Haryana Vet. (December, 2020) **59(2)**, 168-170

Research Article

PRENATAL DEVELOPMENT OF VENTRICULAR SYSTEM AND CHOROID PLEXUS IN BUFFALO

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Received: 22.01.2020; Accepted: 29.02.2020

ABSTRACT

The present study was conducted on the brain of 1.2 cm to 110.0 cm CVRL buffalo foetuses to observe the developmental pattern of ventricular system and choroid plexus. Based on CVRL, the foetuses were divided into three groups i.e. Group I (between 0 – 20 cm), Group II (>20 to 40 cm) and Group III (40 cm onwards). At 1.2 cm CVRL, all the ventricles (both lateral, III and IV) were differentiated and the ependymal layer of each ventricle was lined by pseudostratified columnar epithelium, which later on converted into columnar type in group II and cuboidal type in group III. Small vasculature of choroid plexus developed in lateral ventricle at 1.2 cm CVRL became more extensive and tortuously folded at 7.4 cm CVRL. The junction between cerebrum and thalamus was observed just below choroid fissure at 110 cm CVRL where choroid plexus projected into lateral ventricles. The rostral part of lateral ventricle was devoid of choroid plexus, whereas, these were maximum in middle part at the level of interventricular foramen. In 2.6 cm CVRL, the choroid plexus originated from the interventricualar foramen from a small stalk. The choroid plexus consisted of dilated blood vessel, connective tissue, remnant of piamater and a layer of ependymal cells. It is concluded that the lining epithelium of ventricles was pseudostratified non-ciliated in group I, which became simple columnar to simple cuboidal type with the advancement of foetal age which may be correlated with the CSF production.

Keywords: Buffalo, Choroid plexus, Foetus, Ventricular system

The ventricular system of brain develops from the single cavity formed by neural tube. It is made up of two lateral ventricles, a third ventricle and a fourth ventricle (Dyce *et al.,* 1996). During early foetal life, the neural tube contains amniotic fluid which later on is synthesized by specialized vascularized structure called choroid plexus. The choroid plexuses exist within the ventricles to produce the CSF. The studies have been conducted on the prenatal development of brain in sheep (Lignereux *et al.,* 1991), goat (Lucy *et al.,* 2008), and mouse (Sturrock, 1979), but scanty information is available on brain ventricles and choroid plexus in buffalo fetuses, therefore, the present study was planned to evaluate the prenatal development of ventricular system in buffalo.

MATERIALS AND METHODS

The present study was conducted on brains of twelve buffalo foetuses obtained from local abattoir. The foetal body length was measured as curved line in centimeter with the help of inelastic thread along the vertebral column between the most anterior part of frontal bone to the rump at ischiatic tuberosity and designated as crown rump length (Edward, 1965). The approximate age of the foetuses were calculated by using the formula given by Soliman (1975) and foetuses were divided into three groups based on their CVRL i.e. Group I (between 0 – 20 cm), Group II (>20 to 40 cm) and Group III (40 cm onwards).

The tissue samples from different foetuses were collected immediately after slaughter and fixed in 10% NBF and then processed for paraffin blocks preparation by acetone benzene schedule. The paraffin sections of 5-6 µm were cut with the help of rotary microtome and obtained on glass slides and stained with haematoxylin and eosin for general histomorphology (Luna, 1968).

RESULTS AND DISCUSSION

The cavities of brain vesicles gave rise to ventricular system of brain. The ventricular system consisted of two lateral ventricle, third ventricle and fourth ventricle. The lumen of ventricles filled with choroid plexus, are responsible for production of cerebrospinal fluid. These dilated cavities of brain vesicles became enlarged due to cellular proliferation and growth of brain ventricles at different stages of development.

Lateral ventricles: In buffalo foetuses, both the right and left lateral ventricles were differentiated at 1.2 cm CVRL, which were communicated with each other and with third ventricle by interventricular foramen and foramen of Monro. At this stage, the lateral ventricle were subdivided into three parts i.e., central part, rostral horn and a temporal horn same as described by Dellmann and McClure (1975). With advancing age of foetus, the rostral horn extended forward and downward into the frontal lobe and entered into the olfactory bulb whereas posterior horn proceeded into central white matter of occipital lobe. The primodium of telencephalic choroid plexus developed from medioventricular wall rostrodorsal to interventricular

