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Prenatal and Postnatal Development of the Rat Choroid Plexus

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Abstract: Choroid plexus found in brain ventricles makes up the blood brain barrier, secrets Cerebrospinal Fluid (CSF) and also preserves the homeostasis of CSF. With these functions, choroid plexus plays an important role in the growth and development of brain. Choroid plexus from the rat brain ventricles was investigated at ages from 14 days of gestation to 5 days after birth. On the 14th day of embryonic life, the structure of choroid plexus was observed. On the prenatal 18th day, it was found that the structure of choroid plexus was like the structure of choroid plexus seen after birth. The aim of our research is to assess different developmental characteristics choroid plexus with light microscope and to determine its histological structure.

Key words: Choroid plexus, development, rat, CSF, brain, embryonic life

INTRODUCTION

Choroid plexus found in brain ventricles makes up the blood brain barrier. In addition to this, choroid plexus secrets Cerebrospinal Fluid (CSF) and also preserves the homeostasis of CSF. With these functions, choroid plexus plays an important role in the growth and development of brain (Keep *et al*., 1986; Thomas *et al*., 1989). The secretion rate of CSF has not been reported in prenatal period. In neonatal period, however, it has been reported that it increases with age (Keep *et al*., 1986). Johansen *et al*. (1976) showed that the secretion amount of choroid plexus in a unit area increased between postnata l8th and 23rd days. Keep *et al*. (1986) reported that in rats, the cells in the fourth ventricle did not increase after birth, but the secretion amount to one cell increased and that this increased CSF played a significant role in potassium homeostasis. Cseer *et al*. (1986) showed the conduction of fluid between brain ventricles and other extra cellular areas. The early development of blood brain barrier shows that choroid plexus plays an important role in the development and growth of brain. Brain is surrounded by cerebrospinal fluid and is separated from other parts of body by blood brain barrier. This barrier prevents the unrestricted flow of macromolecules from plasma to CSF.

The epithelial cells in choroid plexus that are bound to each other tightly and the endothelial cells in brain capillaries make up the morphological basis of this barrier (Thomas *et al*., 1989). Chamberlain (1973) claimed that the choroid plexus, formed with the differentiation of ependymal cells, shaped the histological structure of telencephalon in rats. We do not precisely know when the main function of choroid plexus, which is to secret CSF and the homeostasis of ions, begins, but it is thought to begin in intrauterine life (Bass and Lundborg, 1973). According to Keep *et al*. (1986), the weight of choroid plexus increases fast between 19th days of foetus until the 10th day neonatally, but after this time the growth rate decreases gradually.

The aim of the research is to assess different developmental characteristics choroid plexus with light microscope and to determine its histological structure.

MATERIALS AND METHODS

We used Wistar albino rats produced in Dicle University Health Sciences Research Center (DUSAM). For this study, we took smears from female rats and left them with male rats for one night. When we detected spermatozoon in rats, we accepted it as the 1st day of pregnancy. Later on 14th, 18th, 19th and 20th day of pregnancies, the foetuses were taken with caesarean under Ketamin HCl anaesthesia and were preserved in 10% neutral formalin. The 1, 3 and 5 days old baby rats were sacrificed postnatal period. The brain tissues taken from these rats were also preserved in 10% neutral formalin. After formalin fixation, we performed routine

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histological methods. We took 4-6 μm thick of transverse and frontal sections from paraffin blocks that were prepared with Rotary microtome and stained them with Hematoxylen-Eosine dye. By taking micrographs with Nikon ellipse E400 model photo microscope, we investigated the histological structure of choroid plexus with a light microscope.

RESULTS AND DISCUSSION

On the 14th day of embryonic life, the structure of choroid plexus was observed. It was seen that epithelium lining the ventricle area was cubic epithelium and the thin walled capillaries coming from piamater was near to epithelial cells. Because the nucleus was growing towards the apical cytoplasm, this was accepted as a positive finding that the cells were going to secretion phase (Fig. 1).

On the prenatal 18th day, it was found that the structure of choroid plexus was like the structure of choroid plexus seen after birth. The cells making up the choroid plexus that was near to surface were generally squamous in appearance. In the inner parts, especially in areas near to capillaries, it was observed that the nucleuses were more spherical. In middle areas, the start of secretion period was seen (Fig. 2).

