which considerably influence the formation of the primary sections of the future nasal cavity.

We believe that the critical periods is the period of the primary nasal cavity development and its joining with the primary mouth cavity, and also the period of the primary palate, nostrils and choanae formation. The disorder on these stages can result in the abnormalities of the nostrils and upper lip development.

That is why with the help of the new methods of the morphological investigation, it is necessary to carry out some further investigations of the nasal cavity development in the following development stages especially in the pre-embryonic period when the final (secondary) nasal cavity and its sides are formed.

Conclusions:

1. By the end of the embryonic period the primary nasal cavity is developed, which is separated from the primary mouth cavity by a palate and opens through the primary choanae.
2. The nasal septum is developed by the way of the nasal processes' joining.
3. As a result of the epithelium evagination of the side walls of the primary mouth cavity the permanent palate develops.

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