HISTOLOGICAL STUDY OF FOETAL SUPRARENAL CORTEX

Sushma Korukonda[1], Jami Sagar Prusti[2]

[1]Assistant Professor, Department of Anatomy, Gayatri Vidya Parishad Institute of Health Care and Medical Technology, Visakhapatnam, Andhra Pradesh.
[2]Professor and HOD, Department of Anatomy, Saheed Laxman Nayak Medical College, Koraput, Odisha.

ABSTRACT

BACKGROUND

The cortical portion of the suprarenal gland (SRG) develops rapidly and is relatively more advanced during the first half of pregnancy than the other abdominal or thoracic organs. The cortex of the foetal adrenal gland is much thicker than that of the adult gland and consists of at least two histologically distinct layers: the outer definitive zone and the inner provisional zone. The inner, provisional cortex continues to grow as long as the foetus remains in the uterus, but immediately after delivery it begins to retrogress. No other organ in the body except the uterus and mammary gland grows in this manner.

MATERIALS AND METHODS

In view of the interesting changes in the histology of the gland during its development, this study was undertaken to study its histogenesis in 50 human foetuses of different age groups ranging from 12-40 wks. using routine histological stain haematoxylin and eosin and to observe with the advancing gestational age, the changes in the cortex of the gland, the ratio of the permanent cortex to foetal cortex, the differentiation of permanent cortex into its three zones and do histometry to measure the thickness of capsule, superficial and deep cortices. Very less literature is available regarding the histogenesis of the SRG. The present study is an attempt to add data to the existing literature.

RESULTS

The capsule was identifiable by 12 wks. and it increased in thickness with increasing gestational age. Two regions in the cortex were identified i.e. the adult cortex with small basophilic cells that was subcapsular in position, and foetal cortex with large eosinophilic cells towards medulla. Micrometry was done and in the early weeks, the adult cortex seems to occupy 1/4th of the cortex and foetal cortex the remaining 3/4th; later by 24 wks., the foetal cortex became bulkier and measures 4/5th of the cortex with the adult cortex occupying only 1/5th.

CONCLUSION

The large size of the SRG results from the extensive size of the foetal cortex, which produces steroid precursors that are used by the placenta for the synthesis of oestrogen.

KEYWORDS

Adult Cortex, Capsule, Foetal Adrenal Gland, Foetal Cortex, Micrometer.

HOW TO CITE THIS ARTICLE: Korukonda S, Prusti JS. Histological study of foetal suprarenal cortex. J. Evid. Based Med. Healthc. 2018; 5(45), 3144-3148. DOI: 10.18410/jebmh/2018/640

BACKGROUND

The foetal Suprarenal glands are relatively large. At four months of gestational age the SRGs are larger than the foetal kidney and at birth they weigh approximately 0.2% of the total body weight and thus accounting to about twenty times their relative size in the adult.[1] Within a few days of birth striking changes occur in the foetal cortex and there is a net loss of about 50% in the total weight of the gland in the first 2-3 weeks of the postnatal period. The study of the development and histology of the foetal SRGs reveals interesting histological changes that relate to the morphometric changes observed in the glands. The SRGs of higher vertebrates are formed by two primordia of different origin; mesodermal and ectodermal, which become respectively the cortex and the medulla of the adult gland. The foetal suprarenal cortex, in contrast to the other endocrine glands i.e. thyroid, parathyroid and pancreas, is a mesodermal structure.[1]

The first intimation of the development of the cortices of the glands is a thickening that occurs in the mesoderm near the root of the dorsal mesentery. Two substantial masses of cells, one on each side, form in this region and come to lie close to the developing kidney. It seems likely, from the studies of Keene and Hewer that, as development proceeds, the original mass of cells making up the cortex becomes capped and then surrounded by a second mass of cells derived approximately from the same site as the first. The original or inner mass forms what is called the provisional or foetal cortex of the gland, and the second or outer mass that subsequently covers it, the permanent cortex.[2]

