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GROSS AND HISTOLOGICAL STUDY ON THE ADRENAL GLANDS IN CAMELS (*Camelus dromedarius*)

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ABSTRACT

In this investigation, macroscopic and microscopic structure of the adrenal glands was studied in 15 one humped camels. The results were compared with the available data on the humans and other species. The right adrenal was approximately bean shaped; whereas the left gland was almost triagular and in outline resembled the heart. The average weight, length, breadth, and thickness of the right and left glands were determined. Histologically, the adrenal glands were surrounded by a capsule of dense irregular connective tissue. Trabeculae were originated from the capsule and penetrated the cortex. The zona glomerulosa was formed of clusters cells. The zona fasciculata was consisted of radially arranged cords of cells and the cytoplasm of the cells of upper part was more foamy than the lower part. The cells of the zona reticularis were smaller and darker than the cells of the zona fasciculata. The endocrine cells of the adrenal medulla were arranged in irregular cords or clusters.

Key words: Adrenal glands, camel, cortex, histology, morphology

The adrenal gland is one of the important endocrine glands that are required for life. The cells of the gland produce important hormones, including mineralocorticoids, glucocorticoids, sex hormones and catecholamines. It has been studied anatomicaly in squirel (Adams *et al,* 1965), dolphin (Clark *et al,* 2005) dog (Evans and Christensen, 1979), rat (Koko *et al,* 2004) and other domestic animals (Banks, 1993; Dellmann and Eurell, 1998; Gett 1975a,b). It has not been studied in camels, previously. The present study was therefore done to study the histology of the adrenal gland in one humped camel.

Materials and Methods

The anatomical location, weight, dimensions and shape of the right and left adrenal gland were determined in 10 slaughtered camels. Histological structure of the glands was studied by using routine histological techniques in 5 camels. Sections at 5 µm thickness were cut and stained with the methods of Haematoxylin and Eosin, green Masson's trichrome and Van Geisson (Luna, 1968).

Results

The adrenal glands of the camel were situated near the cranial pole and at the medial border of the kidneys. The glands were embedded in fat. The right gland was situated more cranially than the left gland. The right adrenal gland was more elongated than the left one. It was approximately bean shaped; whereas the left gland was almost triangular or in outline resembled the heart (Fig 1). Macroscopically, the cortex and medulla were brown and cream coloured, respectively. The average weight, length, breadth and thickness of the right adrenal gland were 23.19 gm, 6.38 cm, 3.36 cm and 2 cm, respectively. The left adrenal gland of camel measured 20.43 gm in weight, 4.68 cm in length. 4.26 cm in breadth and 1.96 cm in thickness. The mean percentage of the cortex and medulla was 60.2% and 39.7% for the right gland and 59.4% and 40.5% for the left gland.

Histologically, the adrenal glands of camel were enclosed within a capsule of dense irregular connective tissue. Trabeculae originated from the capsule and penetrated the cortex (Fig 2). The glands were highly vascularised organs. Scattered smooth muscle fibres and nerve fibres were seen in the connective tissue of the capsule and trabeculae. The cortex of the adrenal glands was divided into 3 zones; the outer zona glomerulosa followed by the zona fasciculata and the zona reticularis, which lied adjacent to the medulla. The zona glomerulosa lied beneath the capsule. It was formed of irregular clusters of spherical cells (Fig 3, 4). Fine septums of connective tissue were separating the clusters of cells. The basophilic granules were seen in the cytoplasm. The zona fasciculata was the widest zone of the

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cortex. It was mainly consisted of radially arranged cords of cuboidal or columnar cells usually one cell layer in thickness which was separated by sinusoids. The cells of the upper part of the zona fasciculata were larger and more foamy than the cells of the lower part (Fig 3, 5). The boundary between the zona fasciculata and zona reticularis was not distinct. The zona reticularis consisted of cells disposed as freely anastomosing cords. The cells were smaller than the zona fasciculata. They had darker cytoplasm after staining. The pyknotic nuclei was observed in the zona reticularis (Fig 6). The corticomedullary junction in the adrenal gland of camel was distinct. The medulla was extended into the cortex in some areas (Fig 7). The cells of the adrenal medulla of camel had round nuclei and basophilic cytoplasm. They were arranged in irregular cords or clusters. There were veins, sinusoids and lymph vessels between the cells of the medulla (Fig 8).

