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Scanning and Transmission Electron Microscope Study of the Adrenal Gland of the Camel (*Camelus dromedarius*) During the Prenatal Life

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Authors' contributions

This work was carried out in collaboration among all authors. Author HBZ designed the study, collected the sample and doing the lap work performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author DIO mange the analysis of the study and managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The objectives of the present study are to investigate the features of camel foetal adrenal gland using scanning and transmission electron microscopes. This study was conducted in 14 dromedary camel foeti at different stages of development collected from different slaughters houses in sudan With scanning electron microscope, at the early stages the adrenal zones were not be differentiated Cleary, then the cells of the zona glomerulosa were arranged in compact clusters or groups and capillaries network were arranged between these groups. The cells of the zona fasiculata were arranged in the form of laminae or vertical parallel cords separated by longitudinally arranged sinusoids. The cells of the foetal zone were irregullary arranged. Some medullary islets were found between the cortical cells and some of the cortical cells were found between the cells of the medulla. The innervations and the blood supply of the adrenal gland increased with development. Ultrastructurally the noradrenalin secreting cells have more electron dense cytoplasmic granules than the adrenalin secreting zzcells. With advancing age, the cell organelles like mitochondria,

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smooth endoplasmic reticulum and the lipid droplets increased.
In conclusion, the major changes observed in the cells of the zona fasiculata and this may be due to its important role in the development of organs and during parturition. It was found that the prenatal development of the dromedary camel adrenal gland was similar to the development other animal adrenal gland but with special characteristic of it's on.

Keywords: Adrenal gland; animal histochemichal; Veterinary science; adrenal cortex.

1. INTRODUCTION

The prenatal development of the adrenal gland has been described in numerous published reports covering a wide variety of species, including the horse [1,2], sheep [3], ox [4] swine [5]. The prenatal development of the camel adrenal gland was briefly studied by El-Nahla, Imam, Moussa and El- sayed [6] and El-Nahla, Imam, Moussa, El- sayed and Aboot [7]. This study covered only the topography, histogenesis, and migration of the chromaffinoblast cells and some histochemical observations on the adrenal glands during prenatal life.

The ultrastructure of the adrenal gland was studied in rabbits [8],sheep [9], rats [10] and rodents [11]. There is no such information about the adrenal gland of camel in the available literature, there for this work was carried out to investigate the morphology of the camel foetal adrenal gland using electron microscopic technique.

There was not available literature about scanning electron microscope of the foetal adrenal gland. In the foal foetus, the cells of the zona glomerulosa contained smooth and rough endoplasmic reticulum and mitochondria with lamellar cristea. The cells which situated near the cortico-medullary border contained smooth endoplasmic reticulum, mitochondria with lamellar or vesicular cristae and a large Golgi apparatus [2].

In sheep foetus, Robison, Rowe and Wintour [9] stated that, between 35 and 60 days of gestation, one cortical cell type predominated. It contained mitochondria with lamellar and vesicular cristae, scattered long strands of granular endoplasmic reticulum and only small amount of smooth endoplasmic reticulum. After about 60 days of gestation, two zones were apparent in the cortex and chromaffin cells became concentrated in the medulla. After 80 days of foetal age, the outer zone contained cells which resembled mature zona glomerulosa cells and the cells in the inner zone remained like those seen between 35 and 60 days, except they contained even less smooth endoplasmic reticulum. However, after about 90 days, a small number of deep inner zone cells contained mitochondria with vesicular cristae which thus resemble mitochondria in the mature zona fasciculata.

From about 120 days, there was an increase in the number of cells in the inner zone containing mitochondria with vesicular cristae. These cells also contained substantial quantities of smooth endoplasmic reticulum. At term most inner zone cells have this mature appearance.

The cells of the adrenal cortex which have the typical ultrastructure of steroid-secreting cells do not store their secretory products in granules; rather, they synthesize and secrete steroid hormones when required [12].

In the dog, small granules were identified in the chromaffin cells of the adrenal medulla and cytoplasmic projections were observed in some of these cells. The densities of secretory granules were variable ranging from high to low electron density [13]. The small granule chromaffin cells were rich in free ribosomes and polysomes but were relatively poor in other cell organelles [14].

A well developed Golgi apparatus, abundant rough endoplasmic reticulum, a large number of mitochondria and lipofucsin pigments can be seen in the chromaffin cells in green land seal [15].

Kajihara et al. [13] identified small granules in the chromaffin cells in the dog adrenal medulla and these cells were characterized by having cytoplamic projections and contained a variable number of small secretory granules, rich in free ribosomes and polysomes but were relatively poor in other organelles. In human, chromaffin cells are characterized by a well developed Golgi apparatus, an abundant rough endoplasmic reticulum, a large number of mitochondria and lipofucsin pigments, [15].

