Institute of Experimental Morphology and Anthropology

Acta morphologica et anthropologica, 5
Sofia • 2000

# Morphometrical study of the nuclear, cytoplasmic and cell area of the rat choroid plexus epithelial cells during development

*V. Ormandjieva*

*Institute of Experimental Morphology and Anthropology, Bulgarian Academy of Sciences, Sofia*

The nuclear, cytoplasmic and cell area of the rat choroid plexus dark and light epithelial cells was measured from 17 days postconception to 22 months. The changes noted with age were the differences in the nuclear, cytoplasmic and cell area between dark and light cells from 17 days postconception to 22 months. The dark cells were smaller than light cells at an average: nuclear area — 27.4%, cytoplasmic area — 36.9% and cell area — 35%. Changes in the nuclear, cytoplasmic and cell area of the dark and light epithelial cells noted with age proceed simultaneously.

The morphometrical changes suggest that dark and light choroidal epithelial cells are modulations of the same basic cell with possible functional differentiation starting from 17 days postconception and continue to 22 months.

*Key words:* plexus choroideus, morphometry, light and dark epithelial cells, development.

## Introduction

Plexus choroideus and circumventricular organs are considered as a selective barrier between the blood and cerebrospinal fluid (blood-liquor barrier) [1, 2, 12]. Plexus choroideus participates in the formation of the cerebrospinal fluid and in the regulation of the cerebrospinal fluid homeostasis, as in the transportation of the substances from the blood to the cerebrospinal fluid and vice versa [6, 7, 8].

Light and dark choroidal epithelial cells were identified by W i s l o c k i and L a d m a n [9] in the one of the earlier electronmicroscopic investigation of the plexus choroideus. According to D o h r m a n n [3] the basic difference between dark and light choroid plexus epithelial cells is in the electron density of the cytoplasm, nuclei and matrix of the microvilli. The dark epithelial cells are smaller with respect to light.

S t u r r o c k [5] established that light and dark choroid plexus epithelial cells of mice are present from 14 days postconception and that the correlation between dark and light epithelial cells appears constant from 14 days postconception to 90 days postconception.

According to data in the literature there are not systematically morphometrical investigations of the choroid plexus epithelial cells during development. The data in the literature connected with functional morphology of the light and dark epithelial cells are discussed.

The aim of the present study is to investigate the morphometrical changes of the nuclear, cytoplasmic and cell area of the light and dark epithelial cells of the rat choroid plexus during development.

## Material and Methods

Male Wistar rats aged 17 and 20 days postconception, 5, 15, 30, 45 and 60 days postnatum and 4, 7, 10, 13 and 22 months were used in the present study. The animals were anesthetized with sodium pentobarbital (22 mg/kg) and fixed by immersion [10] and by intracardial perfusion [4]. The choroid plexus was postfixed in 1% osmium tetroxide in 0.2M cacodilate buffer, dehydrated through graded ethanol and embedded in Durcupan. Semithin sections (1μm) were stained with 1% toluidine blue and examined by light microscope CARL ZEISS JENA under a magnification of × 1000.

The morphometrical investigations of the choroid plexus epithelial cells were performed on semithin sections, by using a point-counting (625 test point) method [11], performed with combined greed in the ocular of the light microscope for linear and planimetrical estimations. All values expressed as the mean ± standard error. The areas of the dark epithelial cells with respect to light epithelial cells are present in percentage.

## Results

In the present morphometrical investigation of the nuclear, cytoplasmic and cell area of the dark and light epithelial cells of the rat choroid plexus during development was established that the nuclear, cytoplasmic and cell area of the dark epithelial cells is smaller with respect to the same parameters of the light epithelial cells in all investigated periods during development (Table 1). Changes of the nuclear, cyto-

T a b l e 1. Area ( % ) of the dark epithelial cells with respect to light epithelial cells of rat choroid plexus

| Age | Nuclear area | Cytoplasmic area | Cell area |
|---|---|---|---|
| E17 | - 11.5 | - 50 | - 42.3 |
| E20 | - 20.4 | - 48 | - 42.3 |
| 5 days | - 40.5 | - 42.8 | - 42.4 |
| 15 days | - 40. | - 32 | - 33.7 |
| 30 days | - 31.7 | - 32.4 | - 32.3 |
| 45 days | - 24.3 | - 29.8 | - 28.7 |
| 60 days | - 31.3 | - 34.4 | - 33.8 |
| 4 months | - 28.8 | - 36.8 | - 35.4 |
| 7 months | - 27.6 | - 29.5 | - 29.2 |
| 10 months | - 33.5 | - 40.3 | - 37.4 |
| 13 months | - 21.6 | - 36.9 | - 34.2 |
| 22 months | - 17.3 | - 30.8 | - 35 |
| Average | - 27.4 | - 36.9 | - 35 |

