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Light and dark epithelial cells of the rat choroid plexus

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In the present study were carried out ultrastructural investigations of the light and dark epithelial cells of the rat choroid plexus during development. Investigations of the rat choroid plexus during development provide evidence that light and dark epithelial cells finish their differentiation on 30 days postnatum. Changes of the epithelial cells of the rat choroid plexus during development suggest that dark and light cells are modulations of the same basic cells with possible functional differentiation starting from 17 days postconception and continue to 22 months.

Key words: light and dark epithelial cells, rat choroid plexus, development.

Introduction

The choroid plexuses are specialized highly vascular anatomical structure which protrudes into the lateral ventricle, as well as in the third ventricle and fourth ventricle. The surface of the choroid plexus consists of numerous villi each covered with single layer of epithelial cells surrounded by vascular connective tissue cells [3, 10, 11]. These cells are generally considered to be modified ependymal cells with epithelial cell characteristics and referred to as choroidal epithelial cells.

Plexus choroideus participates in the formation of cerebrospinal fluid (CSF) and in the transportation of the substances from the blood, to the CSF and vice versa [13]. As a secretory source of vitamins, peptides and hormones for neurons, the choroid plexus provides substances for brain homeostasis [5]. Most blood vessels in the plexus choroideus are wide-calibers (approximately 15 μm) capillaries with thin fenestrated endothelial walls and bridging diaphragms overlying the fenestrations [9]. Light and dark choroidal epithelial cells were identified by Wislocki and Ladman [17] and they suggested that the difference in the cell density reflected different stages in the secretory cycle of the choroidal epithelium. Arginine vasopressin (AVP) decreases CSF formation rate and choroidal blood flow, and AVP also increases by more than twofold the number of dark epithelial cells and possibly dehydrated but otherwise morphologically normal choroid epithelial cells in adult rat choroid plexus [6].

Development of the choroid plexus has been studied with light microscope by Goldmann [4], Weed [16] and Kappers [7], with the transmission electron microscope by Tennyson and Pappas [15] and Davis, Lloyd and Milhorat [2], and scanning electron microscope by Chamberlain [1].

The purpose of this paper is to describe light and dark epithelial cells of the rat choroid plexus during development.

Materials and Methods

Wistar rats (n=60) aged 17 and 20 days postconception, 5, 15, 30, 45 and 60 days postnatum and 4, 7, 10, 13 and 22 months were used. The animals were fixed by immersion [18] and by intracardial perfusion [8]. The choroid plexuses were embedded in Durcupan and examined with light microscope Carl Zeis Jena and JEOL JEM 1200EX transmission electron microscope.

Results and Discussions

The most essential structural elements of the brain ventricles are developed before birth. The light and dark epithelial cells of the rat choroid plexus are present from aged 17 days postconception to 22 months. In our investigations of the rat choroid plexus we established the three periods of the development.

The light and dark epithelial cells possess through pseudostratified, low columnar and cubic during the first period of the development (17 days postconception — 30 days postnatum).The epithelial cells have electron-light cytoplasm with many glycogen granules and scanty cell organelles, concentrated at the apical part. There are many cytoplasmic protrusions, short and fine microvilli in the apical part of the epithelial cells. The most marked ultrastructural changes of the epithelial cells are many cytoplasmic protrusions, filled with glycogen, many vacuoles, granular endoplasmic reticulum and mitochondria with unformed cristae. The concentration of glycogen in the rat choroid plexus epithelial cells increased to 5 days postnatum and decreased at the 15 days postnatum. Similar ultrastructural changes are observed in the mouse choroid plexus epithelial cells [14]. The electron density of the epithelial cytoplasm is increased, the microvilli are well shaped and tight packed, and the connective tissue and the blood vessels are well differentiated. The main difference between *dark* and *light* epithelial cells was the density of the cytoplasm, nuclei and matrix of the microvilli (Fig. 1). Dark cells were uniformly denser than the light cells. A slightly increased concentration of osmiophilic droplets in the cytoplasm was observed in the dark cells. Observation of the plasma membranes of dark and light cells revealed membrane continuity and no differences in membrane structure. The dark cells have a much darker cytoplasm but organelles are generally similar to those of the light cells except that the dark cells seem to contain more ribosomes and rough endoplasmic reticulum. The microvilli of the dark cells are much thinner, and seem to be longer, than those of light cells.