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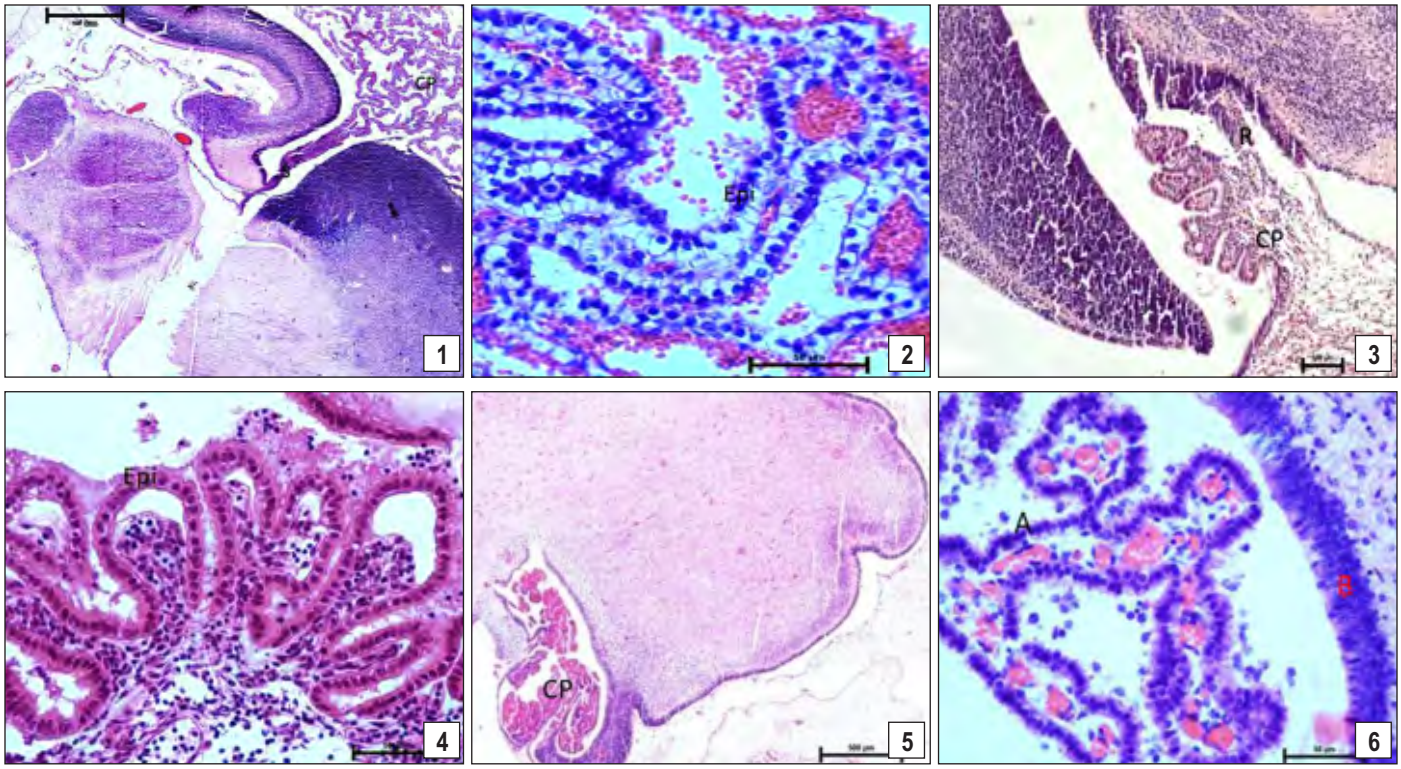

Fig. 1 -6. **(1)** Photomicrograph of 7.4 cm CVRL buffalo foetus showing vascularized mass of choroid plexus (A) attached by a broad stalk (B) in lateral ventricle. (H&E, ×100); **(2)** Lateral ventricle of 7.4 cm CVRL buffalo foetus showing vascularized choroid plexus (A) in lateral ventricle lined by cuboidal epithelium (B). (H&E, ×400); **(3)** Photomicrograph of 2.6 cm CVRL buffalo foetus showing choroid plexus in 3rd ventricle (A) originating from the roof (B). (H&E, ×100); **(4)** Photomicrograph of 7.4 cm CVRL buffalo foetus showing completely folded choroid plexus (A) in 3rd ventricle lined by low cuboidal epithelium (B). (H&E, ×400); **(5)** Photomicrograph of 7.4 cm CVRL buffalo foetus showing vascularized mass of choroid plexus (A) in 4th ventricle. (H&E, ×100); **(6)** Photomicrograph of 21.5 cm CVRL buffalo foetus showing choroid plexus lined by cuboidal epithelium (A) and multilayered ependyma (B) of 4th ventricle. (H&E, ×400)

foramen at 1.2 cm CVRL. Similar observations were made in buffalo (Bansal and Uppal, 2010) and goat foetii (Shrivastava, 1989 and Lucy, 2005).