2. MATERIAL AND METHODS

This study was conducted in 14 dromedary camel foeti collected from different slughter houses, The collected foeti which used in the study were waste material, the pregnant she camel were slaughtered for their meat by accident and their pregnancy was not diagnosis, when we found a graved utreus we collected the foetuses and calculated their ages by using CVRL equations.

For scanning electron microscopy specimens were immersed in amylacetate for 1-2 days and then dried using critical point drying process. Finally the specimens were coated by a very thin layer of gold and examined by JEOL JSM-6390LA analytical scanning electron microscope.

For transmission electron microscopy 21.4g of sodium cacodylate was dissolved in 900 ml distilled water and 40 ml from 1M hydrochloric acid was added and adjusted to PH 7.2 and then 30 g sucrose was added and shake. The solution was completed to 1000 ml by distilled water and the final PH was adjusted to (7.2). To make 2.5% glutaraldehyde fixative, 5 ml from 50% glutaraldehyde diluted by 95ml from the stock solution.

Stock solution this solution was prepared according to the method of [16].

Adrenal glands, at different stages of developments were cut into small pieces and fixed in 2.5 % gluteraldehyde in 0.1 M sodium cacodylade buffer. The sections were postfixed in 1% osmium tetraoxide and then dehydrated in ascending grades of alcohool (50, 70, 80, 90 and 100%) and embedded in Epon resin. Semi thin sections were cut and stained with toluidine blue and examined using Lica ICC50 HD camera with the light microscope to determine the desired area. Ultra- thin sections from the selected areas were cut with a diamond knife using lica Ultra cut ultra microtome (Bancroft and Steven, 1990). The sections were mounted on copper grids, treated with 5% aqueous solution of Uranyl acetate for 10 minutes, washed with distilled water and were stained with Reynoldes lead citrate for 10 minutes. The sections were examined by transmission electron microscope (JEOL (JEM-1400 TEM) for studying the intra cellular components of the different types of cells [16].

3. RESULTS

3.1 Scanning Electron Microscopy

3.1.1 First trimester

At the early stages of development, 7 cm CVRL (85 days of age) the adrenal gland has an oval shape and was attached to mesonephros, metanephros and gonads (Fig.1). At the surface of the gland as well as inside it, groups of migrating cells from the neural crest were detected. The majority of the gland was occupied by the foetal zone which appeared like irregular anstomosing cords with blood vessels in between (Fig.2).

With advancing development, the gland was covered by a thin capsule and the subcapsular arterial plexus began to be formed. The medulla was larger than the cortex and the medullary blood vessels were detected.

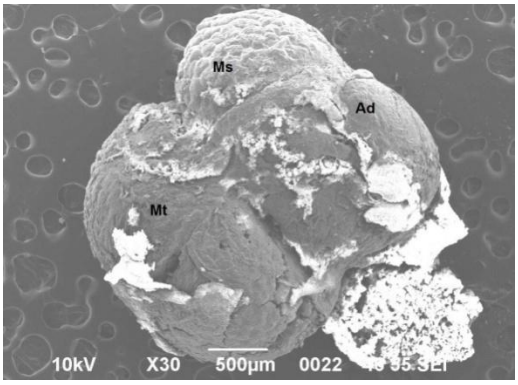

Fig. 1. Scanning electron micrograph of the adrenal gland from 7 cm CVRL foetus (85 days of age), showing the relation between the adrenal gland (Ad) mtetanephros (Mt) and mesonephros (Ms). X=30.

3.1.2 Second and third trimesters

The thickness of the capsule was increased, while the thickness of the cortex was narrower than that of the medulla and the subcapsular arterial plexuses were numerous. In the medulla the medullary vein were increased in size and its number of branches (Fig. 2).

The cells of the zona glomerulosa were arranged in compact clusters or groups of medium size and capillary networks were arranged between these groups. The cells of the zona fasiculata were arranged in the form of laminae or vertical

parallel cords separated with longitudinal capillaries. The cells of the foetal zone were irregullary arranged. With advancing age, groups of medullary islets were detected between the cortical cells. The cortex increased in width more than in the earlier stages. Pits and cavites were seen inside the gland stroma. The laminae of the zona fasiculata increased in length and some medullary islets were still present (Figs. 3). The cells of the zona reticularis were started to appear like anastomsing cords with large number of capillaries in between. The medullary vein and its branches were observed and medullary islets increased in number more than in the earlier stages (Fig.4). Externally, the adrenal gland nodules were attached to the adrenal surface by connective tissue (Fig.5). The adrenal gangilion and the greater splanchnic nerves were observed at the surface of the gland (Fig.5).