On the basis of the ultrastructural investigations of the rat choroid plexus during the *second period* of development (45 and 60 days postnatum, 4, 7, 10 and 13 months), it was established that the light and dark epithelial cells are cuboidal. The nuclei of the epithelial cells are rounded, located basally and have homogeneous chromatin. The large numbers of mitochondria are present, concentrated at the apical ends of the cells. These ultrastructural changes are evident for increased choroid

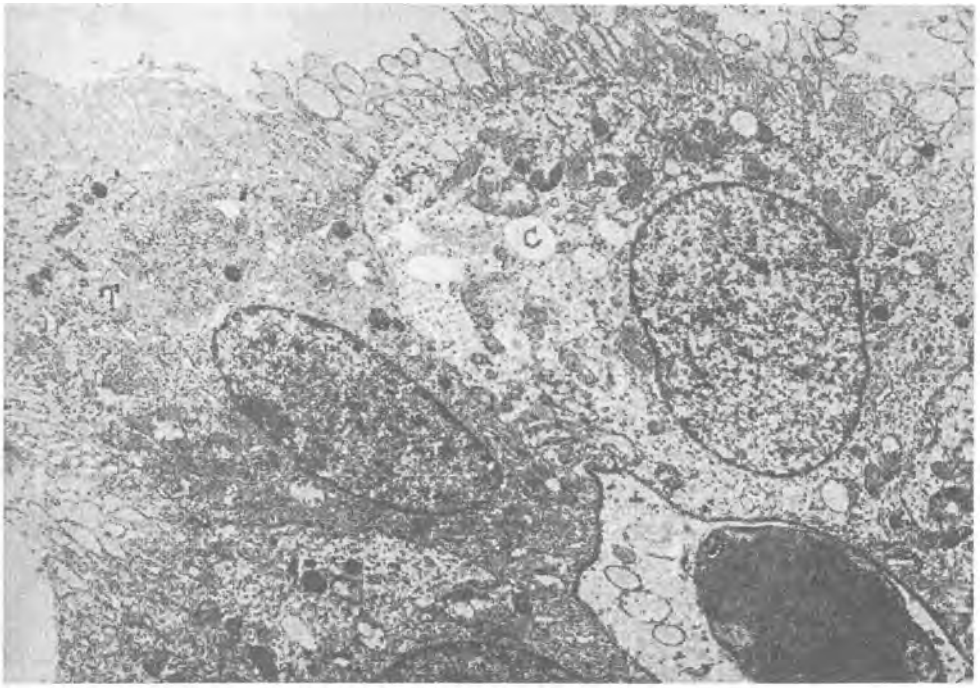

Fig. 1. Dark (D) and light (L) epithelial cells of the rat choroid plexus 45 days postnatum. The dark epithelial cell has more electron-dense cytoplasm and contains more polyribosomes and granular endoplasmic reticulum. × 3000

plexus functions of secretion, absorption and transport of the substances, which are necessary for cerebrospinal fluid homeostasis.

The most marked ultrastructural changes of the epithelial cells during the *third period* of development (13-22 months) are the presence of many lipid droplets, second lysosomes, imbibing mitochondria and dense bodies (Fig. 2). The main morphological changes noted with age suggest a decrease in efficiency of choroid plexus cells in old age [5]. From morphometrical analysis of the rat choroid plexus during development in previous your investigations it was established that the nuclear, cytoplasmic and cell area of the dark epithelial cells is smaller than the same parameters of the light epithelial cells during the whole investigated period [12]. The relative part of the dark epithelial cells increased during the whole period of development and after the age of 13 months remains higher (61.97%) than the relative part of the light epithelial cells (38.08%). This tendency concurs with ultrastructural data of decreased functional activity of the choroid plexus with age, and may be correlated with the age changes of the rat choroid plexus epithelial cells.

Conclusion

Plexus choroideus performs a multiplicity of functions for the central nervous system. Changes of the epithelial cells of the rat choroid plexus suggest that dark and light cells are modulations of the same basic cells with possible functional differentiation starting from fetal period of development through adult, and extending into terminal physiological stages.

