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DEVELOPMENT OF THE HUMAN NOTOCHORD

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Resume. The notochord – the embryonic axial structure (a primitive form of cartilage), which for some time performs the function of the axial structure of the embryo, and is also an inducer of development of the central nervous system and axial skeleton. The notochord is a major regulator of embryonic patterning in vertebrates and abnormal notochordal development is associated with a variety of birth defects in man.

Keywords: notochordal process, notochordal plate, notochord, embryo.

Relevance. The notochord – the embryonic axial structure (a primitive form of cartilage), which for some time performs the function of the axial structure of the embryo, and is also an inducer of development of the central nervous system and axial skeleton. The notochord is a major regulator of embryonic patterning in vertebrates and abnormal notochordal development is associated with a variety of birth defects in man.

Aim. To describe the histological pattern of the notochord development and to find the prerequisites for the presence of this structure in adults.

Material and methods. Histological sections from Virtual Human Embryo (VHE) project, 36 serial histological sections of embryos from 8 to 130 mm crown-rump length impregnated by the silver nitrate according to Bilshovsky-Buke and stained with hematoxylin and eosin were studied, 3 CBST scan of the adult human vertebral column.

Results. According to the Carnegie staging criteria, the primordium of the notochord is first seen in stage 7 (16–19 days) embryos as the notochordal process (figure 1A). In stage 8 (21–25 days) the notochordal process ventrolaterally attached to the endoderm and is located between neural groove and endoderm [1,2]. The notochordal process gradually transforms into the notochordal plate in stages 9 to 10 (19–23 days), except for the most caudal part [3]. In late stage 11 (26 days) the definitive notochord has formed in the caudal and middle region, still leaving a notochordal plate at the most cranial end. At stage 12 (26–30 days) the notochordal plate has fully transformed into the definitive notochord. In the region of the caudal neuropore the notochord is substantially larger in diameter, compared to the cranial part [4,5]. The notochord is almost completely detached from the endoderm, except cranial part. In this stage the notochord is cranially, but not caudally, detached from the neural tube. (figure 1B, C).

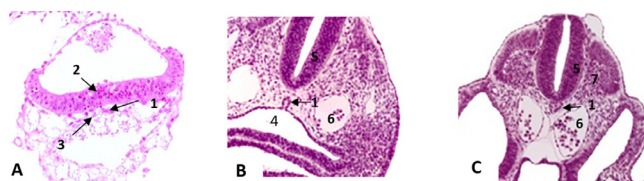


Fig. 1 – Notochord

Embryo 10 mm CRL (5 weeks of gestation), the vertebral body bookmarks are

mesenchymal condensations around the notochord, which has the form of a solid structure consisting of densely arranged cells surrounded by a layer of the acellular matrix (the notochord's vagina) (figure 2A). The notochord is detected throughout the all vertebral column and continues to the cranial end of embryo (figure 2B).

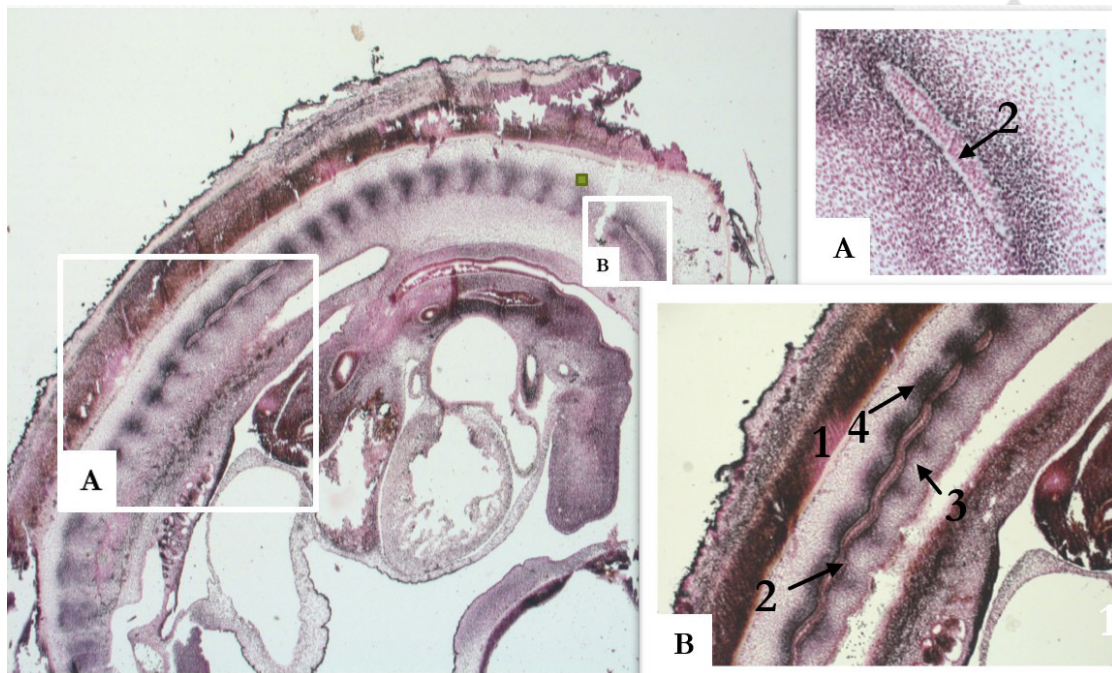


Fig.2 – Human embryo 10 mm CRL (5 weeks)