Financial or Other, Competing Interest: None.
Submission 08-10-2018, Peer Review 11-10-2018,
Acceptance 28-10-2018, Published 02-11-2018.
Corresponding Author:
Dr. Jami Sagar Prusti,
Professor and HOD, Department of Anatomy,
SLN Medical College, Koraput- 760004,
Odisha.
E-mail: sagarprusti72@gmail.com
DOI: 10.18410/jebmh/2018/640

The provisional cortex becomes arranged into cords separated by blood vessels, and the structure as a whole reaches a high state of development during foetal life. Not only do the cells of the provisional cortex comprise the bulk of the cortical tissue that exists at this time, but also, they are so numerous as to make the adrenal cortex of the human foetus an organ of impressive size. The cells of the permanent cortex do not develop to any great extent during this time. However, after birth the foetal cortex – so highly developed during foetal life – undergoes a rapid involution. As this occurs, the cells of the permanent cortex begin to differentiate into the 3 zones that characterize the adult cortex.[2]

The fact that the provisional cortex of the SRG has a somewhat different origin from the permanent cortex of the gland and that it is enormously developed in foetal life but involutes after birth suggests strongly that this provisional cortex should be regarded as an endocrine gland in its own right, having a special function in foetal life. Since it involutes after birth, the trophic hormones that cause its great development during foetal life may perhaps be the gonadotrophic like hormones made by the human placenta during pregnancy, and that they might require the cooperation of the anterior pituitary of the foetus to be effective in the foetus. One difficulty in determining the function of the adrenal cortex in foetal life is that a comparable development of the provisional cortex does not occur in the foetuses of the common experimental animals; hence the experimental study of the provisional cortex of the foetus is correspondingly restricted.[2]

In view of the interesting changes in the histology of the gland during its development, this study was undertaken to study its histogenesis in different age group foetuses ranging from 12-40 wks. using routine histological stains haematoxylin and eosin and to observe with the advancing gestational age, the changes in the cortex of the SRG, the ratio of the permanent cortex to provisional cortex, and to do histometry and measure thickness of the capsule, superficial and deep cortices. Limited literature is available regarding the histogenesis of the SRG. The present study is an attempt to add data to the existing literature.

MATERIALS AND METHODS

The present study was carried out in the Department of Anatomy, GVP medical college, Visakhapatnam. The material for the study consisted of 50 human foetuses aged between 12-40 weeks of gestational age. The foetuses were obtained from the Department of Obstetrics and Gynaecology, GVP Hospital, Visakhapatnam.

All the foetal specimens obtained for the study were the result of intra-uterine death and spontaneous abortions. Obstetric history was obtained in each case. The obtained foetuses were numbered appropriately. The age of the foetuses was calculated from the crown-rump length measured by using thread and scale, foetus weight that was measured using weighing scale and by observing the external features of the foetuses. The reference values were taken from Langman's text book of Medical Embryology.[3] Irrespective of the gender, the foetuses were grouped into 6 groups based on their gestational age. The foetuses were subjected to dissection. Both the right and left SRGs were used for the study. The suprarenal glands thus obtained were processed for histological study using haematoxylin and eosin staining method. The sections were studied under low power objective to study the capsule.

Histometry was done using the ocular micrometer to measure the thickness of capsule and the cortex. The total width of the cortex, width of permanent cortex and width of foetal cortex where taken using a horizontal eye piece micrometer called graticule. The graticule was calibrated using a stage micrometer. A stage micrometer is a glass slide of three inches in length and is divided into 0.1 and 0.01 parts of a millimeter. The value of one eyepiece division is determined by calibrating with stage micrometer for every optical combination to be used. Width of the permanent zone as a percentage of the total width of cortex was calculated at five different sites in a selected section of the gland. Then the average values were calculated.

Groups	Gestational Age (Weeks)	Number of Foetuses
A	12-16	3
B	17-21	4
C	22-26	8
D	27-31	8
E	32-37	12
F	38-40	15

Table 1. Grouping of Foetuses

Inclusion Criteria

The foetal specimens obtained were the result of intrauterine death and spontaneous abortions. Foetuses, which appeared normal in appearance were only included for the study.