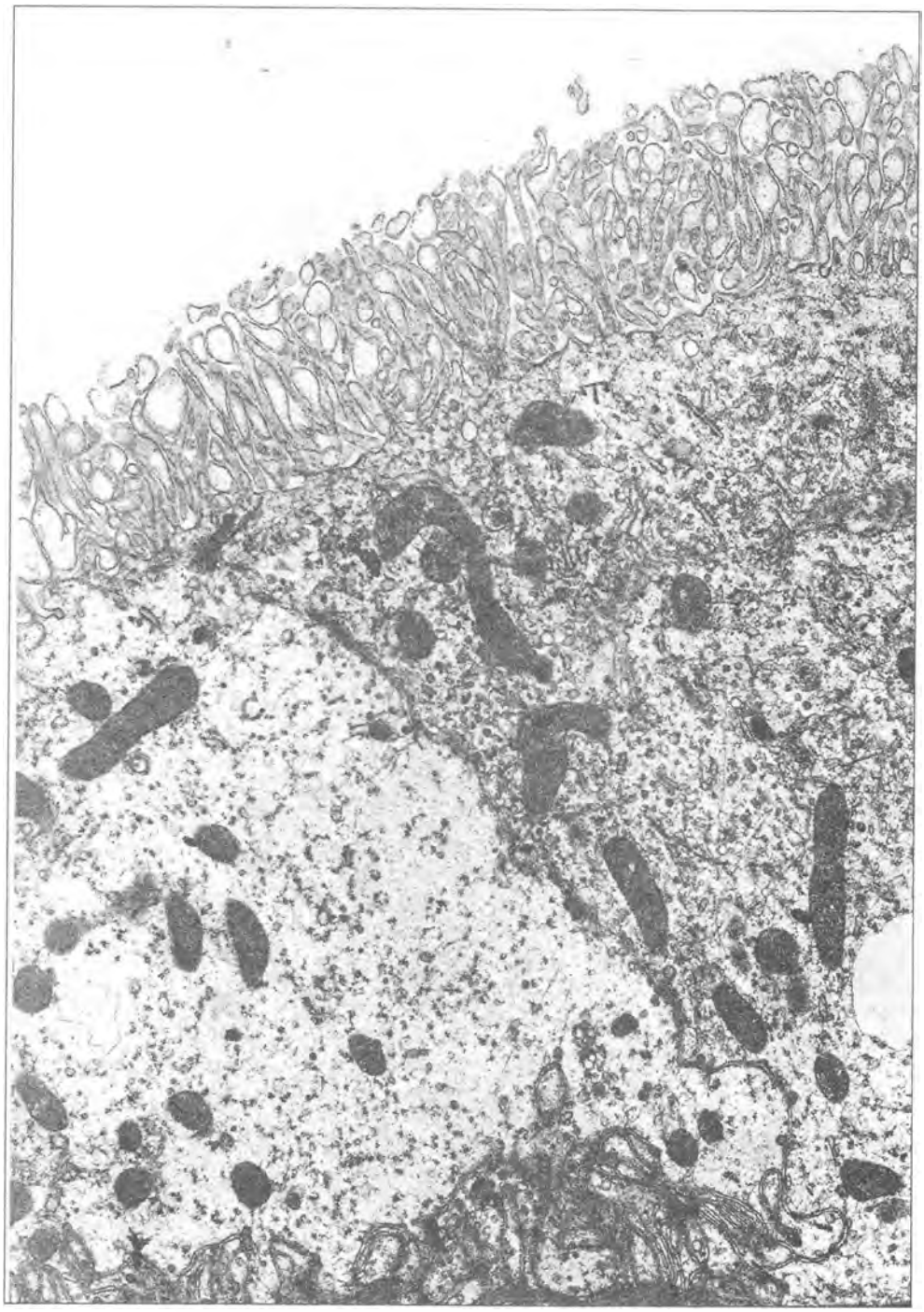

Fig. 2. Light (L) and Dark (D) epithelial cells of the rat choroid plexus aged 22 months. The cytoplasm of the dark epithelial cell contains more polyribosomes and granular endoplasmic reticulum. × 5000

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