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Neurulation Mechanisms in the Human Development

Mirna Saraga Babic, Vedran Stefanovic, Eero Lehtonen1, Damir Sapunar, Marijan Saraga2, Jorma Wartiovaara3

Department of Histology and Embryology, Zagreb University School of Medicine – Split Branch, Croatia; 1Department of Pathology, University of Helsinki, Finland; 2Department of Pediatrics, University Hospital Split, Croatia; and 3Department of Electron Microscopy, University of Helsinki, Finland

Aim. Synthesis of our morphological and immunohistochemical investigations on normal and abnormal development of the neural tube in 4 to 16-week human embryos and fetuses.

Methods. The analysis of paraffin embedded embryonic tissues processed for light microscopy and detection of expression pattern of intermediate filaments (cytokeratins, neurofilaments, vimentin, GFAP) and extracellular matrix components (collagen type III and IV, laminin and fibronectin) in axial organs during human development. Electron microscopic analysis of changes in the relationship between the axial organs and their ultrastructural characteristics.

Results. In the early 4-week embryos, two types of neurulation, primary and secondary, were observed along the cranio-caudal neural axis. The cranial neural tube, formed during primary neurulation, gave rise to the brain and cranial part of the spinal cord down to the lumbo-sacral region. Its differentiation appeared to be influenced by the underlying notochord and paraxial mesoderm. In the secondary neurulation, mesenchymal cells in the tail bud gave rise to the caudal neural tube. During tail regression, the relative position of the caudal neural tube changed and subsequently the structure disappeared by apoptosis. Cranial and caudal neural tubes were continuous at the level of the caudal neuropore. In the case of abnormal development, malformations of the cranial neural tube varied along the neural axis. They were associated with anomalous formation of the notochord and vertebral column. Only mild neurulation alterations were found in the caudal spinal cord.

Conclusion. The mechanism of neurulation and developmental fate of the cranial and caudal parts of the neural tube were different. The consequences were seen both in the normal and abnormal neural development.

Key words: fetal development, neural differentiation; human embryo; neural tube defect; spinal cord regression