



# HISTOMORPHOGENESIS OF PINEAL GLAND IN GOAT FOETUSES\*

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Received - 24.09.11

Accepted - 21.10.11

## Abstract

Prenatal development of pineal gland in goat was studied using 52 goat foetuses ranging from 1.4cm CRL (24 days of gestation) to 41.5cm CRL (full term). Pineal gland developed during the seventh week as a conical evagination on the caudo-dorsal aspect of the diencephalon and lumen of the third ventricle extended towards the pineal body as the pineal recess. During third month, the stalk was divided into a dorsal lamina continuous with the dorsal commissure and a ventral lamina, continuous with the posterior commissure. A thin connective tissue capsule covered the pineal gland by 76 days of age. The parenchymal cells were arranged in a cord-like manner and there was a central lumen. The neuroglial cells were scattered among the pinealocytes from which they could be distinguished by their smaller and darker nuclei. By 124 days of age, the pineal gland was elongated or oval in shape. The accessory pineal gland could not be located. Histologically the pineal gland acquired the adult characteristics towards the terminal stages of pregnancy. From the capsule, connective tissue septa penetrated the gland, dividing the parenchyma into small lobules. The parenchyma consisted of pinealocytes and glial cells scattered throughout in the fibrous network of interstitial tissue, fine blood vessels and nerve fibres. Towards the central portion, the cells were loosely arranged when compared to the periphery and the central lumen disappeared at this stage. The

*pinealocytes were of two types namely the light and dark cells. Four types of glial cells could be identified based on the nuclear morphology.*

**Keywords:** Pineal gland, goat, prenatal development

Pineal gland or epiphysis cerebri is located on the dorsal aspect of brain stem in the central depression between the rostral colliculi at the caudal end of thalamus. Gross anatomical and histological studies of pineal gland have been made in domestic animals by Calvo *et al.* (1988) and Kumar *et al.* (1995a). However, embryological changes have not been well documented in ruminants. Therefore, the present work was undertaken to study the prenatal histomorphogenesis of pineal gland in goats.

## Materials and Methods

Prenatal development of the pineal gland was studied using 52 goat foetuses ranging from 1.4 cm CRL (24 days of gestation) to 41.5 cm CRL (full term). The material available in the Department of Anatomy and those collected from the farms and clinics were used for the study. Body parameters of the subjects were recorded. Age of the foetuses was calculated from the formula,  $W^{0.75} = 0.096 (t-30)$  derived by Singh *et al.* (1979) for goat foetuses, where 'W' is the body weight of the foetus in g and 't' is the age in days. Based on age, foetuses were divided into five groups, representing the five months

\*Part of Ph. D thesis submitted by the first author to the Kerala Agricultural University, Thrissur

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of gestation. Embryos of the Group 1 were fixed in toto for histological and histochemical studies. From Group 2 onwards, the head was separated at occipito-atlantal junction and the brain was then carefully dissected out and fixed in 10 percent neutral buffered formalin. Standard procedures were adopted for histological and histochemical studies. The sections were stained using Haematoxylin and Eosin (H&E), Van Gieson's method for collagen, Holzer's method for glial fibres, Sevier-Munger silver impregnation method for neural tissues, Aldehyde-thionine-PAS method for central nervous system, Phosphotungstic acid haematoxylin (PTAH) method for CNS tissue and Periodic acid Schiff's reaction for carbohydrates (Luna, 1968). Histochemical studies employed were Gomori's alkaline phosphatase cobalt method for alkaline phosphatase and Gomori's method for acid phosphatase (Singh and Sulochana, 1996), Oil Red 'O' in propylene glycol method for fat and Best's carmine method for glycogen (Luna, 1968). Measurements of the pineal gland were taken using an ocular micrometer.

## Results and Discussion

Epiphysis or pineal body developed during the seventh week as a conical evagination at the caudo-dorsal aspect of the diencephalon with a thickness of 131.0  $\mu\text{m}$ . Lumen of the third ventricle extended towards the pineal body as the pineal recess at this stage (Fig. 1). In front of this was another small evagination that represented the habenula. Pineal body appeared at 14<sup>th</sup> day of gestation in albino rats (Clabough, 1973) and in the sixth week of gestation in the human fetus (Sadler, 2004).