On the 19th day of pregnancy, the structure of choroid plexus could be clearly observed. On the 20th day of pregnancy, advanced branching in the structure of choroid plexus was seen. In the choroid plexus structures, a mild vacuolisation was found (Fig. 3).

On the first day after birth, the epithelium making up the choroid plexus was squamous in appearance. It was found that the villus branches was too near to each other, cell nucleuses was near to surface, vascular vessels were very near to squamous cells and that there was active secretion (Fig 4). On the 3rd day, it was seen that the vascular vessels found in the structure of choroid plexus had widened. There was an increase in epithelial cilia, the cell nucleuses was becoming spherical and the secretory period was normal (Fig. 5).

When we look to the nucleuses of the epithelial cell in choroid plexus in the 5th day, we see that squamous structures are more common than cubical ones, the windowed type capillary vessels look like the capillary vessels seen in mature choroid plexus and that the secretory period appears normal. It was observed that the villus structures were near to each other, the cells were getting spherical, there was vacuolisation in cytoplasm, there was an increase in secretion and there was dilatation in vascular vessels (Fig. 6).

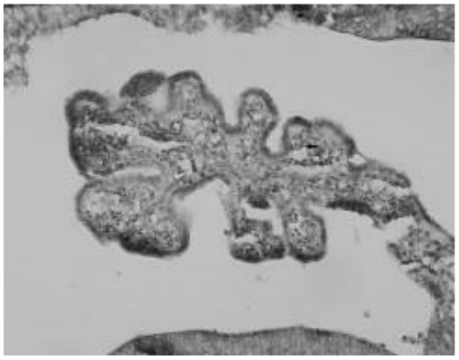

Fig. 1: General appearance of choroid plexus in the prenatal 14th day. The nearness of capillary vessels to epithelium (arrow) (Stain: Hematoxylen Eosine ×20)

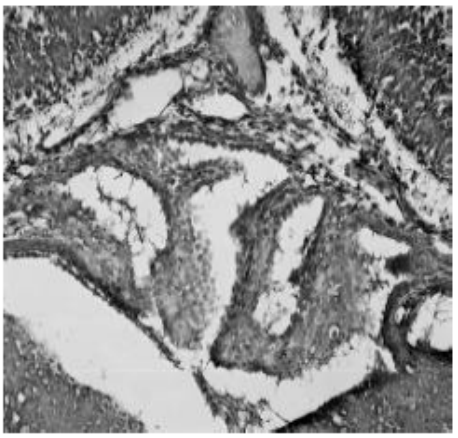

Fig. 2: The squamousition of epithelial cells in prenatal 18th day (arrow), the spherical appearance of cells that are near to capillary vessels (arrow) (Stain: Hematoxylen Eosine ×40)

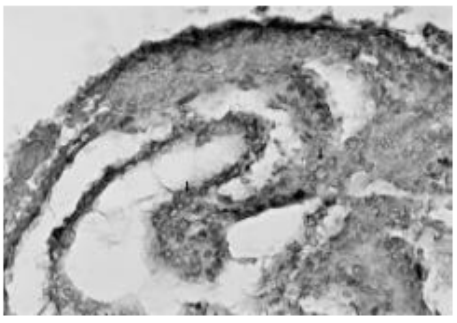

Fig. 3: The distinct structure of villus in the choroid plexus in prenatal 20th day (arrow), mild vacuolisation in cytoplasmic structures (arrow) (Stain: Hematoxylen Eosine ×40)

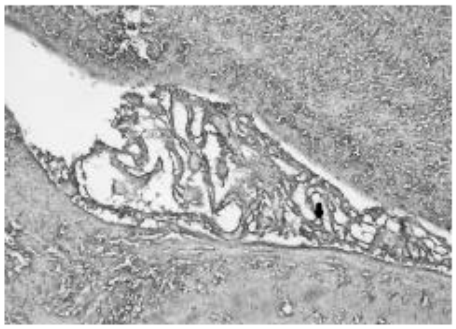

Fig. 4: The appearance of choroid plexus in neonatal 1st day, the localisation of vascular vessels near to epithelium (arrow) (Stain: Hematoxylen Eosine ×20)

