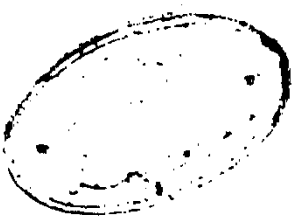
POSTNATAL CHANGES OF THE PINEAL GLAND IN THE ALBINO RAT



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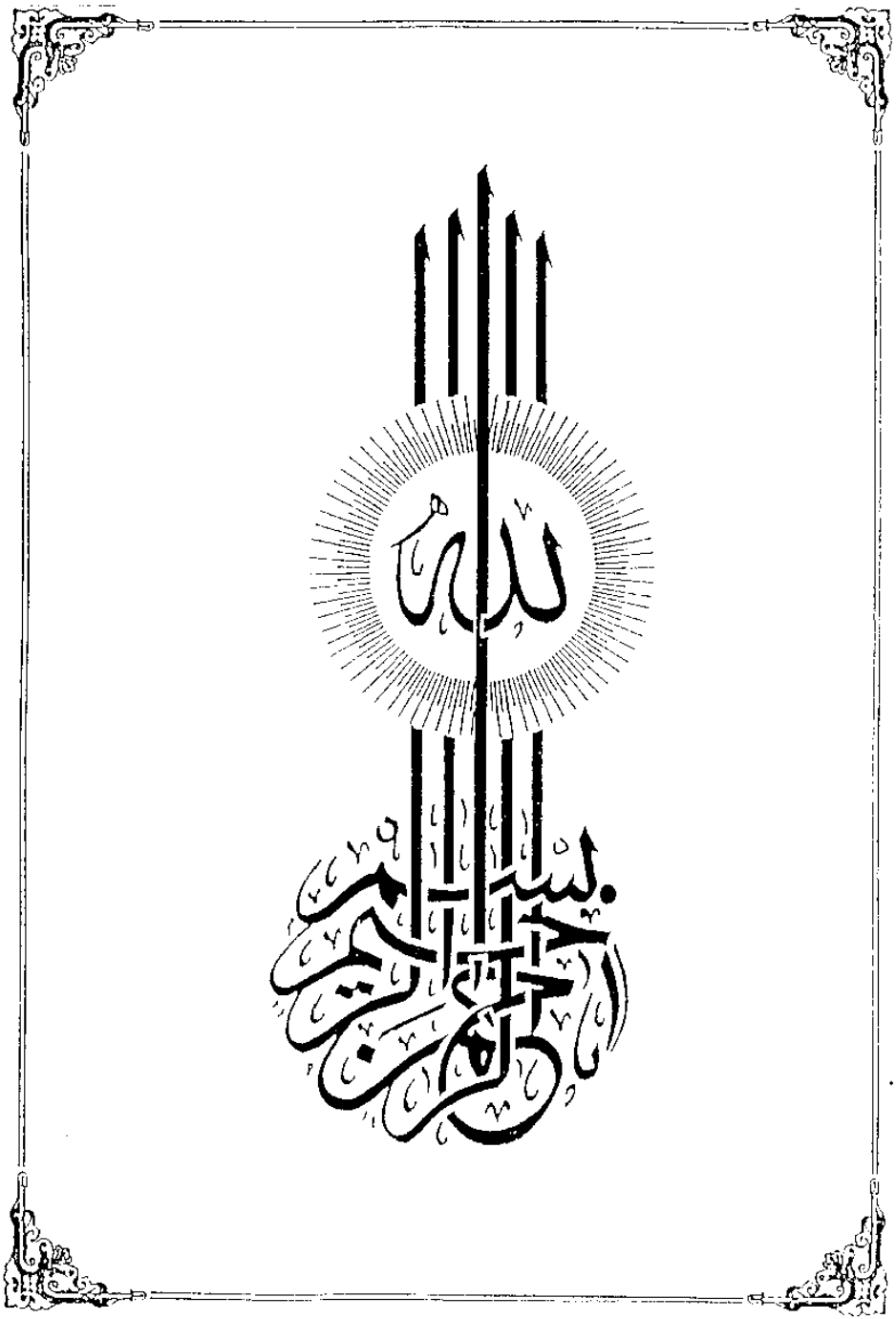
CONTENTS



Introduction
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The pineal gland is considered to be one of the most mysterious glands in the body. Extensive work had been done as regards the histological structure of the gland in various species Kappers (1976), Reiter (1981) studied the mammalian pineal body. Quay (1959), Reuber and Vollarth (1983) studied the rat pineal gland. Karasek and Hansen (1982) studied the fox pineal gland. Ellsworth, Yang and Ellsworth (1985) studied the dog pineal gland. However, the development of the gland in the albino rat received little attention. Calvo and Boya (1981)a (1983)b studied the prenatal and postnatal development of the albino rat pineal gland.