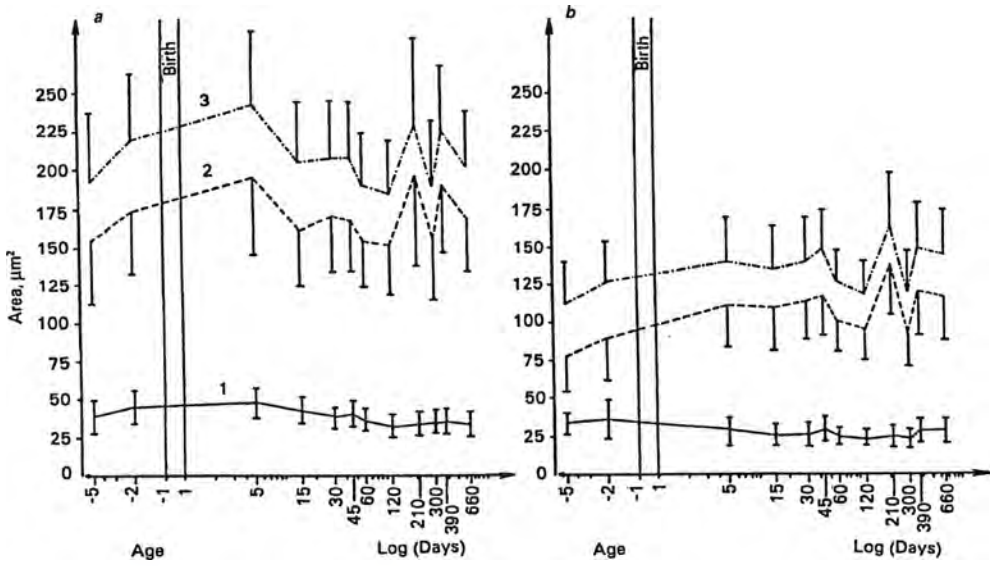


Fig 1. Morphometrical analysis of choroid plexus epithelial cells during development
*a* — light epithelial cells; *b* — dark epithelial cells;
*1* — nuclear area; *2* — cytoplasmic area; *3* — cell area

plasmic and cell area of the dark and light epithelial cells of the choroid plexus in investigated periods are proceeded simultaneously (Fig. 1). The dark cells were smaller than light cells at an average: nuclear area — 27.4%, cytoplasmic area — 36.9%, and cell area — 35% (Table 1).

## Discussion

W i s l o c k i and L a d m a n [9] suggested that the difference in cell density reflected different stages in the secretory cycle of the choroidal epithelium. Van D e u r s et al. [8] observed differences in choroidal cell density in adult rat choroid plexus from brains fixed both by vascular perfusion and by ventricular perfusion. These authors were of the opinion that the dark cells were not fixation artefacts.

S t u r r o c k [5] found that as well as being much more electron-dense than the light cells, the microvilli of the dark cells are much finer than the rather spatulate microvilli of the light cells. This author was of the opinion that this might suggest that the dark cells are relatively dehydrated and shrunken, but it is unlikely that they are degenerating cells since they form more that 10% of the cell population of the choroidal epithelium yet pycnotic cells are not found in the choroid plexus after 13 days postconception.

W i s l o c k i and L a d m a n [9] suggested that the dark and light cells are either modulations of the same basic cell or they are cells with permanently different function. D o h r m a n n [3] found that there was no fine structural evidence to suggest that the dark and light choroidal epithelial cells were two separate and discrete cell types each with unique function and concluded that the dark and light cells of the mammalian choroidal epithelium might represent various states of cellular hydration.

In this study differences in the nuclear, cytoplasmic and cell area between dark and light epithelial cells from 17 days postconception to 22 months support the opinion that dark cells are not fixation artefacts. Simultaneously proceeded changes in the nuclear, cytoplasmic and cell area of the dark and light choroidal epithelial cells noted with age suggested that it is unlikely that dark and light cells might represent various states of cellular hydration. It is not possible from morphometrical studies to interpret such differences and simultaneously proceeded changes in nuclear, cytoplasmic and cell area of the dark and light choroidal epithelial cells from 17 days postconception to 22 months in terms to a difference in function, but the morphometrical changes suggest that dark and light cells are modulations of the same basic cell with possible functional differentiation starting from 17 days postconception and continue to 22 months.

## References


1. Brightman, M. W., T. S. Reese. Junctions between intimately apposed cell membranes in the vertebrate brain. — J.Cell Biol., **40**, 1969, 648-677.
2. Davis, D., T. A. Milhorat. The blood-brain barrier of the rat choroid plexus. — Anat. Rec., **181**, 1975, 779-790.
3. Dohrmann, G. J. Dark and light epithelial cells in the choroid plexus of mammals. — J. Ultrastruc. Res., **32**, 1970,268-273.
4. Karnovsky, M. J. A formaldehyde-glutaraldehyde fixative of high osmolarity for use in electron microscopy. — J. Cell Biol., **27**, 1965, 137A.
5. Sturrock, R. R. A morpholodical study of the development of the mouse choroid plexus. — J. Anat., **129**, 1979, 777-793.
6. Van Deurs, B. Structural aspects of brain barrier, with special reference to the permeability of the cerebral endothelium and choroidal epithelium. — Intern. Rev. Cytopl., **65**, 1980, 117-191.
7. Van Deurs, B., F. von Bulow, M. Moller. Vesicular transport of cationized ferritin by the epithelium of the rat choroid plexus. — J.Cell Biol., **89**, 1981, 131-139.
8. Van Deurs, B., M. Moller, O. Amtorp. Uptake of HRP from CSF into the choroid plexus of the rat, with special reference to transepithelial transport. — Cell Tiss. Res., **187**, 1978, 215-234.
9. Wislocki, G. B., A. J. Ladman. — In: The Cerebrospinal Fluid. The Fine Structure of the Mammalian Choroid Plexus (Eds G. E. W. Wolstenholme, C. M. O'Connor). Boston, Brown, 1958, 55-79.
10. Zaki, W. Ultrastructure of the choroid plexus and its development in mouse. — Z. Mikrosk. and Forsch., **95**,1981, 919-935.
11. Автандилов, Г. Г. Медицинская морфометрия. М., Медицина, 1990.
12. Младенова, В. К. Електронномикроскопски и хистометрични изследвания на plexus choroideus в мозъка на плъх в онтогенеза и при експериментални въздействия. Дисерт. труд. 1993.