Discussion

The anatomical location of the adrenal glands of camel is similar to those of other domestic animals. In humans the suprarenal (adrenal) glands are located at the superior poles of the kidneys embedded in adipose tissue. The right and left suprarenal glands are not mirror images of each other (Gartner and Hiatt, 1997). The right adrenal gland of camel was approximately bean shaped; whereas the left gland was almost triangular or in outline resembled the heart. In humans the right suprarenal gland is pyramid-shaped and attached directly on top of the right kidney, whereas the left suprarenal gland is more crescent-shaped and lies along the medial border of the left kidney from the hilus to its superior pole (Gartner and Hiatt, 1997). In horse, the right adrenal gland is elongated, flattened and irregularly J-or comma-shaped. The left gland is somewhat tongue-shaped, elongated and flattened (Getty, 1975a). The right adrenal gland of ox is roughly V-shaped, whereas the left gland is roughly C-shaped (Getty, 1975a). In sheep the adrenal glands are both bean shaped (Getty, 1975a). In dog, the right gland is triangular in shape and the whole left gland gives a figure of eight appearance (Getty, 1975b). In aves, the adrenal glands lie against the cranial poles of the kidney just caudal to the lungs. They usually exist as 2 distinct organs. The shape of the glands varies; they may be oblong, oval or pyramidal, but in general they appear flattened and irregular in outline (Getty, 1975b). In camel the cortex and medulla of the adrenal glands were brown and cream coloured, respectively. The suprarenal glands of humans contains an outer yellowish cortex and a small dark medulla (Gartner and Hiatt, 1997). The cream or yellowish coloured cortex is due to more lipid droplets in the cells of the cortex and there glands are rich in lipids (Getty, 1975b). The average weight, length, breadth and thickness of the right adrenal glands in camel were 23.19 gm, 6.38 cm, 3.36 cm and 2 cm, respectively. The left gland measured 20.43 gm in weight, 4.68 cm in length, 4.26 cm in breadth and 1.96 cm in thickness. Both glands of humans are about 1 cm in thickness, 2 cm in width at the apex, and up to 5 cm at the base; each weighs 7 to 10 gm (Gartner and Hiatt, 1997). In horse, the right adrenal gland measures approximately 7.5 cm in length, 3.0 cm in breadth and 1.5 cm in thickness. The left gland measures approximately 8.0 cm in length, 3.5 cm in breadth and 1.2 cm in thickness (Getty, 1975a). The right adrenal gland weighs 12 to 13 gm in adult cattle. Roughly the gland measures 8 cm in length, 3 cm in breadth and 2 cm in thickness. In adult cattle, the left gland may measure 8 cm in length, 6 cm in breadth and 3 cm in thickness. The left adrenal from adult cattle weighs approximately 14.5 gm (Getty, 1975a). In sheep, the right adrenal gland is 2 cm long and 1 cm wide. The left gland is usually longer than the right adrenal (Getty, 1975a). The adrenal glands in mature dogs measure from 2 to 3 cm in length, 1.0 cm in breadth and 0.5 cm in thickness. Each gland weighs approximately 0.5 gm (Getty, 1975b). In the Atlantic bottlenose Dolphin mean mass for the right and left adrenal glands are 4.99±0.513 and 5.36±0.558 gm, respectively. No statistical differences are found between average gland mass and sexual maturity or sex (Clark *et al,* 2005). In California Ground Squirrel the adrenal glands from males weigh more than female (Adams *et al,* 1965). In rat, under acute heat exposure the adrenal gland mass and volume decrease, probably as the consequence of adrenal cortex reduction, especially that of the zona fasciculata. Histological examination revealed that many zona fasciculata were deprived of lipid droplets (Koko *et al,* 2004).

In general, the histological structure of the adrenal glands of camel is similar to those of humans and other mammals. The zona glomerulosa is formed of clustered groups of glomeruli in camel. It is similar to that of ruminants and humans (Banks, 1993; Dellmann and Eurell, 1998). In carnivores (Evans and Christensen, 1979), horses, donkeys, and pigs, this zone is called the zona arcuate because the cells are arranged in arcs, with their convexity directed towards the periphery (Banks, 1993; Dellmann and

Fig 1. The right (upper row) and left (lower row) adrenal of camels.

