MICROANATOMIC STUDIES ON THE RENAL CORTEX OF GUINEA FOWL

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ABSTRACT

In the renal cortex of guinea fowl, cortical and juxta-medullary renal corpuscles were observed. The intermediate renal corpuscles could not be noticed. The cortical renal corpuscles were distributed throughout the cortex but concentrated more in the periphery of the cortex. The cortical renal corpuscles were found to be numerous than that of juxta-medullary corpuscles in guinea fowl. Proximal convoluted tubules of nephrons were distributed throughout the cortex along with other segments of nephrons. The brush border of the proximal convoluted tubules was positive to PAS along with the basement membrane of cells, in all age groups studied except in day-old. Further, the microanatomical studies of other components of nephrons in the cortex were discussed.

Key words: Renal cortex, Microanatomy, Guinea fowl

INTRODUCTION

Guinea fowls are good homestead and multipurpose birds. They are raised mainly for their gamy flesh, in many parts of the world. They are popular for flavoured meat which is rich in essential fatty acids. They are highly adaptive to all climates and serve to be an excellent table fowl (Ayeni and Ayanda, 1982). Further, avian osmoregulation involves the interacting contribution of a number of organs among which kidneys are usually considered as the primary organs.

Although the kidney of birds is clearly less efficient in its capacity to concentrate the urine than that of mammals, there are interspecific differences in renal structure and physiology that may be correlated with the ecological habits of birds and hence to represent the adaptive mechanism to prevent water loss. Since, the histomorphological differences among the birds are evidenced and the paucity of literature in the structure of kidney of guinea fowl is obvious, the present research work is carried out.

MATERIALS AND METHODS

Guinea fowls of different age groups (day-old, two week, four week, eight week and twelve week) were utilized for the research work. From each age group, six birds (irrespective of the sexes) were used for the study.

Tissue pieces of the kidney from the cranial, middle and caudal divisions were collected for the present research work. Tissue pieces were fixed in various fixatives and processed for paraffin embedding and sections of 6 to 7 µm were cut and utilized for histological and histochemical studies. Cryosections of 15 to 25 µm thickness were obtained from fresh and foraml calcium fixed tissues for different histochemical and histoenzymic studies. Various histological and Histochemical staining methods were employed for the study.
By using ocular micrometer, diameter of the renal corpuscles in the kidney of guinea fowl in all the age groups under the present study were measured and recorded.

RESULTS AND DISCUSSION

Histologically, there were no obvious differences noticed in the cranial, middle and caudal divisions of kidney of the guinea fowl. The kidney of guinea fowl was invested by a well defined thin fibrous capsule which was mainly made up of collagen fibres along with few delicate reticular and elastic fibres. The collagen fibres from the capsule were found to enter into the parenchyma and into lobules as reported by Fitzgerald (1969) in Japanese quail. The capsule was positive to PAS, acid and alkaline phosphatases.

Renal lobules in the kidney of guinea fowl was composed of a large pear shaped cortical areas with small cone shaped medullary areas (fig.1) as described by Nishimura et al. (1986) in birds. These renal lobules are considered as the basic units of the kidney in domestic fowl (Hodges, 1974). The interstitial tissue was scanty and few mast cells and macrophages along with the reticular and collagen fibres were noticed in the renal parenchyma.

Renal cortex of guinea fowl composed of many polygonal lobules and each lobule was situated around a central vein (intralobular renal vein) (fig.2). Thus the lobular arrangement of the renal cortex resembled the lobular pattern of liver as observed by Johnson and Mugaas (1970) in avian kidney. The lobular pattern was seen mainly in the periphery of the renal cortex which is in contradiction to the statement of Hodges (1974) in fowl where he noticed the same in the central areas. Lymphatic infiltration and aggregation in the renal cortex of a few individuals of eight and twelve week-old, were recorded in the present study. This may be due to defensive mechanism of the organ.

The cortical areas were closely packed with various components of nephron viz., renal corpuscles, proximal convoluted tubules, distal convoluted tubules, intermediate segments, cortical collecting tubules and peribular collecting ducts along with the many peritubular capillary sinuses.