1 - primordium of the spinal cord, 2 – notochord, 3 - primordium of vertebrae, 4 - primordium of intervertebral disc

The embryo is 7.5 - 8 weeks old, in the center of the vertebral bodies throughout the longitudinal axis of the vertebral column, a notochord is visible, which is on the periphery and a small number of irregularly shaped cells surrounded by the remainder of the cell-free perichordal vagina (figure 3A). At the base of the skull at this stage is also noticeable notochord, which has a tortuous course and is in contact with the mucous membrane of the pharynx (figure 3B).

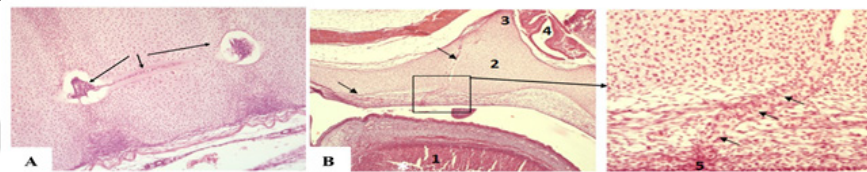


Fig.3 – Human embryo. A – 33 mm CRL (8 weeks); B – 27 mm CRL (7,5 weeks) 1 - tongue, 2 – basilar plate, 3 – sella turcica, 4 - primordium of hypophysis, 5 – notochord connection of the notochord to the mucosa of pharynx Notochord indicated by arrows

In an adult, the notochord remains only in the form of gelatinous nuclei of the intervertebral discs, in rare cases, the remains of the chord are found at the base of the skull as a navicular fossa or central clival canal (figure 4). In some cases, these embryonic residues cause dangerous pathology (cysts, tumors) [6,7].

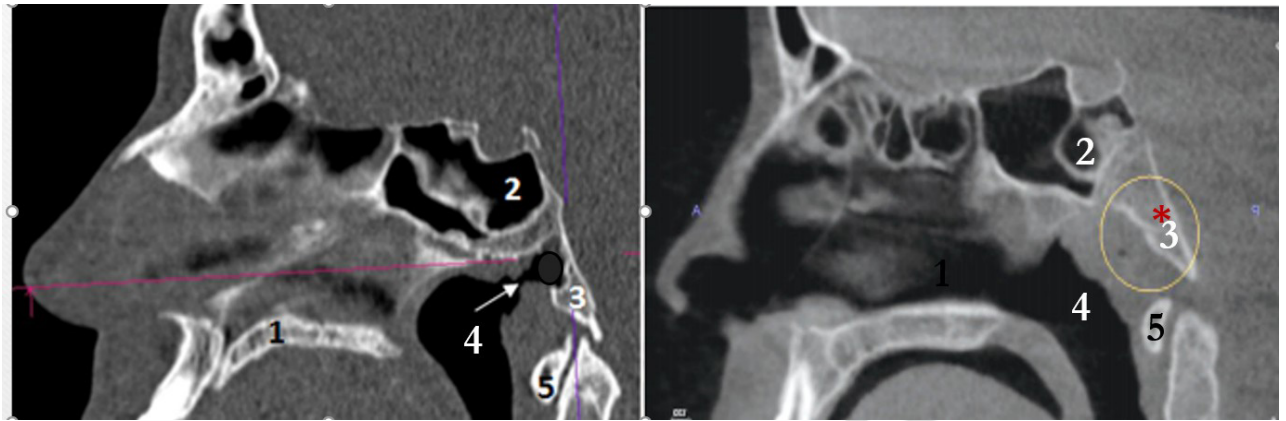


Fig.4 – CBCT-scans of the head (sagittal sections)

1 – hard palate, 2 – sphenoid sinus, 3 – clivus, 4 – pharynx, 5 – anterior arch of atlas Navicular fossa indicated by arrow* bony clival canal

Conclusions.

- 1 Progressive degeneration of the notochord begins at 8th week, and it ends at 16th week of fetal development of human embryos.
- 2 In the region of the vertebral column, the remains of the notochord in an adult are present in the form of a nucleus pulposus, which are located in the center of the intervertebral discs.
- 3 Bone canals of the skull base are formed from the remnants of the notochord, in some cases can be the cause of serious diseases.

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