Exclusion Criteria

Foetuses with gross malformations, urogenital anomalies and of mothers suggestive of endocrine disturbances were not included in the study.

RESULTS

The capsule and cortex were studied and measured. In the foetuses grouped in Group A, the capsule of SRG was thin and well identifiable measuring 40-45 microns at the periphery and 80-85 microns at hilum. In the SRG of foetuses in Group B, the capsule was thicker and better defined with a thickness of 50-55 microns with connective tissue septa radiating from it and extending into the cortex. Under high power (40X) magnification, the capsule showed collagen fibres and fibroblasts with occasional blood vessels. The septa also showed blood vessels. With increasing gestational age, the capsule increased in thickness and measured about 55-60 microns in foetuses of Group C; 65-70 microns in foetuses of Group D; 100-105 microns wide in Group E and Group F showed thick and dense capsule measuring about 130-135 microns in width. (Table 2)

Group	Capsule Thickness in Microns
A	40-45
B	50-55
C	55-60
D	65-70
E	100-105
F	130-135

Table 2. Showing the Increasing Thickness of Capsule with Each Group

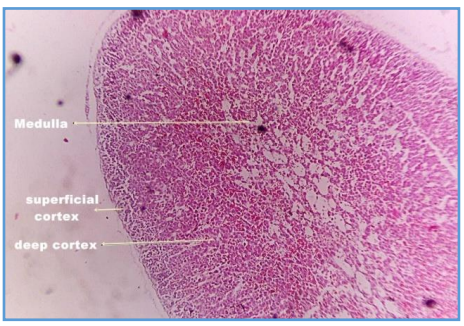

Figure 1. H & E Stained Section of SRG of 24 Wks.

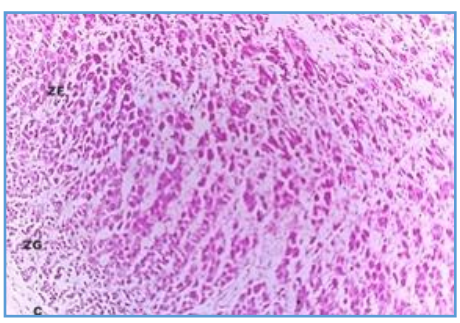

Figure 2. H & E Stained Section of SRG at 24 Wks.

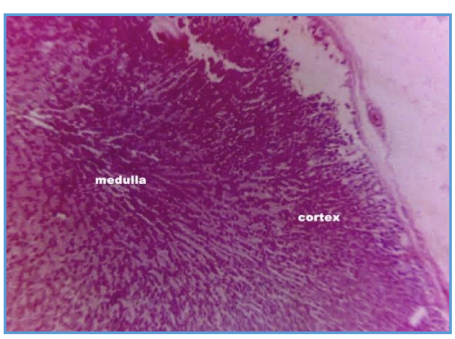

Figure 3. H & E Stained Section of SRG at 28 Wks.

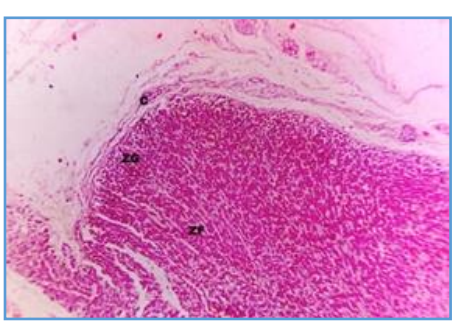

Figure 4. H & E Stained Section of SRG at 32 Wks.

