Al Ameen J Med Sci 2013; 6(1):80-84 ● US National Library of Medicine enlisted journal ● ISSN 0974-1143

ORIGINAL ARTICLE CODEN: AAJMBG

Comparative histomorphological study of the pineal gland in human and fowl

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Abstract: *Objectives*: Comparative histological studies of pineal gland of man and fowl has been made to observe structural differences if any between these two species. *Background*: Some works have been done sporadically on laboratory animals and on birds and also in human correlating with other parameters. In this investigation an approach has been made to observe the cellular organization of the pineal gland parenchyma in these two vertebrates, having different physiological aspects. *Methods:* Some special stains were used to observe connective tissue elements (Reticulin,collagen and elastic fibers) along with conventional H and E stains. *Result and conclusion:* The lobular character of the gland, connective tissue septa, shape and size of the pinealocytes were found to be almost common in both species. Major differences seen in fowl pineal gland are the presence of ependymal cells on the walls of the lumen of the lobules and absence of corpora arenacea.
Keywords: Pineal gland, comparative histology, man, fowl.

Introduction

Pineal gland is a small pea like cone shaped structure situated in the midline at the superior aspect between the superior colliculi and related to the third ventricle and forms part of epithalamus in man. However, in case of fowl the gland is situated superficially behind the junction of cerebral hemisphere in a triangular space formed between the enlarged superior colliculi and the anterior aspect of cerebellum. It is connected to the roof of the third ventricle by a long flexuous stalk. Earlier this gland was believed to be a vestigial structure but after the discovery of the hormone melatonin from the pineal body, it is considered as an endocrine gland. This hormone modulates wake/sleep process in higher vertebrates. In some lower vertebrates pinealocytes show resemblance to the photoreceptor cells of eye and according to some evolutionary biologists vertebral pineal cells and retinal cells share a common evolutionary ancestor. Exposure to light can set off a chain reaction of enzymes, hormones and neuroreceptors in some vertebrates which may regulate animal's circadian rhythm. It is also believed that in several species pineal hormones influence sexual development, hibernation and seasonal breeding. Melatonin inhibits testosterone secretion by acting at Hypothalamo pituitary-gonadal axis in rat [1]. Light therapy and melatonin supplement is helpful in restoring circadian rhythm in aged human [2].

Melatonin alters the firing rate of the gonadotropin-releasing hormones (GnRH) pulse frequency generator in the hypothalamus, thus reduce pituitary secretion of gonadotropin and PRL and indirectly the secretion of estrogen by the gonads. In mammals it has shown to delay puberty, suppress ovulation and reduce gonadal steroidogenesis. In the present study histomorphological observation has been made in the parenchyma of pineal gland of human and bird (fowl) on comparative basis to find out structural differences if any.

Material and Methods

Six sets of samples (whole pineal gland) of human and fowl were collected. Samples from human brain were collected from freshly available cadavers in the department of Anatomy, R.G.Kar Medical College, Kolkata. Samples from fowl were collected from slaughter house materials.

In all the cases the skulls were exposed at the level of mid brain by removing the skin, bone and meninges. In case of man the pineal gland was accessed by separating the cerebrum and cerebellum manually. In case of fowl the small reddish brown pin head structure was found superficially just below the skull bone and meninges as it was attached to the mid brain by a flexuous long stalk.

Each of the samples was preserved in 10 % Neutral buffer formation (NBF) for histological study. 5 micron thick sections were cut with the help of rotary microtome and stained with Harris hematoxylin. For staining reticular fibers Gridley's modification of the silver impregnation method (Gridley, 1951) was used. For studying collagen fibers, Van-Gieson's method (Mallory, 1961) and for elastic fibers Weigerts Resorchin-Fuchsin method (Mallory 1961) was adopted.

Results

The Pineal gland of human and fowl was found to be surrounded by a connective tissue capsule which invaded the parenchyma in the form of thin trabeculae. These trabeculae divided the whole parenchyma into a number of irregular lobules (Fig 1, 2). This lobular pattern was well defined in fowl in comparison to that of human. The trabeculae were rich in reticular fibers but poor in collagen and elastic fibers (Fig 3). The diameter of the lobules were 169.74±35.84 microns in man and 174.75±41.37 microns in fowl.