A small vasculature of choroid plexus observed in wall of each lateral ventricle at 1.2 cm CVRL became more extensive and tortuously folded at 7.4 cm CVRL buffalo foetus (Fig. 1). In 2.6 cm CVRL, the choroid plexus were observed to be originated from the interventricular foramen by a small stalk. The vascularized mass of choroid plexus was attached by the broad stalk in the lateral ventricle at 7.4 cm CVRL. In group II, the stalk of choroid plexus was double layered with inner plial membrane and outer ependymal layer. Cells at this level were pseudostratified with eosinophilic cytoplasm and centrally located large ovoid nucleus. Away from the stalk, these cells of choroid plexus had spherical nucleus in apical portion with clear and vacuolated basal part. At 110 cm CVRL, the junction between cerebrum and thalamus was observed just below choroid fissure from where choroid plexus projected into lateral ventricles. It was also noticed that the rostral part of lateral ventricle was devoid of choroid plexus whereas these were maximum in middle part at the level of interventricular foramen.

At 1.2 cm CVRL, the choroid plexus were lined by low cuboidal type of epithelium with large nucleus. At 7.4 cm CVRL, the choroid plexus were consisted of dilated blood vessel, connective tissue, remnant of piamater and a layer of ependymal cells (Fig. 2). At 21.5 cm CVRL, the choroidal epithelium was more in height with apically located nucleus. The ependymal layer of each lateral ventricle was lined by pseudostratified columnar epithelium in group I, which differentiated into columnar type in group II and cuboidal type in later stages of group III. The lining epithelium of lateral ventricle changed from multilayered ciliated in group I, bi-layered in group II, single layer with more cuboidal and less columnar cells in group III.

Third ventricle: The third ventricle appeared as an unpaired cleft like space between the two thalami extending downward into the hypothalamus. In group I, third ventricle was broad which became narrow in group II with the thickening of lateral walls of diencephalon. The

lining epithelium of third ventricle was pseudostratified non ciliated in group I, which became simple columnar ciliated epithelium with advancing age of the foetus. The formation of optic, infundibular and pineal recesses were noticed in the third ventricle of buffalo foetus at 7.4 cm CVRL, similar formation were observed in goat (Lucy, 2005) and buffalo foetii (Bansal and Uppal, 2010).

The choroid plexus were originated from the roof of third ventricle in 2.6 cm CVRL (Fig. 3), which was completely folded as chorionic villi lined by low cuboidal epithelium at 7.4 cm CVRL (Fig. 4). Similarly, in goat foetii choroid plexus was confined the dorsal part of third ventricle as observed by Shrivastava (1989) and Lucy (2005).

Fourth ventricle: Fourth ventricle developed in the hind brain, rostral to the cervical flexure was noticed in 1.2 cm CVRL buffalo foetus. The choroid plexus of fourth ventricle branched several times but did not completely fill the cavity (Fig. 5). These choroid plexuses were lined by a layer of cuboidal epithelium and surrounded by a core of capillaries and loose connective tissue at 2.5 cm CVRL. A rapid increase in the size of folding of choroid plexus occurred at 7.4 cm CVRL, these choroid plexus folded into many villi around each capillary were projected into the lumen of fourth ventricle. In group II, these cuboidal epithelium of choroid plexus changed to pseudostratified columnar with light and dark cells as observed in goat (Lucy, 2005) and buffalo (Bansal and Uppal, 2010).

The difference in the cellular density of choroid plexus may be related to the secretory activity of choroidal epithelium at different stages of development. Similar findings were reported on the development of choroid plexus in mouse (Sturrock, 1979). The ependyma of fourth ventricle was lined by pseudostratified columnar ciliated epithelium in 21.5 cm CVRL buffalo foetus (Fig. 6). Similar observations were reported in goat foetii by Shrivastava (1989) and Lucy (2005).

It is inferred from the present study that the normal development of ventricular system and choroid plexus in the brain may be correlated to evaluate the congenital neural abnormalities in buffalo during prenatal life.

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