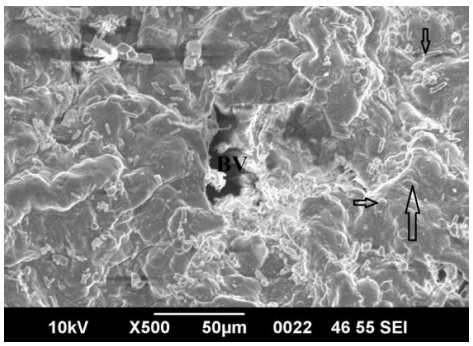

Fig. 2. Scanning electron micrograph of the adrenal gland of 7 cm CVRL foetus (85 days of age), demonstrating two types of cells (arrows) and blood vessel (BV). X=500.

3.2 Transmission Electron Microscopy

3.2.1 First trimester

At the age of 7 cm CVRL foetus (76 days of age), the adrenal gland was surrounded with a capsule and undifferentiated flat and dark cells were found at the surface of the gland. Some neuroblasts and fibroblasts were also found between these cells (Fig. 6). The glandular zonation was not formed. The cells at the outer region of the gland contained a few sporadic ovals to cuboidal cells which possessed microvilli, oval to round nuclei with some invaginations, heterochromatin and euchromatin and one nucleolus. Mitochondria were few and round to oval in shape and had tubular cristae, the rough endoplasmic reticulum was more prominent than the smooth endoplasmic reticulum and a Golgi apparatus was observed (Fig .6).

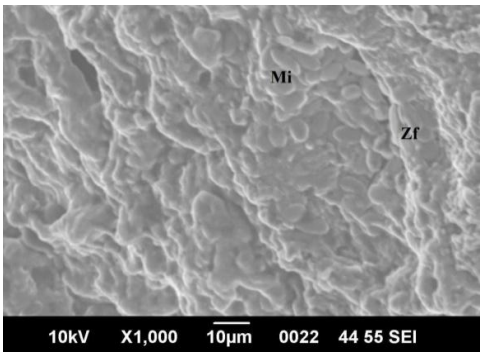

Fig. 3. Scanning electron micrograph of the adrenal gland of 92 cm CVRL foetus (317 days of age), demonstrating meullary islets (Mi) between the cells of the zona fasiculata (Zf). X= 1000.

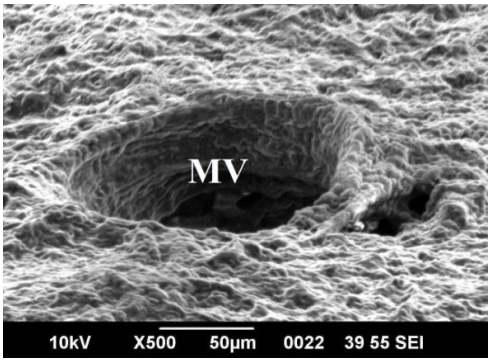

Fig. 4. Scanning electronmicrograph from 75 CVRL foetus (270 days of age) showing medullary vein (Mv). X= 500.

The cytoplasm of these cells was dense and a few secretory granules were found. The cells at the foetal zone were oval in shape and possessed large oval nuclei with heterochromatin and the electron dense cytoplasm contained coated vesicles (Fig.7). Oval mitochondria, Golgi complex, a few secretory granules and smooth endoplasmic reticulum were developed. The rough endoplasmic reticulm and ribosomes were found peripherally at one side of the cytoplasm (Fig.7).

The zona fasiculata consisted of cells with oval nuclei surrounded by narrow cytoplasm which contained Golgi apparatus with well developed cisternae, few round mitochondria and vesicular endoplasmic reticulm. Small cells with small nucleus and one or two neucleoi and contained

dark secretion, round to oval mitochondria, vesicular smooth endoplasmic reticulm, lysosomes, and dark secretory granules were also found.

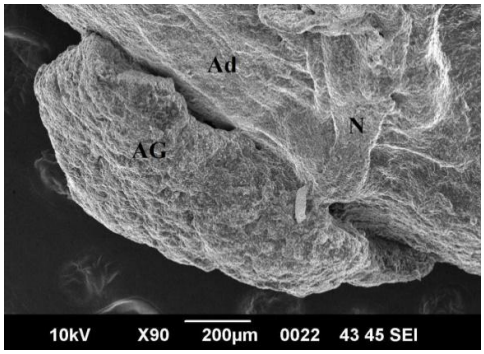

Fig. 5. Scanning electron micrographfrom92 CVRL(317 days of age) foetus demonstrating the relation between the adrenal gangilion (AG),the adrenal gland and the greater splanchnic nerve(N) . X= 90