In the present study, cortical and juxta-medullary renal corpuscles (fig.1) are observed. The intermediate renal corpuscles could not be noticed. By their location and size of renal corpuscles they were confirmed as components of cortical (loopless) and juxta-medullary nephrons (looped) as per the statement of Casotti and Richardson (1993) in honey eater birds respectively. Both types of renal corpuscles (cortical and juxta-medullary) were spherical in shape.

As per Nishimura (2008) in birds, loopless cortical nephrons resemble the reptilian type and looped juxta-medullary nephrons resemble the mammalian type of nephrons. The reptilian type nephrons might limit the capacity of the kidney produce hyperosmotic urine (Braun, 1993), whereas, the juxta-medullary nephrons might be essential for the formation of a concentrated urine (Wideman and Nissley, 1992). The cortical renal corpuscles were distributed through out the cortex but concentrated more in the periphery of the cortex. Juxta-medullary renal corpuscles were located in the cortex, but near the medullary area.

Most of the cortical renal corpuscles presented a horse-shoe appearance around a central vein. The cortical renal corpuscles were found to be numerous than that of juxta-medullary corpuscles in guinea fowl. This observation concurs with the opinion of Casotti and Richardson, (1993) in honey eater birds and Tsucamoto et al. (2005) in chicken kidney. Cortical nephrons were said to constitute 99 per cent of nephrons in humming birds (Casotti et al., 1998). However, in day-old birds, juxta-medullary renal corpuscles were found to be apparently more than that of cortical renal corpuscles. This could be due to the earlier...
Microanatomical.....


The juxta medullary renal corpuscles were larger in diameter in all the age groups studied than the cortical renal corpuscles. The diameter of cortical renal corpuscle varied from 27.47±0.48μm to 41.39±1.59μm, whereas the diameter of renal corpuscles of juxta-medullary region ranged from 47.5 ± 0.48μm to 61.74 ± 1.16μm from day-old to twelve week-old guinea fowl in the present study. In birds, corpuscles of cortical nephrons are said to range from 25-35 μm, whereas juxta-medullary corpuscles range from 75-125 μm in diameter as per Johnson (1979).

The Bowman's capsule of both the renal corpuscles was composed of a parietal layer and a visceral layer. Parietal layer of Bowman's capsule was lined by a single layer of a flattened epithelial cells resting on a thin basal membrane and they showed a strong PAS positive reaction in all age groups of the present study (fig.3). The nuclei of cells of visceral layer were found to be seen in some places since the podocytes lining the visceral layer could be well appreciated only by electron microscopy.

Within all the renal corpuscles (both cortical and juxta-medullary), the tuft of capillaries were located as observed by King and McLelland (1975) in the avian kidney. The capillaries were lined by the endothelial cells and their basement membrane found to be PAS positive and alcian blue negative in all the age groups.

A compact mass of (intra)mesangial cells was observed within each glomerulus. The cell mass was composed of elongated small cells with large nuclei with one or two nucleoli and many chromatin clumps were observed in the nuclei. As a whole, the cells appeared deeply basophilic. However, the cytoplasm of these cells was clear and positive to PAS reaction (fig.3). This finding is contrary to the observation of Nicholson (1982) in starling kidney where the central mesangial core was strongly alcian blue positive, because of their acid mucopolysaccharides.

In mammals, the mesangium in the central region of glomerulus acts as a supportive framework for the capillaries (Cross and Mercer, 1993). Further, they stated that mesangial cells have an important function in the maintenance of the integrity of the glomerular basement membrane.

Proximal convoluted tubules of nephrons (PCT) were distributed throughout the cortex along with other segments of nephrons. They were mostly observed as round profiles along with few elliptical profiles. In between proximal convoluted tubules, peritubular capillary sinuses were observed. These tubules were lined by high cuboidal or pyramidal cells. The nucleus was large spherical or oval in shape and located in the basal half of the cells. They possessed a single nucleoli and the chromatin material was clearly visible.