Figure-1: Section of pineal gland of human showing lobules (L), septa (S) and blood vessel (B). Gridleys modification of silver impregnation method x 40

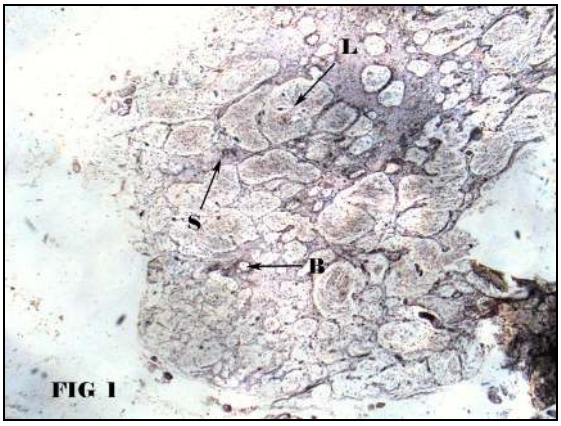


Figure-2: A section of pineal gland of fowl showing lobules (L), capsule (Ca) and septa (S). Gridleys modification of silver impregnation method x 40

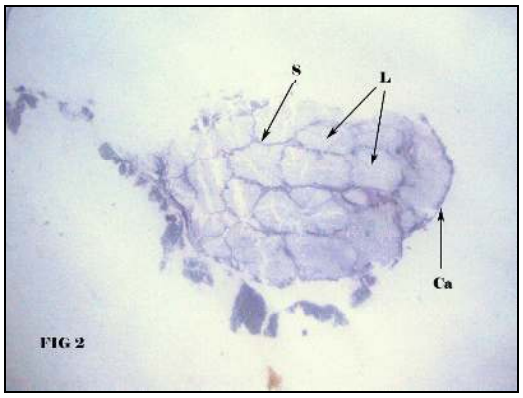
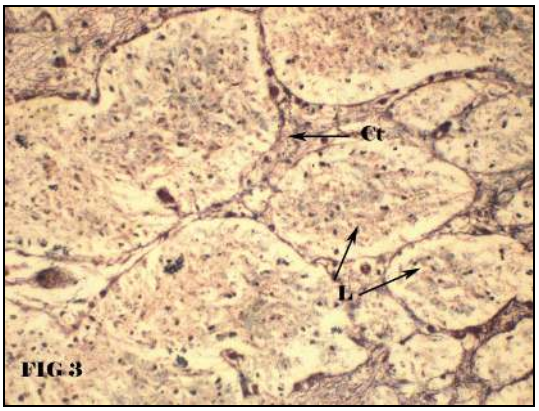


Figure-3: Section of human pineal gland depicting clear lobulation (L) and connective tissue septa (Ct). Gridleys modification of silver impregnation method x 200.



The lumen of the lobule was very clearly observable in fowl (Fig 4). The lumen of the lobule in human pineal gland was found to be ill defined and were mostly obliterated. In few lobules of human pineal gland poorly demarcated lumen were seen which contained desquamated materials (Fig 5). However in case of fowl these lumen were narrow but clear and lined by elongated closely packed columnar types of cells, represented ependymal cells. In the next layer, the wall of the lumen contained numerous discretely arranged cells which differed in structure with those of pinealocytes, called hypendymal cells (Fig-4). Both types of these cells-Ependymocytes and hypendymocytes were not found in human. A good number of blood vessels could be detected within the connective tissue septa around the lobules in all the tissue samples.