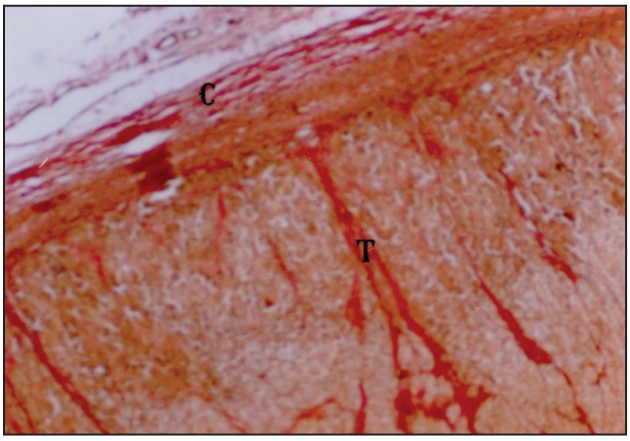

Fig 2. Camel adrenal capsule (C) and trabeculae (T). (Van Geisson × 64).

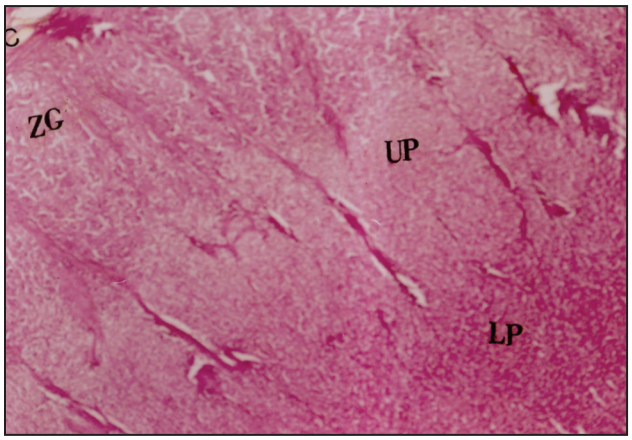

Fig 3. Camel adrenal cortex. There is colour difference between the upper and lower part of the zona fasciculata. Capsule (C); zona glomerulose (ZG); upper part (UP) and lower part (LP) of the zona fasciculata (Haematoxylin and Eosin × 64).

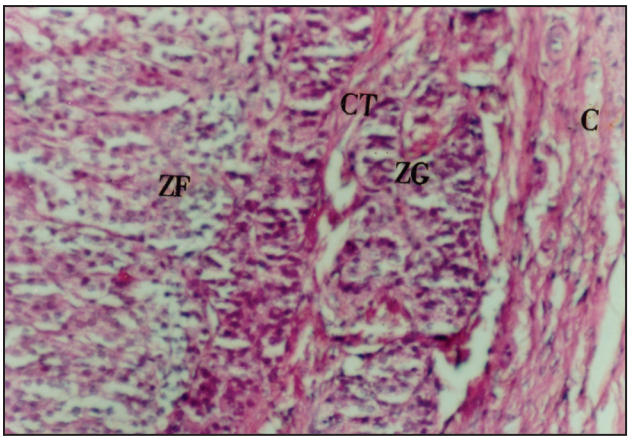

Fig 4. Camel zona glomerulose. The cells of this zone are clustered as glomeruli. Capsule (C); zona glomerulose (ZG); connective tissue (CT) zona fasciculata (ZF) (Haematoxylin and Eosin × 320).

Eurell, 1998). The cells of the zona glomerulosa are tall columnar in horses and donkeys, whereas they are spherical in camel and other domestic mammals (Dellmann and Eurell, 1998). The zona glomerulosa produces primarily aldosterone, a mineralocorticoid, which maintains the electrolyte level in extracellular body fluids by controlling the retention and the excretion of sodium and potassium by the kidney tubules. Secretion of aldosterone is regulated primarily by the rennin-angiotensin system and is largely independent of the adenohypophysis. Hypophysectomy alters neither the function nor the structure of the zona glomerulosa (Dellmann and Eurell, 1998). The zone intermedin was not observed in camel. This zone occurs in carnivores (Evans and Christensen, 1979), horses and to a small degree, in ruminants. This zone of small undifferentiated cells is in transition between the zona glomerulosa and the zona fasciculata (Dellmann and Eurell, 1998). The fine characteristics of the cells of the zona fasciculata are similar to those of the zona glomerulosa, except for quantitative differences; additionally; in most cells, a large number of lipid droplets are present. During routine tissue processing, these droplets are dissolved and the resulting vacuoles confer a foamy appearance to the cells, which are therefore referred to as spongiocyte (Banks, 1993; Dellmann and Eurell, 1998). The cells of the zona reticularis are darker than the zona fasciculata due to relatively greater numbers and size of the sinusoids in the parenchyma of this zone and a relatively lesser amount of lipid storage in the cytoplasm of these cells (Evans and Christensen, 1979). Both the zona fasciculata and zona reticularis are involved in the production of the glucocorticoids (cortisol and corticosterone), which participate in protein, fat, and carbohydrate metabolism. They decrease the number of circulating lymphocytoses and eosinophilia and have anti-inflammatory