As regards the innervation of the pineal gland in the rat; it also received little attention. Gardner (1953), studied the innervation of pineal gland in the hooded rat. Romyn (1973)a studied the innervation of the rabbit pineal gland.

The aim of the present work was to study the postnatal development of the pineal gland in the albino rat with special emphasis on its innervation.

Review of Literature

REVIEW OF LITERATURE

A) PRENATAL DEVELOPMENT

Cormach (1970), noticed that the development of the human pineal body began early in embryonic life. At this time, the roof of diencephalon behind the site of the origin of the choroid plexus of the third ventricle bulged dorsally as a diverticulum. As development proceeded, the wall of the diverticulum thickened so that the lumen of the outgrowth was gradually obliterated, to reappear again in postnatal life as the pineal recess of the third ventricle. The outgrowth of the roof of the diencephalon that gave rise to the pineal body contained two types of cells. First, the roof itself contained neuro-ectodermal cells; second, the pia mater which covered the outgrowth contained mesenchymal cells. Both types of cells participated in the formation of the pineal body. The neuro-ectodermal cells gave rise to parenchymal cells termed pinealocytes and glial cells. The mesenchymal cells gave rise to the connective tissue.

Kappers (1976), studied the mammalian pineal gland. He observed that the primary pineal anlage in mammals was formed by an evagination of the neuro-epithelium constituting that part of the roof of the diencephalon which was situated between the habenular commissure rostrally and the posterior

commissure caudally. The organ therefore was of epithalamic origin. The neuro-epithelial matrix layer proliferated giving rise to lobules and pseudofollicles which may for sometimes contain a lumen. Soon the embryonic mesenchyme surrounding the pineal body produced connective tissue strands and blood vessels growing in between the cell cords and pseudofollicles. Along with these vessels, fibroblasts and other mesenchymal elements such as mast cells and plasma cells moved into the gland.

Calvo and Boya (1981)a, noticed that, at 13 days of development, the pineal evagination in the albino rat presented a barely differentiated epithelium. From 17 days onwards, the transformation of the pineal gland from a tubular evagination into a compact organ occured. The obliteration of the recess occured by means of two mechanisms : (a) multiple foldings of the epithelium which determined an approximation and fusion of the walls of the recess, and (b) occupation of the lumen by cells extruded from the pineal epithelium. Embryos of 18 - 21 days of gestation still showed remains of the pineal recess. The beginning of recognizable differentiation of the pineal cellular types occured at Day 20. However, in the newborn rat, these types were not yet clearly established.

Calvo and Boya (1981)b, studied the embryonic development of the albino rat pineal gland from 13th day of development till birth. They noticed that the first anlage of the

pineal gland manifested itself in embryos of 13 days of embryonic development. The pineal gland appeared as a short evagination located in the midline of the diencephalic roof anterior to the posterior commissure. The pineal epithelium showed no detectable morphologic differences with the adjacent neuro-epithelium. The pineal anlage soon adopted a tubular shape.

At 17 days, the pineal recess disappeared along with the transformation of the gland into a solid organ. The latter was mainly achieved by an infolding and thickening of the dorsal recess wall from which derived most of the future pineal parenchyma. Blood vessels began to appear in the pineal gland of 18-days embryos, these blood vessels were mainly derived from the vessels found in the dorsal surface of the pineal gland.

Reiter (1981), studied the structure and function of the mammalian pineal gland. He stated that although the pineal gland was a single midline structure, yet there were two pineal anlagen, one on each side of neural fold of the developing neural tube. However, when they fused, a single pineal rudiment normally resulted. The neuro-epithelial cells gave rise to pinealoblasts, which differentiated into the definitive parenchymal element, the pinealocytes. He further added that the innervation of the pineal gland began to develop by 18 days of gestation. Nerve fibres from the posterior commissure penetrated at least a portion of the developing gland.

Soon after birth, the sympathetic fibres were found primarily in the capsule of the gland. Two days later, the complete gland was innervated.