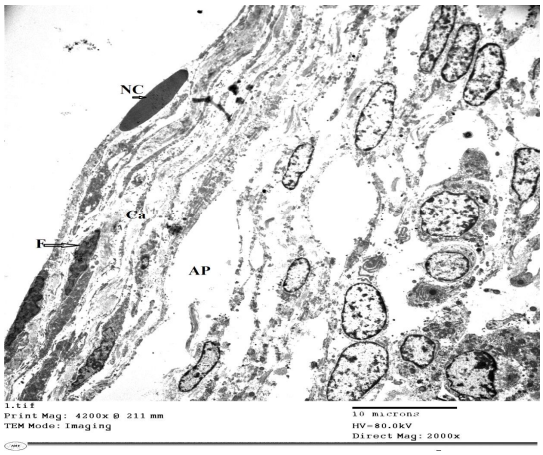

Fig. 6. An electron micrograph of the adrenal gland from 7 cm CVRL (85 days of age) foetus illustrating the ultrastructural features of the migrating neuroblasts (NC) from the neural crest at the capsule (Ca), fibroblasts (F) and subcapsular arterial plexus(AP). X 2000.

In the medulla, the medullary islets were poorly formed and contained a few adrenalin secreting cells, nor adrenalin secreting cells, a few cells containing small secretory granules and neurons. The adrenalin secreting cells possessed large round nuclei with one or two nucleoli, round or oval mitochondria with vesicular cristae, smooth endoplasmic reticulum, prominent rough endoplasmic reticulm, lipid droplets and dark granules (Fig.7). The noradrenalin secreting cells were elongated and have round nuclei with two nucleoli and the cytoplasm was more electron dense than that of the adrenalin secreting cells (Fig.8). Satellite cells were found between the adrenalin secreting cells and possessed rough endoplasmic reticulm and ribosomes. Blood vessels were found between the cells.

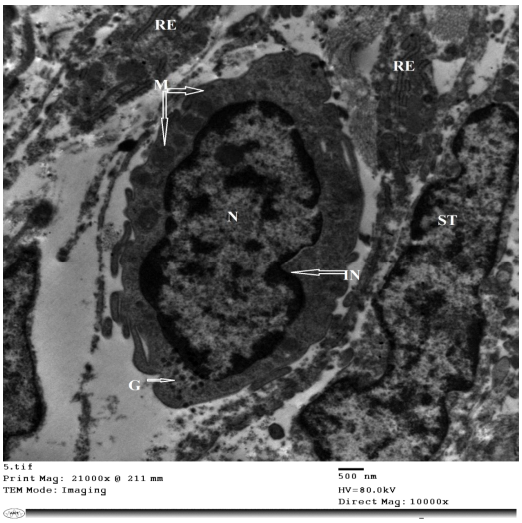

Fig. 7. An electron micrograph of the adrenal gland from 7 cm CVRL (85 days of age) foetus showing the immature cells of zona glomerulosa and sustentacular cell (ST), the immature cell contained dark granules G),the mitochondria (M), and a nucleus (N) with heterochromatin mainly attached to the neuclear membrane which showed invagination (IN) and neighbouring cells containing long cytoplasmic processes and rough endoplasmic reticulum (RE) X=10000.

At the age of 13 cm CVRL and 17 cm CVRL foetus (101 and 112 days of age), the cells of the zona glomerulosa had electron dense cytoplasm and contained oval nuclei large and oval mitochondria and the dark granules and lysosomes. Sinusoids were found in between.

The cells of the zona fasiculata were still not clearly differentiated and contained pale oval nuclei surrounded by narrow cytoplasmic rim, which contained a few round mitochondria, smooth endoplasmic reticulum with vesicular cristae, lipid droplets, vacuoles and Golgi apparatus.

The cells of the foetal zone were arranged in horizontal rows and possessed oval and invaginated nuclei with dark chromatin. And oval mitochondria and the electron dense cytoplasm

less than that of the cells of the zona glomerulosa (Fig. 9) the cytoplasm also contained dark granules, abundant rough endoplasmic reticulum and smooth endoplasmic reticulum, well developed Golgi apparatus and coated vesicles.