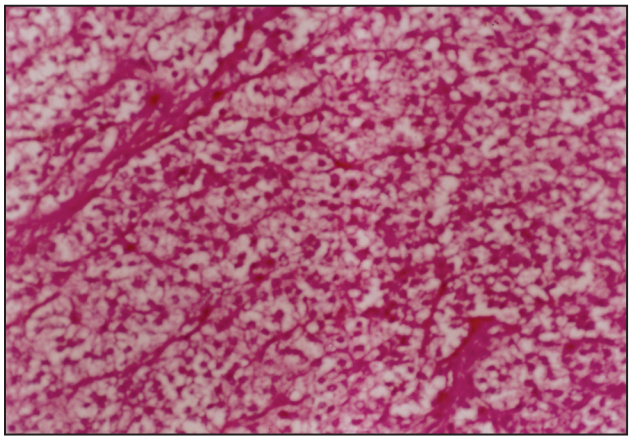

Fig 5. The zona fasciculata of camel adrenal gland. The cells have foamy cytoplasm (Haematoxylin and Eosin × 320).

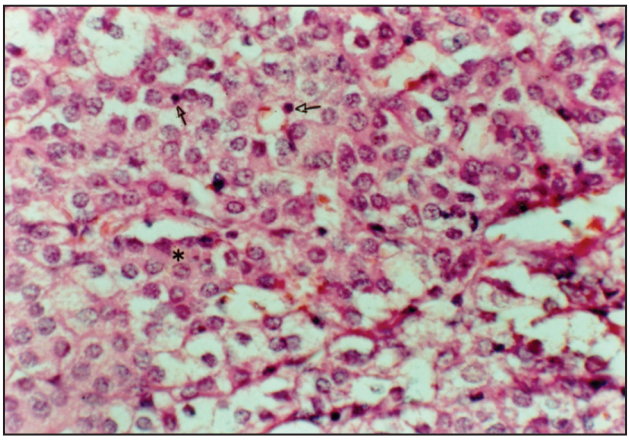

Fig 6. The zona reticularis of camel adrenal gland. The cells are disposed as freely anasomosing cords. Acidophilic cytoplasm (*); pyknotic nuclei (arrows), (Haematoxylin and Eosin × 320).

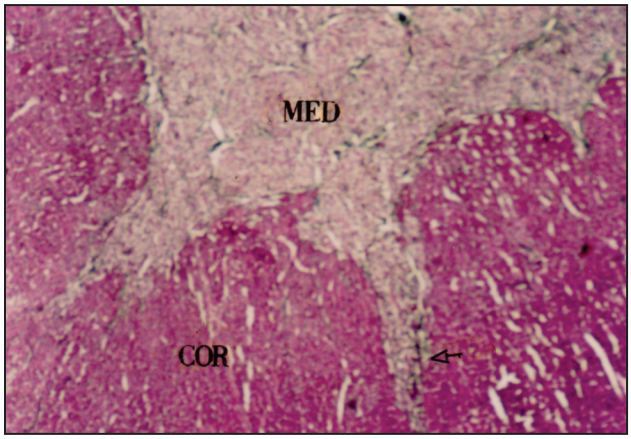

Fig 7. Showing colour difference between cortex and medulla in the adrenal gland of camel. The corticomedullary junction irregular. Cotex (COR); medulla (MED); extending medulla into the cortex (arrow) (Green Masson's trichrome × 64).

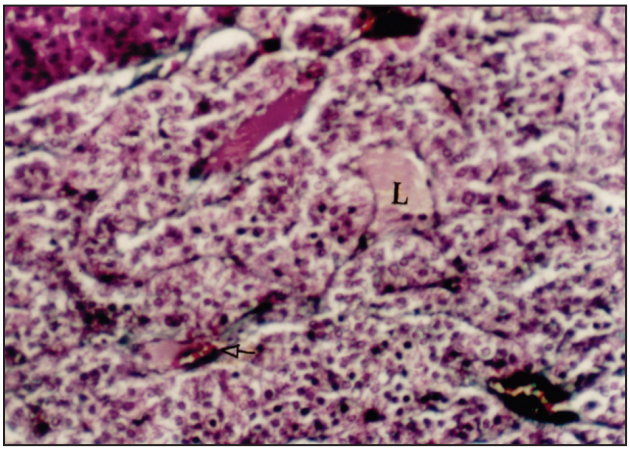

Fig 8. Camel adrenal medulla, Capillary (arrow); lymphatic vessel (L) (Green Masson's trichrome × 320).

effects. Glucocorticoid secretion is controlled by hypothalamic GRH and adenohypophyseal ACTH, the release of which is influenced by a wide variety of internal and external factors, such as stressor and by a negative feedback control by glucocorticoid. Hypophysectomy causes atrophy of the zona fasciculata and zona reticularis and a decline in their secretory activity (Dellmann and Eurell, 1998).