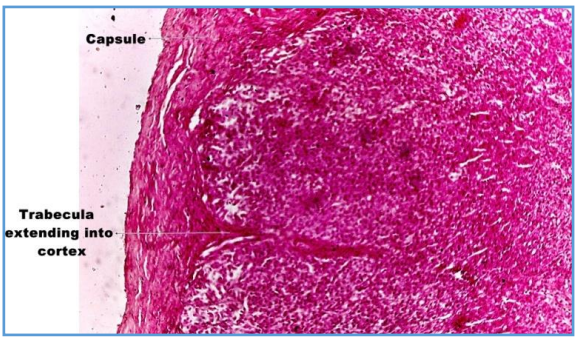

Figure 5. H & E Stained Section of SRG at 32 Wks. Showing the Thick Capsule & Trabecula

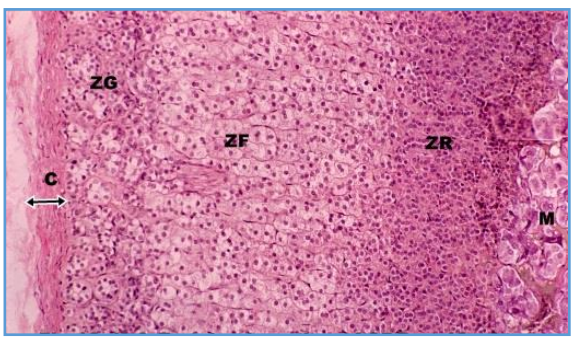

Figure 6. H & E Stained Section of SRG at 40 Wks.

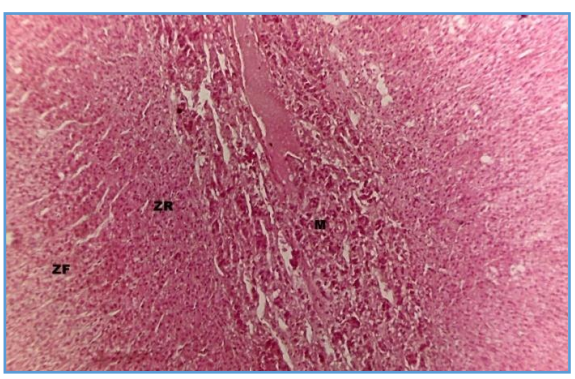

Figure 7. H & E Stained Section of SRG at 40 Wks. – Medulla Showing Blood Vessels

List of Abbreviations used in the figures-

C- capsule
M - medulla
SRG - supra renal gland
Wks. - weeks
ZG – zona glomerulosa,
ZF – zona fasciculata
ZR - zona reticulosa

The cortex was observed to have two zones i.e., superficial and deep zones in all the groups. The superficial zone showed small darkly staining basophilic cells and it was thinner than the deep cortex that showed eosinophilic cells. With increasing gestational age, the deep cortex became bulkier accounting to about 4/5th of the cortex.

In group B foetuses, the superficial zone showed clusters of cells in the form of arches representing the future zona glomerulosa and the deep cortex showed cells arranged in rows like adult zona fasciculata.

In group C foetuses, in the superficial zone, acini were observed with central light core and in the deep zone large cortical cells arranged in rows were seen. Towards the medulla, loose network of cells was observed. (Figure 1, 2).

In group D foetuses, the superficial zone showed small polygonal cells organized in the form of semilunar arcs of acini with lighter core in the centre and the deep zone that became bulkier than before showed polygonal cells arranged in rows extending from superficial dark zone up to the central region towards the medulla. (Figure 3)

In group E foetuses the thin superficial cortex showed cells arranged in the form of groups and the deep cortex showed cells arranged in long rows. (Figure 4, 5)

In Group F, indistinct superficial and deep cortices were observed with the superficial cortex showing small cells arranged in small groups. Glomerular arrangement was appreciated whereas in the deep cortex cells were arranged in rows and were well defined and arranged like adult zona fasciculata. Cells towards the medulla arranged in the form of network. (Figure 6, 7)

Group B onwards, sinusoids were observed in the sections, their number increasing with age and the appearance of perisinusoidal vessels was observed.

DISCUSSION

At birth the supra-renals are relatively large and constitute 0.2% of the entire body weight compared with 0.01% in the adult and are approximately one third size of the ipsilateral kidney.[4]

The large suprarenal glands result from extensive size of the foetal cortex, which produces steroid precursors that are used by the placenta for the synthesis of estrogen.[5]

Starkel & Wegrzynowski,[6] attributed the large size of the suprarenals in foetal period to the presence of a zone which was present only during foetal period occupying about 80% of the entire cortex. This zone is limited by a peripheral strip of darkly stained zone called the permanent cortex constituting about 20% of the entire cortex. However, they did not measure fasciculoreticular zone & sinusoidal vessels. Mc Intosh[7] described the outer permanent zone forming only 20% of the whole cortex.