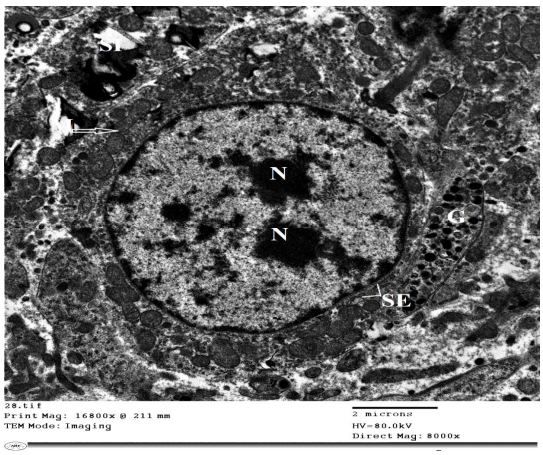

Fig. 8. electron micrograph of the adrenal medulla from 13 cm CVRL foetus (101days of age), illustrating oval adrenalin secreting cells (AD) with electron lucent cytoplasm, oval noradrenalin secreting cells (NA) with electrondense cytoplasm. Nucleus (N), mitochondria (M), rough endoplasmic reticulum (RE), secretory granules (Si) and blood vessel (BV) are present and part from a nor adrenalin secreting cell (NA).X=6000.

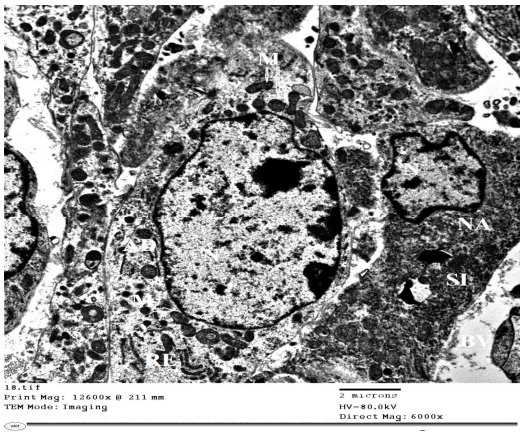

Fig. 9. Electron micrograph of the adrenal gland from 13 cm CVRL foetus (101) foetus. Noradrenalin secreting cell has a round nucleus with two nucleoli (N), mitochondria (M), smooth endoplasmic reticulum (SE), (Si) secretion and secretory granules (G).X=8000.

In the medulla, the adrenalin secreting cells were spherical in shape and possessed oval nuclei and granulated cytoplasm but the electron density of the cytoplasm was less than that of noradrenalin secreting cells (Fig. 9). The noradrenalin secreting cells were found at the center of the medullary islets and possessed electron dense cytoplasm. The two types of cells possessed a few number of mitochondria, and rough endoplasmic reticulum (Fig. 9).

3.2.2 Second trimester

In 23, 33 43, 49 cm 112 dayCVRL foetuses (128 ,156,186 and 189 days of age), the cortical stroma contained mylenated nerve fibers. The cells of the zona glomerulosa increased in number and were characterized by dark nuclei with heterochromatin and electron dense cytoplasm containing large amount of rough endoplasmic reticulum and well developed Golgi apparatus (Fig. 10).

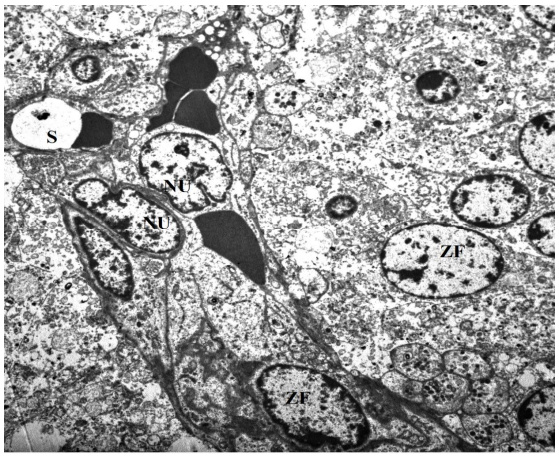

Fig. 10. Anelectron micrograph of the adrenal gland of 33 cm CVRL foetus (156 days of age), the cells of the zona fasiculata (ZF), synaptic gangilion cells (NU) and sinusoids(S). X=2000.

Groups of cells from zona fasiculata were seen between the cells zona glomerulosa. The cells of the zona fasiculata were oval with oval nuclei and pale cytoplasm containing more smooth endoplasmic reticulum than the rough endoplasmic reticulum and the Golgi complex was developed and the nerve fibers and nerve endings were increased in size and number and clear synapses were seen between two cell bodies (Fig.10).

The cells of the foetal zone were organized in the form of horizontal cords and had indented nuclei with heterochromatin. The cytoplasm was electron dense and contained of oval mitochondria, small amount of rough and smooth endoplasmic reticulum. The smooth endoplasmic reticulum was in the form of cisternae intermingled between the mitochondria. The cytoplasm also contained vacuoles and coated vesicles. Dark pigment cells, collagen fibers and nerves were observed.