When the endocrine cells of the adrenal medulla treated with fixative containing chromium salts, the large cells stain dark brown; consequently they are often referred to as chromaffin cells. Chromaffin cells are modified postganglionic sympathetic neurons, the secretory activity of which is under the direct control of acetylcholine released from preganglionic sympathetic nerve terminals. Norepinephrine and epinephrine are released under both physical and psychological stress. They act on adrenergic receptors, especially in the heart, and blood vessels of the lung, viscera, and skin. They activate glycogenolysis in the liver and skeletal muscle, thus increase blood glucose levels (Dellmann and Eurell, 1998). The avian adrenal gland has no clear division into cortex and medulla. Instead, the parenchyma is composed of intermingled cortical tissue and medullary (chrornaffin) tissue. The cortical cells are arranged as anastomosing cords and secret steroid. The chromaffin cells are polygonal (Aughey and Frye, 2001).

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References

Adams L, Biglieri EG and Bern HA (1965). The adrenal cortex and its hormones in the California Ground Squirrel. *Spermophilus beechey*. Journal of Mammology 64:446-450.

Aughey E and Frye FL (2001). Comparative Veterinary Histology. Manson Publishing, London. pp 160.

Banks WJ (1993). Applied Veterinary Histology. Third Ed., Mosby Year Book, London. pp 416-424.

Clark LS, Pfeiffer DC and Cowan DF (2005). Morphology and Histology of the Atlantic Bottlenose Dolphin (*Tursiops truncatus*). Anatomy Histology Embryology 34:132-140.

Dellmann HD and Eurell J (1998). Textbook of Veterinary Histology. 5th Ed. Lippincott Williams & Wilkins, Philadelphia. pp 298-301.

Evans HE and Christensen GC (1979). Miller's Anatomy of The Dog. 2nd Ed. W.B. Saunders Company, Philadelphia. pp 618:622-623.

Gartner LP and Hiatt JL (1997). Colour Textbook of Histology. W.B. Saunders Company, Philadelphia, Pennsylvania. pp 262.

Gett R (1975a). The Anatomy of the Domestic Animals. Volume 1, 5th Ed. W. B. Saunders Company, Philadelphia, U.S.A. pp 552,957-958.

Getty R (1975b). The Anatomy of The Domestic Animals. Volume 2. 5th Ed., W.B. Saunders Company, Philadelphia, U.S.A. pp 1592 and 1966.

Koko V, Djordjeviae J, Cvijiae G and Davidoviae V (2004). Effect of acute heat stress on rat adrenal glands: a morphological and ostrological study. The Journal of Experimental Biology 207:4225-4230.

Luna LG (1968). Manual of Histologic Staining, Methods of The Armed Forces Institute of Pathology. 3rd Ed. McGraw-Hill Book Company, New York. pp 33-39, 76-77 and 94-95.

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For edited symposium/congress/proceedings: Abdalla HS (1992). Camel trypanosomiasis in the Sudan. Proceedings First International Camel Conference, Dubai (UAE), February 2-6, p 401-403.

Books (Personal authors): Gahlot TK and Chouhan DS (1992). Camel Surgery, Ist Edn. Gyan Prakashan Mandir, Gauri Niwas, 2b5, Pawanpuri, Bikaner, India. pp 37-50.

Chapter from multiauthored books: Chawla SK, Panchbhai VS and Gahlot TK (1993). The special sense organs-Eye. In: Ruminant Surgery, Eds., Tyagi RPS and Singh J. Ist Edn., CBS Publishers and Distributors, Delhi, India. pp 392-407.

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Commercial booklets: Anonymous/Name (1967). Conray-Contrast Media. IIIrd Edn., 12-15, May and Baker Ltd., Dagenham, Essex, England.

Magazine articles: Taylor D (1985). The Constipated Camel. Reader's Digest. Indian Edn. RDI Print & Publishing (P) Ltd., Mehra House, 250-C, New Cross Road, Worli, Bombay, India. 126:60-64

News paper articles: Anonymous or name of correspondent (1985). Bright Sunlight causes Cataract. Times of India, New Delhi, City-1, India October-9 pp 3, Col 3-5.

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