The parenchyma of the rest portion pineal gland contained two main types of cells within the wall of the lobules. These were pinealocytes and some supporting cells, the astrocytes. The Pinealocytes were found to be irregularly elongated cells with a good number of processes extended towards the periphery in a radiating manner. Each of these cells contained a large oval nucleus. The cells were arranged in isolation or in groups of 3-4 cells. This was a common feature in human and fowl. The cytoplasmic process were more prominent in the sections of human (Fig 4, 6). With these processes they established connections with surrounding cells (Fig.2, 4 and 6). In some places these processes were found to be attached with the wall of local blood vessels. The average diameter of the pinealocyte was 6.69±0.47 microns in human and 6.2±1.23 microns in fowl.

Figure-4: Section of lobule of pineal gland of fowl depicting lumen (Lu), ependemocyte (E), hypendymocyte (H) and pinealocytes (P). H & E x 400

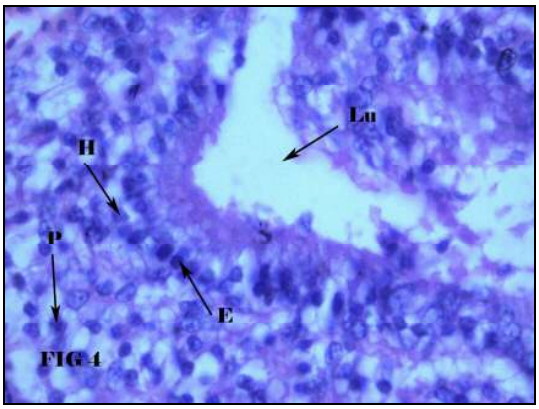


Figure-5: A single lobule of human pineal gland, showing obliterated lumen (Lu), pinealocyte (P), astrocyte (A), their processes (Pr) and blood vessel(B). H&E x 400

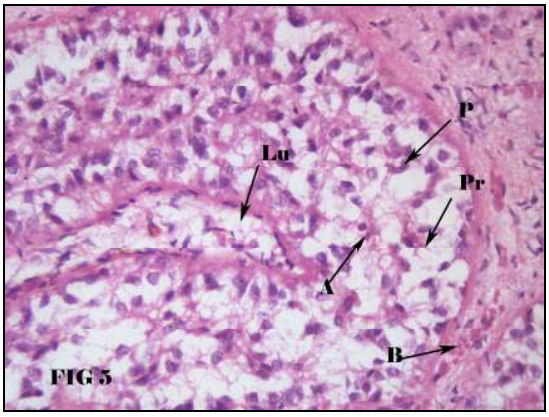
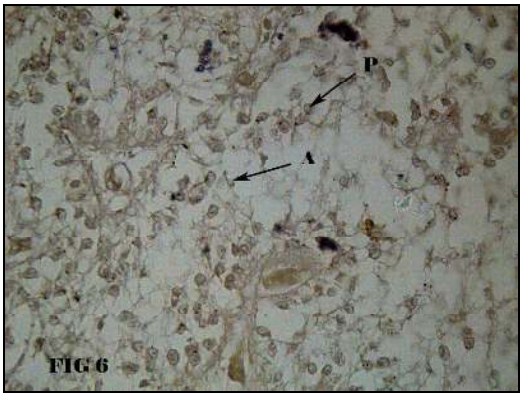
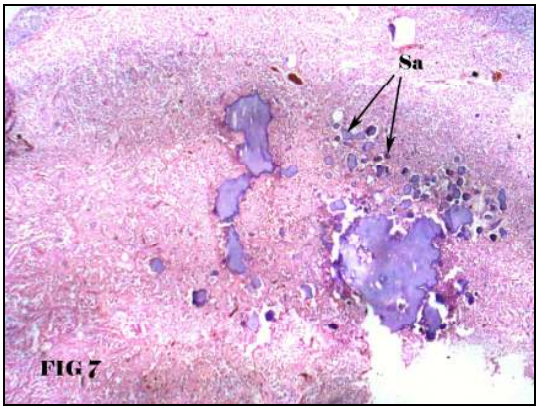


Figure-6: A lobule of human pineal gland showing pinealocytes (P) and astrocytes (A). Weigerts Resorcin- fuschin method x 400



Few small elongated cells with many processes were detected in between the pinealocytes, represented astrocytes. These were deeply stained with ill defined nucleus and arranged singly or in chains of 2-3 cells. The number of astrocytes was far less than that of pinealocytes. A good number of blood vessels were found in the Septa as well as in the inter lobular connective tissue. Numerous calcified masses of varying sizes could be detected only in human samples towards the middle of the gland parenchyma, were the corpora arenacea or the brain sand. They appeared as deep violet structures in H & E stained sections. Any such deposition in the parenchyma of pineal gland could not be detected in fowl (Fig 7).