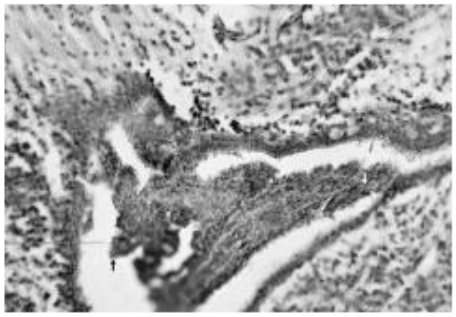

Fig. 5: The increase of apical villi in postnatal 3rd day (arrow), dilatation in capillary arteries (arrow) (Stain: Hematoxylen Eosine ×20)

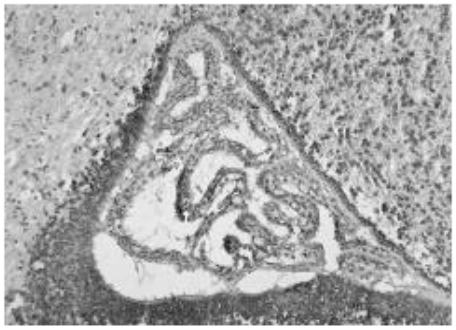

Fig. 6: The appearance of choroid plexus in postnatal 5th day, the vacuolisation in cells (arrow) (Stain: Hematoxylen Eosine ×20)

In the development of choroid plexus, the active proliferation of epithelial cells is faster in prenatal period. In recent studies investigating the changes in the shape of cells, it has been reported that the development of choroid plexus in rats occurs in prenatal periods (Bass and Lundborg, 1973; Davis *et al*., 1973; Gursoy *et al*., 1996; Keep *et al*., 1986; Oda and Nakanishi, 1987). The major reason of the fastness of the proliferation in the development of choroid plexus is that it has an inductive effect. It is said that this effect is done by mesencymal cells (Cavallaro *et al*., 1993). In the study, we observed that the cell proliferation was different in different days. It is known that in embryonic life, there are many factors that induce the development of organs and tissues (Cavallaro *et al*., 1993). In the research, the developments of capillary arteries occur at the same time with cellular proliferation. Therefore, it is thought that the epithelial proliferation with mesencymal cells can have an effect in the development of capillary arteries.

Tauc *et al*. (1984) reported that on 14th day of pregnancy, the epithelial cells in choroid plexus are tightly tied to each other. Chamberlain (1973) reported that the structure of choroid plexus on the 16th day of pregnancy looked like adult choroid plexus structure. On the 14th day of intrauterine life, it was observed that the villi in choroid plexus become more pronounced and that the vascular vessels coming from piamater were localised under the epithelial structure that made up the villi. On same days, it was seen that the layer number in epithelium showed some likeness to stratified epithelial structure (Fig. 1). Around the 18th day of prenatal period, there was short and blunt epithelial branching with the pronounced flatness of epithelial cell nucleuses (Fig. 2). It was reported that in rats in the pre-birth periods, there was a decrease in the volume of epithelial cells (Keep *et al*., 1986). This decrease was explained due to mitosis of the cells that made up the choroid plexus. It is reported that in the late prenatal periods, the choroid plexus is made up of two types of epithelial cells (Sturrock, 1979). In the study, there were dark cells near to basal membrane, which are rich of chromatin and light cells located to the apical side (Fig. 3). It is thought that these dark cells are more prominent in the beginning of neonatal period and that this may have a role in the ion regulation and homeostasis function of CSF. The increase in cytoplasm relation in the neonatal period shows that the speed of secretory period in microvillus in the apical side has increased. The secretory and cellular shaping characteristic of choroid plexus in the end of prenatal period and in the beginning of neonatal period is still unclear.

CONCLUSION

Choroid plexus from the rat brain ventricles was investigated at ages from 14 days of gestation to 5 days after birth. On the 14th day of embryonic life, the structure

of choroid plexus was observed. On the prenatal 18th day, it was found that the structure of choroid plexus was like the structure of choroid plexus seen after birth.

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