B) POSTNATAL DEVELOPMENNT

Ito and Matsushima (1967), studied the postnatal development of the pineal body in mouse. They noticed that during postnatal development, the pineal gland showed no sex difference in absolute size. The growth in volume gradually increased from birth to 40 days, remained the same for a short period between 40 and 60 days, and after 60 days again increased until 90 days, when it finally attained the adult volume. From 90 to 210 days, it remained almost constant. The pineal growth during early postnatal period especially the first ten days, was attributed to both proliferation and enlargement of pineal cells but after 20 days, primarily to enlargement. They further added that the nuclear density (number of nuclei per unit area) of pinealocytes demonstrated a nearly inverse relationship to the growth of the gland. However, the stromal cells remained almost unaltered via all the periods.

Wallace, Altman and Das (1969), studied cell proliferation in the hooded rat with thymidine-H^3 autoradiography. They observed that cell proliferation was high in the neonate (one and six hours age) and continued at a decreasing rate into adulthood. The final development of the pineal body was believed to be due to cellular hyperplasia in the young animals and due to cellular hypertrophy in the adult.

Calvo and Boya (1983)b, studied the morphological development of the rat pineal gland from one day up to 60 days of age using electron microscopy. During the first days, undifferentiated cells (pinealoblasts) with scanty cytoplasm and frequent mitotic figures were observed. The differentiation of cell types (type I and II pinealocytes) began on the third day and was completed by days 15 - 20. At the third day of age, nerve fibres were first observed both in the connective tissue spaces and in parenchyma. After the fifth day, they noticed hypertrophy of pinealocytes, mostly type I pinealocytes which continued until 60 days of age. After 45 days, all the ultrastructural features described in the adult pineal gland were already present.

Sheridan and Rollag (1983), studied the morphological relationships between the superficial and deep pineal glands of neonatal Syrian hamsters. They noticed that on the first day of postnatal life, the pineal organ was a single midline evagination from the diencephalic roof. The pineal organ at this time contained a lumen which was continuous with the pineal recess. The first clear suggestion of separation into superficial and deep components appeared on the third postnatal day. A constriction occured, separating the original evagination into a proximal mass of parenchyma and a larger, more distal mass. At the end of first postnatal week, there was a clear demarcation between the superficial and deep components. They also noticed that the ultrastructure of the deep

gland was similar to that of the superficial gland throughout development.

As regards the postnatal evolution of the gland, they noticed that with the advance of age, there was an apparent increase in the number of dense-cored vesicles. At the end of the first week, light and dark parenchymal cells were present. During the second postnatal week, postganglionic sympathetic axons and their terminals appeared in the superficial pineal gland.

Calvo and Boya (1984), noticed that during postnatal development of pineal gland in rats, there was a marked increase in the gland and pinealocyte volume which was more intense during the first 45 days. After ten days, the differences in nuclear morphology of parenchymal cells showed two different types of pinealocytes. Type I pinealocytes showed large, round nuclei with pale chromatin and prominent nucleoli. These formed 85 - 90 % of parenchymal cells. Type II pinealocytes were fewer, forming about 10 - 15 % of cells, and they presented smaller, ovoid nuclei containing a more dense and homogenous chromatin. The characteristic adult arrangement of pinealocytes in cords and pseudo-rosettes was observed after 15 - 20 days. After 75 days, there was a progressive increase in the number of connective tissue fibres.

C) GROSS ANATOMY

Baker, Lindsey and Weisbroth (1979), noticed that the pineal body of the albino rat appeared as a dark protrusion from the caudal portion of the roof of diencephalon. They considered it as a sense-neuro-endocrine organ or a neuro-endocrine transducer which converted neural input into endocrine output.

Williams and Warwick (1980), stated that the pineal gland in man was a small, piriform, reddish-grey organ which occupied the depression between the superior colliculi, inferior to the splenium of the corpus callosum. They added that its base was attached by a peduncle or stalk which was divided anteriorly into two laminae: superior and inferior, separated from each other by the pineal recess of the third ventricle.

Reiter (1981), stated that the pineal gland of rodents displayed a remarkable degree of anatomical variation in form, size and location. Most of the albino rats had a superficial and deep glands connected by an obvious stalk while few of them had no stalk. In all cases, the deep pineal gland was considerably smaller than the superficial one. There seemed to be no major differences between the sexes in terms of the arrangement of the pineal complex.

This was confirmed by Reuber and Vollarth (1983), who noticed that the superficial pineal gland was found immediately beneath the skull, while the deep pineal gland was found in the inter-commissural region.

As regards the blood supply, Reiter (1981), noticed that the major blood supply to the pineal gland was provided by branches of posterior choroidal arteries that were derived from the posterior cerebral arteries. The arteries branched extensively in the capsule of the gland before they penetrated the parenchyma. Areas of the gland were abundantly supplied with capillaries. The venous drainage of the pineal gland was via the distal end of the great cerebral vein.