According to Wendell Smith[8] after vascularization and encapsulation by surrounding mesoderm, nests of proliferating cells under the capsule form the primitive glomerular zone. From them cords grow centripetally to constitute the foetal cortex, which is bulky and responsible for the relatively large size of the suprarenal in the newborn. The foetal cortex shrinks rapidly after birth as the cords degenerate and are replaced by a definitive fascicular zone growing from the glomerular zone.

In their study, Sangmaet al[9] have reported to have observed a well-defined capsule in foetal SRGs of 9-16 wks. that was well developed and completely surrounding the gland in the SRGs of 28-32 wk. foetuses. They have observed a superficial narrow zone of darkly stained cells underneath the capsule which is the permanent cortex that showed uniformly scattered cells in 16-22nd week foetuses that in later age groups clumped together in arc or acini formation and a deeper lighter zone called the foetal cortex that became bulkier with advancing age occupying 5/6th of the entire cortex in term foetuses.

Sant Ram et al,[10] in their study have done histometry and reported that the capsule was identifiable & measured 59 µ at periphery & 124 µ at hilum, at 11-15 wks. of gestation & the thickness increased to 312 µ at more than 25 wks of gestation. They observed two zones of cells in the cortex like the previous authors. They reported that the superficial strip of dark zone (permanent cortex) occupied 1/4th of the cortex at 11-15 weeks of gestation which increased to 4/5th of cortex at >25wks. They observed that the cells were present in U shaped arrangement/clusters/groups and glomerular arrangements of cells were also seen. They reported that deep to the dark zone there was a lighter zone (foetal cortex) constituting 3/4th of the cortex at 11-15 weeks which increased to 4/5th of the cortex at >25 weeks which suggested that the foetal cortex was becoming bulkier.

In the present study, the capsule was well identifiable by 12 wks. On high power (40x) magnification, collagen fibres, fibroblasts and blood vessels have been identified. This is in accordance with that of Sant Ram et al.[10] Trabeculae extending from capsule into the substance of cortex carrying blood vessels were identified by 24 wks.

The capsule measured 40 microns from 12 -15 wks. after which it measured 54 microns from 16 – 23 wks. By 24 wks. it was 67.5 microns and increased to 108 microns by 32 wks. and 135 microns by 36 wks. These values are less than those obtained in the study by Sant Ram et al.[10] In the present study, like the previous authors two zones in the foetal cortex were observed. Histological study and micrometry done on the cortex of foetal SRGs have revealed a foetal cortex that became bulkier with advancing age that correlated with the findings of the previous studies.

The bulk of the foetal adrenal gland is largely due to the presence of the foetal adrenal cortex that produces Dehydroepiandrosterone (DHEA) and DHEA-sulphate. These weak androgens are important precursors of placental oestrogens. Later in gestation, the foetal adrenal gland will also produce aldosterone and cortisol. Therefore, the foetal adrenal gland is an organ of immense importance for maintenance of pregnancy and foetal homeostasis. The hormone production also promotes organ maturation late in gestation and may assist in the timing of labour. After birth, the foetal zone of the adrenal gland involutes and the adrenal weight is markedly reduced.[11] The foetal zone or transitional cortex, is not present in most mammals, but is seen in humans and a few nonhuman primates.

It appears that the large size of the foetal SRG is due to stimulation by ACTH from the foetal pituitary, although it has been suggested that HCG, secreted by the placenta, may play some part by contributing to the increase of ACTH, by impairing foetal adrenal biogenesis or by accelerating the degradation of the foetal corticoids. Evidence in support of the role of foetal ACTH secretion in the enlargement of the foetal cortex is derived from the fact that in anencephaly, in whom the pituitary is absent, the suprarenals are atrophic.