In the medulla, the noradrenalin secreting cells had electron dense cytoplasm with dark granules and the nuclei contained heterochromatin. The rough endoplasmic reticulum and the Golgi complex were well developed. The adrenalin secreting cells possessed oval or round nuclei and electron lucent cytoplasm, and the rough endoplasmic reticulm was well developed. Close contact between the zona fasiculata and the medullary islets was observed.

lipid droplets and a large number of smooth endoplasmic reticulum and the spongy appearance of cells became quite obvious.

In 55 and 58 cm CVRL foetuses (214 and 225 days of age), the stroma of the adrenal gland contained more differentiated cells, well developed neurons, nerve endings and collagen fibers. The cells of the zona glomerulosa possessed dark oval nuclei and electron dense cytoplasm which contained a large amount of rough endoplasmic reticulum.

The cells of the zona fasiculata were well differentiated and had oval nuclei and each contained a nucleolus. Round to oval mitochondria, smooth endoplasmic reticulum and well developed rough endoplasmic reticulums were found. The maturation starts from the inner part of the cortex and then extended to the outer part. The cells of the foetal zone, containing large indented nuclei with heterochromatin attached to the nuclear membrane, the mitochondria were round to oval in shapes.

In (65 and 71) cm CVRL foetuses, (243 and 260 days of age) the foetal zone decreased in size while the zona glomerulosa became developed and the rough endoplasmic reticulum and mitochondria were increased. Some mature cells from the zona fasiculata with abundant smooth endoplasmic reticulum and mitochondria were sparsely distributed at the corticomedullary junction and the stroma of the zona fasiculata contained cells with dark granules and collagen fibers). In the medulla, noradrenalin secreting cells became more elongated and their cytoplasmic granules were bigger and more electron dense than the cytoplasmic granules of adrenalin secreting cells and the lipid droplets were increased. Groups of sinusoids, nerve fibers, nerve endings and gangilion cells were found inside the midullary stroma and the gland innervation was increased (Fig.11).

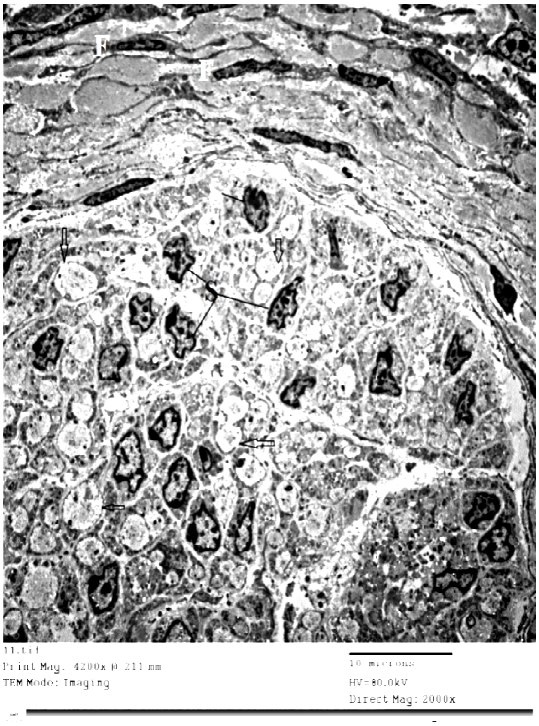

Fig. 11. An electron micrograph of the adrenal gland of 54.5 cm CVRL foetus (204) showing a cross section of a nerve bundle in the medulla surrounded by a connective tissue: fibroblasts (F), supporting cells (S) and axons (arrows). X=2000.

3.2.3 Third trimester

In 88 cm CVRL foetus (306 days of age), the cells of the zona glomerulosa increased in number and the lipid droplets, mitochondria and the rough endoplasmic reticulum were increased. The cells of the zona fasiculata became mature and the lipid droplets, mitochondria and smooth endoplasmic reticulum were abundant (Fig. 12).

Cells resembling the cells of the zona reticularis were seen. These cells were oval in shape and had polyhedral nuclei with hetero chromatin and

electron dense cytoplasm.The cells contained round mitochondria, rough and smooth endoplasmic reticulum, Golgi complex and lipid droplets. These cells were arranged in anastomosing network permeated with capillaries. (Fig.12).

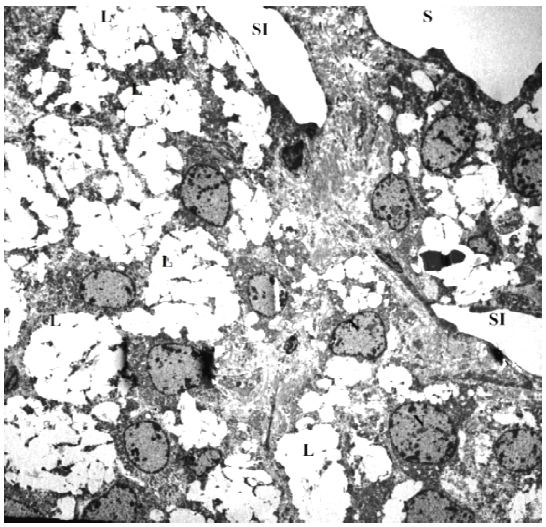

Fig. 12. An electronmicrograph of the adrenal gland from 88 cm CVRL (306 days of age) foetus. The mature cells of the zona fasiculata, contain many lipid droplets (L) and there are sinusoids (SI) in between. X=1500.