The luminal surface of PCT showed a brush border as reported in certain birds by Nabipour et al.(2009) and it was positive to PAS along with the basement membrane of cells in all age groups studied (fig.3) except day-old. In day-old birds along with cytoplasm, brush border and basement membrane of PCT showed a strong positive reaction to alcian blue. But the lumen of PCT of day-old birds showed PAS positive material. This may be indicative of mucopolysaccharides as reported by Nicholson (1982) in starling and Sreeranjini et al.(2000) in japanese quail. The presence of lipids in the cytoplasm of PCT in guinea fowl was recorded in the present study and it is in agreement with Sreeranjini et al. (2000) in japanese quail.

The brush border also showed a strong positive reaction to acid and alkaline phosphatases (fig 4) and succinic dehydrogenase activity in the present study. Shah et al.(1976) noted a strong reaction to acid and alkaline phosphatases.
in brush border of proximal convoluted tubule during pre and post migratory periods of Rosy pastor and Wagtail birds. However, Robinson and Gopinath (1994) observed a less intense reaction to acid phosphatase in the proximal convoluted tubules in kidney of birds.

Distal convoluted tubules of nephrons (DCT) were mostly confined to the area around the intralobular vein of the cortical lobules as reported by Hodges (1974) in fowl. The lining epithelium of DCT in guinea fowl was high cuboidal. The cytoplasm in the cells of guinea fowl was foamy in the basal half and strongly acidophilic. The lumen of DCT possessed a bleb from day-old to twelve week-old birds as reported by Hodges (1974). The bleb, basement membrane and the apical part of cytoplasm stained with PAS in all the age groups (fig.5). In combined alcian blue- PAS, only in day-old birds, these tubules were strongly positive to alcian blue. In two week-old birds, DCT showed mild reaction to alcian blue.

Juxtaglomerular apparatus in the kidney of guinea fowl was composed of only juxtaglomerular cells and macula densa. The third component of JG apparatus, the polkissen cells could not be identified in the present study. The granules of JG cells were stained as pink and red in Smith’s and Masson’s staining techniques respectively. In all the age groups, macula densa was observed as a collection of few slender columnar cells in the wall of distal convoluted tubule.

Intermediate segments of nephrons were observed in the cortical area and lined by short cuboidal cells rested on a distinct basement membrane.

Collecting tubules in guinea fowl were mainly located in the periphery of cortex even though their presence was noticed in other areas of cortex. It might be due to the concentration of distal convoluted tubules in the central area of the cortex as reported by Hodges (1974). The collecting tubules were lined by cuboidal epithelium.

Perilobular collecting ducts were lined by cuboidal epithelium with a small round basal nuclei as recorded by Hodges (1974) in domestic fowl. The cells were positive to PAS as noticed by Nicholson (1982) in starling kidney. Metachromasia with toluidine blue was observed both in cortical and perilobular collecting ducts (fig.6). This might bedue to the presence of sialic acid mucin in these ducts as per Nicholson (1982) in starling.

**SUMMARY**

Microanatomical studies on the renal cortex of guinea fowl was conducted on different age groups. Both the cortical and juxta-medullary renal corpuscles were found to be present in all the age groups. The cortical renal corpuscles were found to be numerous than that of juxta-medullary corpuscles in guinea fowl. Generally, an increase in diameter of both types of renal corpuscles was noticed as age advanced. In all the age groups, the juxta-medullary renal corpuscles were larger in diameter than the cortical renal corpuscles. The brush border of PCT also showed a strong positive reaction to acid, alkaline phosphatases and succinic dehydrogenase activity. The bleb, basement membrane and the apical part of cytoplasm of cells of DCT stained with PAS in all the age groups. In combined alcian blue-PAS, only in day-old birds, these tubules were strongly positive to alcian blue. Juxtaglomerular apparatus in the kidney of guinea fowl was composed of only juxtaglomerular cells and macula densa. Collecting tubules in guinea fowl were mainly located in the periphery of cortex even though their presence was noticed in other areas of cortex.

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