There is indirect evidence that the production of ACTH from the foetal pituitary is under some regulatory control. The large SRGs normally encountered in the foetus are not under maximal stimulation by ACTH since larger ones are encountered in patients with the adrenogenital syndrome, consequent upon excessive ACTH stimulation. Conversely, cortisone administration to the mother can cause foetal suprarenal atrophy; this suggests that inhibition of foetal ACTH secretion may occur.[12]

The cortex and medulla of SRG have different origins, characters and functions. Therefore, each suprarenal gland is to be thought of as two glands in one. A better knowledge of the developing SRG would be obtained by studying together the morphological & histological changes that are taking place in the development of the gland.

CONCLUSION

The study of the histological changes of foetal adrenal cortex has revealed two zones of cells in the cortex- a subcapsular basophilic zone & an inner bulky eosinophilic zone. Patterning of the cells into networks, columns were observed but the stratification of the cortex into three layers like that of the adult cortex was not observed. The subcapsular zone was the permanent adult cortex and inner to it the provisional foetal cortex. Micrometry was done & in the early weeks, the adult cortex was found to occupy 1/4th of the cortex & foetal cortex occupied the remaining 3/4th; later by 24 wks., the foetal cortex became bulkier & measured 4/5th of the cortex with the adult cortex occupying only 1/5th. The development, differentiation & changes in the cortex of the foetal SRG, into peripheral and inner cortex & later changes relative to the foetal age have been found & confirmed in the present study. Morphometric study done on these specimens revealed a correlation between the increase in the size of the SRGs and the increase in thickness of the cortex. The bulky foetal adrenal cortex produces steroid precursors like dehydroepiandrosterone that is an important precursor of placental oestrogen that promotes organ maturation late in gestation and may assist in the timing of labour. The present study is an attempt to add to the existing literature on the histogenesis of the suprarenal gland. Histological studies on sections obtained from neonate and infant SRG specimens would show the involution of foetal cortex and the persistence of the adult cortex that is similar to the cortex of the adult SRG.

REFERENCES

[1] Hamilton WJ, Boyd JD, Mossman HW. Nervous system. In: Hamilton, Boyd and Mossman's human embryology. Prenatal development of form and function. 4th edn. London: W. Heffer and Sons Ltd 1976:518-159.

[2] Ham AW, Lesson TS. The endocrine system. In: Histology. 4th edn. London: Pitman Medical Publishing Co. Ltd 1961:763-765.

[3] Sadler TW, Langman Jan. Third month to birth: the foetus and placenta. In: Langman's medical embryology. 12th edn. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins 2012:96-100.

[4] Stranding S. Gray's anatomy: the anatomical basis of clinical practice. 40th edn. Philadelphia: Churchill Livingstone/Elsevier 2008:1218-1219.

[5] Moore KL, Persuad TVN. The urogenital system. In: The developing human clinically oriented embryology. 6th edn. Philadelphia: WB Saunders Company 1999:303-345.

[6] Starkel S, Wegrzynowski L. Beitrag zur histologie der nebenniere bei feten und kindern. Arch Anat Physiol 1910;8:214-235.

[7] Mc Intosh AD. The human foetal adrenal: a morphological and histochemical study with comment on the problem of function. Scotland Medical Journal 1940;5:242-249.

[8] Smith CPW, Williams PL, Sylvia T. The pharynx, face, respiratory system and endocrine glands. In: Basic human embryology. 3rd edn. London: Pitman Publishing Company 1966: p. 78.

[9] Sangma GTN, Ibochouba Y, Damayanti N. Development and maturation of suprarenal glands in human foetuses. J Anat Soc India 2008;57(1):1-7.

[10] Ram KS, Sharma M, Sharma A. Histogenesis of suprarenal gland in foetuses of different gestational age groups. International Journal of Biological & Medical Research 2013;4(1):2675-2682.

[11] Ernst LM. Adrenal gland. In: Ernst LM, Ruchelli ED, Huff DS, eds. Colour Atlas of foetal and neonatal histology. New York: Springer 2011:201-212.

[12] Lanman JT. The foetal zone of the adrenal gland: its development course, comparative anatomy and possible physiologic functions. Medicine 1953;32(4):389-430.