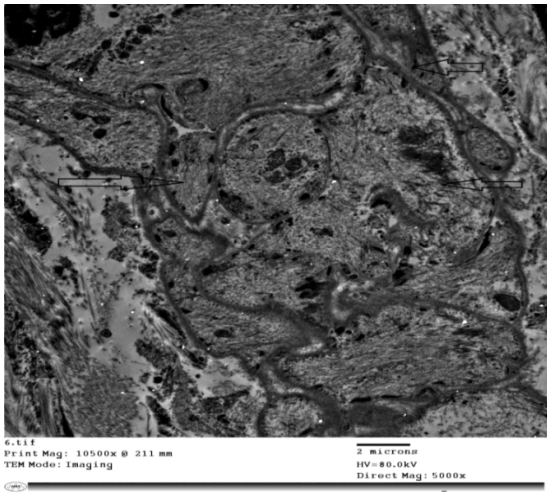

Fig. 13. An electron micrograph of the adrenal gland from 75 cm CVRL foetus (204 days of age) illustrating the cells of the medulla (medullary islets). Note adrenalin secreting cells (AD), noradrenalin secreting cells (NA), secretory granules (S) and rough endoplasmic reticulum (RE). X=2500

Fig. 14. An electronmicrograph of the adrenal gland from 88 cm CVRL foetus (306 days of age). The cells of the zona reticulariscontain elongated nuclei with hetero chromatin attached to the nuclear membrane (arrows) and round cell with oval nucleus in between(N). Note large sinusoids (SI). X=4000.

The cells of the adrenal medulla contained more secretory granules and the neurons, nerve fibers and nerve endings increased in number.

In (101,112 and 131) cm CVRL foetuses (342, 372 and 423 days of age), the cells of the zona glomerulosa had more electron dense and granulated cytoplasm. Mitochondria, rough endoplasmic reticulum, free ribosomes and lipid droplets were abundant. The cells of the zona fasiculata consisted of abundant smooth endoplasmic reticulum, mitochondria and lipid droplets the cells of the zona reticularis were also increased in number and possessed elongated nuclei and abundant smooth endoplasmic reticulum and lipid droplets (Fig.12). The lipid droplets increased more than in the early stages. Large mylenated nerve fibers and neurons were seen (Fig. 13). In the medulla adrenalin and noradrenalin secreting cells became more differentiated and the secretory granules increased and the neurons, nerve fibers and nerves endings were increased in number the cells of zona reticulris increased and were distributed between a large sinusoides (Fig. 14).

4. DISCUSSION

There is meager information about the ultrastrucure in the foetus of mammals in the literature available. There is no such information about the adrenal gland of camel in the available literature except El-Nahla, Imam, Moussa and El-sayed, [6] and El-Nahla, Imam, Moussa, El-sayed and Aboot [7]. But they were only study the development and some histochemical and mesurment and gross anatomical features

In the present study the cells of zona glomerulosa at the early stages of the first trimester have some microvilli at their cytoplasmic membrane, oval to round shaped nuclei and the cytoplasm contains a few mitochondria, endoplasmic reticulum and lipid droplets.

Weeb and Steven [2] described the cells of the zona glomerulosa as columnar in shape and were tightly packed together into cell clusters and contained smooth and rough endoplasmic reticulum and mitochondria with lamellar cristae. The ultrastructural characteristics of the cells of the zona glomerulosa changed little throughout the course of gestation in foal foetus. The present investigation is in accordance with the previous study.

Cells which in the zona fasciculata at the cortico-medullary border contained mitochondria with mainly vesicular and some tubulolamellar cristae, smooth endoplasmic reticulum and large Golgi apparatus [1]. In the present investigation the early differentiated cells of zona fasiculata are found at the boundary between the cortex and medulla and they possessed a large number of mitochondria, smooth endoplasmic reticulum and lipid droplets.

As the cells of the zona fasiculata differentiated, the amount of endoplasmic reticulum increased and changed from mainly rough to predominantly smooth profiles. The mitochondrial cristae became mainly vesicular. These changes appear to be relating to an increase in steroidogenic capacity of the cells [1]. The present investigation is in agreement with the above mentioned information.