Figure-7: A transverse section of a pineal gland of man showing corpora arenacea (brain sand) (Sa) of various sizes which stained deep violet. H & E x 100



Discussion

The pineal gland was surrounded by a connective tissue capsule which sent septa and trabeculae inside and divided the parenchyma into numerous lobules in both the species. Fibrous capsule derived from the piamater sent numerous vascular septa into the body of the organ [3-4]. In fowl the capsule of the organ originated from leptomeninx and is fused with duramater on the surface next to the cerebral hemisphere [5-6].

The lobulations of the gland was prominent in both human and fowl which were so formed by the invasion of vascularised septa into the parenchyma. The trabeculae were rich in reticular fibers but poor in collagen and elastic fibers. The average diameter of these lobules were 169.74± 36 microns in man and 174.75±41 microns in fowl. A space within the lobule was found very clearly in fowl which represented lumen. In human samples such clear lumen could not be detected. However, in some limited area ill defined obliterated luminal spaces were observed. Existence of follicles and cords within the parenchyma has been observed in human [7-8]. The wall of the sac of the epiphysis is thrown into folds to form crooned plates which are broken up into cords [4]. The presence of lobules within the parenchyma have been recorded in fowl [5], in duck [6, 9], in nocturnal birds [10] and in turkey [11].

A closely packed columnar type of cells lined the lumen of the lobules in fowl. These cells contained a deep stained round nucleus situated close to their bases, represented Ependymocytes. In the next layer the wall of the lobule contained numerous discretely arranged cells were Hypendymocytes. Rest portion of the lobules accommodated two main types of cells. The large oval elongated cells with a large round nucleus and several processes were the Pinealocyctes. These cells were found to be similar in shape and size in fowl and in human. The ependymocytes and hypendymocytes could not be detected in human tissue samples .The pinealocytes were distributed in an isolated manner or in the form of small cords in both the species. Plenty of intercellular spaces were observed which were mostly occupied by the cell processes of pinealocytes and by another variety of small supporting cells with elongated body and plenty of processes. There were the Astrocytes. Presence of ependymocytes in the form of tall columnar cells with basally situated vesicular nuclei arranged radially at the lumina of follicles are seen in fowl [5]. The mammalian pineal body was characterized by the occurrence in it of parenchymatous cells, neuroglia and ependyma [12]. The parenchyma of human pineal gland retained the histologic structure of the embryonic neural tube and composed of cells which have processes with club shaped ends in contact with blood vessels [4].

Neuroglial cells support the parenchyma and may be intermingled with pial, areolar connective tissue in the septa. The presence of ependymocytes in the pineal recess in man has been recorded [8]. The pinealocytes contained spherical, oval or lobulated nucleus and had basophilic processes which end in slightly expanded terminal buds close to capillaries [8]. Corpora arenacea or the brain sand in the form of numerous calcified masses of varying sizes with deep violet colour could only be detected in the medullary portion of the gland of human pineal gland in H & E stained sections. No such structure could be found in case of fowl. The presence of corpora arenacea in the form of mulberry shaped concretions could be seen which stained dark blue in H & E stains in human [4]. The calcium carrier complex so formed was deposited in concentric layers around the exocytotic debris formed corpora arenacea or brain sand [8].

Structural differences with regard to the presence of lumen inside the lobules lined by ependymal cells and absence of brain sand in the fowl pineal gland were clearly detected when compared to that of human.

Acknowledgement

The authors acknowledge the co-operation and help of the staff members of the departments of Anatomy, R G Kar Medical College, Kolkata and Bengal Veterinary College, Kolkata.

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