During third month, an epithalamic sulcus separated the thalamus from the epithalamus. The pineal gland lay in the depression between the rostral colliculi (Fig. 2). The base was attached to the taeniae thalami and habenular and posterior commissures by a shallow stalk. The stalk was divided into a dorsal lamina continuous with the dorsal commissure and a ventral lamina, continuous with the posterior commissure.

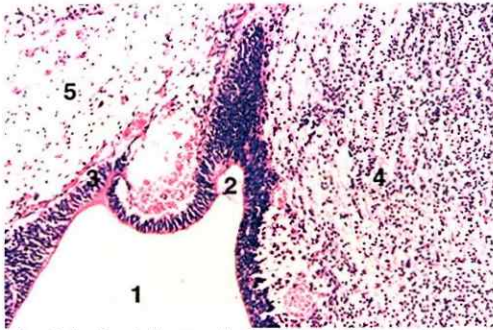
A thin connective tissue capsule covered the pineal gland by 76 days of age. The parenchymal cells were arranged in a cord-like manner (Fig. 3). There was a small

central lumen. The lining cells were columnar in shape with basally located round nucleus and eosinophilic cytoplasm. The pinealocytes were not differentiated into light and dark types in the third month of gestation. The neuroglial cells were scattered through the parenchyma from which they could be distinguished by their smaller and darker nuclei. Number of pinealocytes was more than that of the glial cells. Reiter (1981) distinguished three phases during the development of pineal gland in rat. The morphogenetic phase was considered to begin at about the 12<sup>th</sup> embryonic day and extended until the young were delivered. The cellular proliferation phase commenced on the 16<sup>th</sup> embryonic day and terminated within several days after birth. The cellular hypertrophy and differentiation phase began roughly at birth and terminated nine to twelve weeks postpartum. Kumar *et al.* (1995b) described the topography and histology of pineal gland in young goat. According to them, the parenchyma was formed of pinealocytes, glial cells, fine blood capillaries and nerve fibres.

Measurements of pineal gland increased progressively during the fourth month. Histological structure was the same as that of the third month. Pinealocytes were not differentiated into light and dark cells. By 124 days of age, the pineal gland was elongated or oval in shape located in the central depression at the caudal end of the thalamus in between the rostral colliculi of corpora quadrigemina. The accessory pineal gland could not be located in the present study. Kumar *et al.* (1995a) reviewed the anatomy of pineal gland in domestic animals and found that the gland was conical in shape in cattle, round to oval in sheep, goats and buffaloes, fusiform or ovoid in horses, elongated cone-shaped in pigs, lancet-shaped in dogs and conical in cats. They also reported the occurrence of an accessory pineal gland in buffaloes on the posterior margin of the main gland.

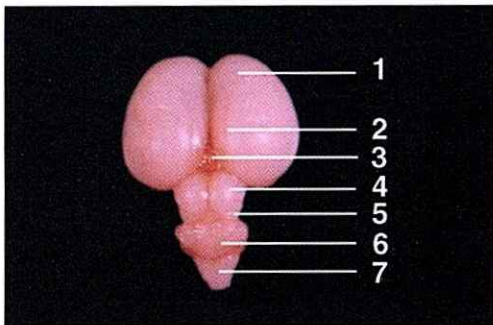
Histologically the pineal gland acquired the adult characteristics towards the terminal stages of pregnancy. At 144 days of age, simple ciliated columnar ependymal cells covered the surface facing the third ventricle. From the capsule, connective tissue septa penetrated the gland dividing the parenchyma into small lobules (Fig. 4) as reported by Kumar *et al.* (1995b) in young





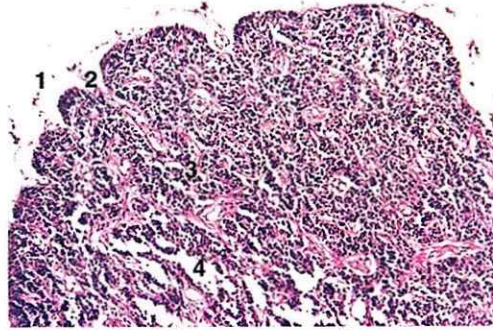
**Fig. 1.** L. S. of diencephalon and mesencephalon showing pineal evagination (48 days). H&E. x 100