In foal foetus, the predominant cell type in the zona fasciculata was angular in profile, and its cytoplasm contained smooth and rough endoplasmic reticulum and mitochondria with lamellar cristae [2]. The second and larger cell type was situated nearer the cortico-medullary border. It contained abundant smooth endoplasmic reticulum, mitochondria with lamellar and/or vesicular cristae, and large perinuclear Golgi complex [2]. The present investigation also demonstrated two types of cells as mentioned above.

There was a very close correlation between the weight of the gland and the cortical thickness, indicating that the increased size of the gland resulted from differential growth of the inner cortical zone, [17,18].There has been general agreement on the significance of the relationship between a well developed smooth endoplasmic reticulum, mitochondria with tubular or vesicular cristae, lipid droplets, and corticosteroid secretion by adrenocortical cells [19]. The present study in agreement with previous suggestion.

In the present study, the mature cells of the zona fasiculata possessed abundant mitochondria, smooth endoplasmic reticulum and lipid droplets and these are indication to an increase response to ACTH. Magalhães, Breda and Maria [20] reported that, between Days 16 1/2 and 17 1/2,most mitochondria had vesicular and tubular or lamellar cristae, and a few vesicular cristae only in rat adrenal cortex; endoplasmic reticulum cristae were large, and there were numerous free ribosomes and scarce lipid droplets. From 18 1/2 to 22 1/2 days of development, adrenal cells showed an increasing number of mitochondria and lipid droplets and a gradual decrease in the area occupied by the endoplasmic reticulum.

Bogdanova and 55%Debelenko [21] they stated that at the ages between 10 and 12 weeks, glomerular and fasciculo-reticular zones are already differentiating in human adrenal gland. Subsequently, during following stages of the prenatal morphogenesis, ultramicroscopical signs of the zonal belonging of cells and specific activity of steroid-synthesizing are developed.

In the present study, the chromaffin cells began to coloniz the adrenal medulla as early as 7 cm CVRL foetus (85 days of age) and according to electron density two type of cells can be detected: dark and light cells.There is no available information about the electron microscopic at the early stages of prenatal development in the camel foetus.

Adrenalin secreting cells possessed large round nuclei, prominent mitochondria with oval shapes

and have vesicular cristae, smooth and rough endoplasmic reticulm and lipid droplates. Nor adrenalin secreting cells were elongated and have round nuclei and the cytoplasm was denser than that of the adrenalin secreting cells [22,23]. The present study is in agreement with the above finding.

The granular substance of chromaffin granules appears to accumulate initially in the membranes of the Golgi zone and is finally extruded from the cell surface. Cilia are often observed arising from chromaffin cells and may form a constant feature of all chromaffin elements in the rat adrenal medulla [22,8].Such observation was not confermed in the present study.

The adrenal chromaffin cells possess ultrastructural features typical of the peptide/amine secreting endocrine cells. Thus the most prominent cytoplasmic organelle is the chromaffin granules. In the secretory granules, catecholamines form a storage complex with chromogranins, neuropeptides, adenine nucleotides and calcium ions [24,14]. The explanation reported above may be applicable to the camel foetus as revealed electron microscopically.

Kobayashai and Coupland [24] reported that, the adrenal chromaffin cells secrete their granule contents by exocytosis in response to the administration of acetylcholine, stimulation of the splanchnic nerve and other secretory stimuli. Adrenal chromaffin cells are innervated by preganglionic sympathetic nerve fibres in asimilar way to sympathic gangilion cells. Coupland [22] reported a variation in amount of endoplasmic reticulum as well as in electron-dense contents of chromaffin granules during the chromaffin cell secretory cycle. In the present study the adrenal glands of the camel foetus is innervated by greater and leaser splanchnic nerves.

5. CONCLUSIONS

- The cells of the zona glomerulosa were arranged in small groups or clusters and were differentiated after the cells of the zona fasiculata.
- The major changes in the adrenal cortex was found in the cells of the zona fasiculata and this may be due to its important role in the development of organs and parturitions (Cortisol secretion).
- The cells of zona reticularis were began to appear at the late stages of the third trimester with variable degrees of development.
- During the third trimester all the cells of the adrenal gland showed increase in the amount of organelles like mitochondria, smooth endoplasmic reticulum and lipid droplets.
- The blood supply of the adrenal gland comesfrom the suprarenal arteries which are branched of the phrinc and the renal arteries and innervated by the lesser and greater splanchnic nerves.
- It was found that the prenatal development of the dromedary camel adrenal gland was similar to the development other animal adrenal gland but with special characteristic of it's on
- Further immunohistochemical investigations are needed to explain the relation between the cortical cells associated with the medullary nerves and vessels in the medulla and the medullary islets inside the cortical zones.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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