1. Third ventricle 2. Pineal evagination  
3. Habenulae 4. Rostral colliculus 5. Pia mater



**Fig. 2.** Dorsal view of brain (76 days)

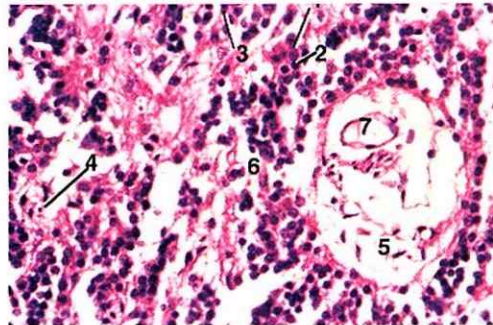
1. Cerebrum 2. Marginal sulcus  
3. Pineal gland 4&5. Caudal colliculus  
6. Cerebellum 7. Medulla oblongata



**Fig. 4.** C. S. of the pineal gland (144 days).

H&E x 100

1. Capsule 2. Connective tissue septum  
3. Cortex 4. Medulla

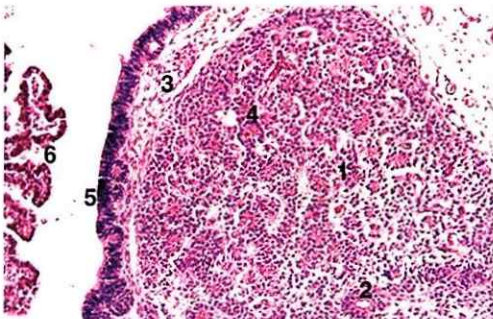


**Fig. 5.** C. S. of the pineal gland (144 days).

H&E x 400

1. Light pinealocytes 2. Dark pinealocytes  
3. Type I glial cell 4. Type II glial cell  
5. Type III glial cell 6. Type IV glial cell  
7. Blood vessel 8. Nerve fibres

goats, Pawar and Ramakrishna (2000) in adult Indian donkeys and Saggar *et al.* (2001) in adult sheep. The parenchyma consisted of pinealocytes and glial cells scattered throughout in the fibrous network of interstitial tissue, fine blood vessels and nerve fibres. Towards the central portion, the cells were loosely arranged when compared to the periphery. Lalitha and Seshadri (1986)



**Fig. 3.** C. S. of the pineal gland (76 days). H&E. x 100

1. Pineal gland 2. Central lumen 3. Capsule  
4. Cell cords 5. Third ventricle with lining ependyma  
6. Choroid plexus of third ventricle

reported that in buffalo calves, the pineal gland showed a diffuse narrow peripheral zone and syncytium-like central arrangement. The small central lumen that appeared during third month of gestation disappeared later.

The pinealocytes were of two types, namely the light and dark cells (Fig. 5). The round to oval irregular nuclei of light pinealocytes had fine chromatin localised more towards the periphery. The dark cells showed uniform distribution of chromatin. Similar observations were made in young goats by Kumar *et al.* (1995b). The parenchyma showed a greater population of pinealocytes than glial cells. Four types of glial cells could be identified based on nuclear morphology, viz., glial cells with round, oval or cone-shaped nucleus, smaller glial cells with round or oval strongly basophilic nuclei, glial cells with elongated nuclei closely associated with the blood capillaries and a few cells with large nuclei. Similar observations were made in adult buffaloes by Prasad and Sinha (1984),

in goats by Kumar *et al.* (1995b) and in sheep by Saggarr *et al.* (2001). The nerve fibres were distributed irregularly adjacent to the pinealocytes. The pigmented cells and corpora arenacea as reported by Saigal *et al.* (1976) and Calvo *et al.* (1988) in the adult goat and the dog, respectively were not observed in the present study.

### Acknowledgement

The authors are thankful to the Dean, College of Veterinary and Animal Sciences, Mannuthy for providing the facilities for this study.

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