Comparative anatomical and histological features of the kidney in Harrier (*Circus aueroginosus*), Chicken (*Gallus domesticus*) and Mallard duck (*Anas platyrhynchos*)

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Summary

The aim of this study was to compare anatomical and histological of the kidney in three type of birds. The study revealed that, in harrier species the cranial lobe of kidney was the largest with elongated shape. In mallard the cranial lobe was small round-oval, while middle and caudal lobe were lobulated and larger .In chicken the caudal lobe was the largest. Statistically, in harrier the mean length of cranial lobe (20±0.1mm) and the width of the middle lobe (5±0.5mm) were significantly higher than those of mallard (10±0.3mm) (8.0.2mm) and chicken (15±0.2mm) (4±0.4mm) respectively. The mean weight of the kidney in harrier is (5.8±0.20g) this value significantly was higher than those of mallared (8.9±0.11g) and chicken (6.8±0.10g) in compare to the total body weight. Histologically, in harrier species the kidney had larger cortical region and the nephron types were numerous of mammalian type in medulla and few of reptilian type was presented in sub-capsular region. In mallard species the renal lobule was relatively divided into two equal cortical and medullary regions and the nephrons showed two types, numerous of mammalian and reptilian types presented in medulla and intermediate zone of kidney. In chickens the cortical region was the larger compared to medullary region which contained numerous mammalian types and few of reptilian type.

Keywords: Kidney, Anatomy, Histology, Chicken, Harrier, Mallard duck.

Introduction

The kidney of bird is flattened organs embedded in ventral surface of synsacrum bone and each incompletely divided into three lobes; cranial, middle and wider-largest caudal lobes (1). Avian kidney lobes are showing subdivion; into units called lobules. Each lobule has a cortex and medulla, (2-5).The nephron is the functional unit of kidney and greatly varies in its structure amongst different vertebrates; also the structure of nephrons shows variable degree of differences among species. In birds, kidneys have two kinds of nephrons a reptilian type. small sized, with no loops of Henle, and a mammalian type large size with long or intermediate length loops (6-8).Many studies have been published on the histology of the mammalian kidney, but comparatively were few about avian kidneys. The aim of study was to investigate the anatomical and histological differences of the kidney in three species of bird, Harrier (as pattern of Kessler and wild birds), Mallared duck (as a pattern of marine birds) and the chicken (as a pattern of domestic birds).

Materials and Methods

Three avian species were chosen including Marsh harrier (*Circus aueroginosus)*, Mallard duck (*Anas platyrhynchos)*, and Broiler Chickens (*Gallus domesticus).*Five healthy birds of each species were used in this study. All birds of this study were collected from local markets. Before animals scarifying, body weight of each bird was calculated. The birds were euthanized by intravenous injection of an overdose of Phenobarbital-sodium through the wing vein. Kidneys samples were removed out of synsacral fossa.The total weight of each kidney were recorded while the length and width of each kidney lobe were measured immediately after obtaining the kidneys from the cadavers. The percentage of kidney weight to the total body weight was calculated.The area of cortex and medulla was estimated using an oculometer. The weight of the

kidneys was calculated according to the formula used by (**9**) as follows:

$$\text{Index of kidney weight} = \frac{\text{weight of kidney}}{\text{body eight}}$$

The kidneys samples were fixed in 10% formalin then the routine histological technique was done, all the tissues sections were stained with Hematoxylin and Eosin (10).

Results and Discussion

The present study showed that, the kidneys of all studied birds were flattened organs which extended from the ventral aspect of the lungs to the end of the synsacrum, occupied the synsacral fossa and their color was brown in harrier and chicken while in Mallared the color was grayish. Each kidney consisted of three lobes; cranial, middle and caudal. The shapes of kidney lobes showed some difference, in harrier the cranial lobe of kidney was the largest,and elongated shape compared to those elongated middle and triangular-shape caudal lobe, (Figs. 1and2). In mallard, the kidneys cranial lobe was small round-oval in shape. The middle lobe was elongated and the caudal lobe was the largest and most elongated, (Fig. 3). In chicken the cranial ,middie and caudal lobes showe relatively large (Fig. 4 and5).

The statistical measurements of kidneys lobes and their length, width and total lengths in all species were shown in (Table, 1)

The total weights of kidneys (left and right) and their percentage to total body weight showed differences, (Table, 2). The kidneys of all studied birds were divided into units called lobules. Each lobule has a cortex (outer area), and medulla or medullary cone (inner area). The cortex composed of large and small renal corpuscles (mammalian type) or (reptilian type), each renal corpuscle consisted of Bowman's capsule and glomerulus.

The proximal and distal convoluted tubules and collecting tubules were lined by simple cuboidal epithelium. Medulla of kidney was composed of thin and thick segment of Henle loop and collecting ducts, these structures were lined by simple cuboidal epithelium. The collecting ducts continued to form the papillary ducts, which lined by simple columnar epithelium. In addition to number of capillaries this called vasa recta.

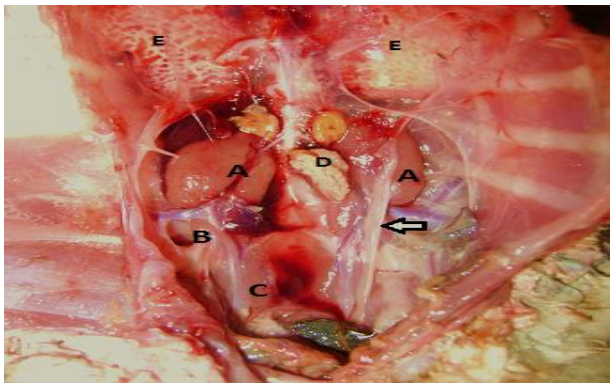
In harrier, the renal nephrons (Glomeruli) were located in the medulla and intermediate zone (between cortex and medulla) involved numerous of mammalian type (large and intermediate size), while the reptilian type (small size) was few and most of this type present in sub capsular region of each lobule, (Fig. 6).The volume of cortex ranged from 60-70% and the medulla was 30-40%. In mallard, the nephrons showed two types, numerous of mammalian and reptilian types which located in medulla and intermediate zone, (Fig. 7).

The volume of cortex ranged from 50-52% and of medulla was 48-50%. In chickens the nephrons showed three types, numerous mammalian types of two sizes (large and intermediate types), and few of reptilian type (small size) located in medulla (Fig. 8). The volume of cortex was 80-85% and medulla was 15-20%.

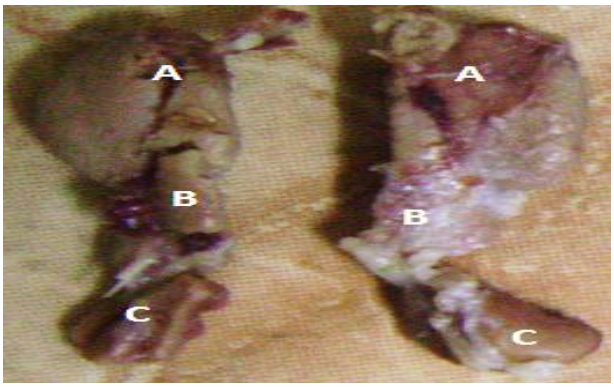
Table, 1: illustrated the measurements of kidneys' lobes and their total lengths (n=5 in each species) (N=15).

Species	Cranial lobe		Middle lobe		Caudal lobe		Total length / mm
	Length /mm	Width /mm	Length /mm	Width /mm	Length /mm	Width /mm	
Circus aueroginosus	20±0.1	9±0.2	7±0.1	5±0.5	9±0.2	4±0.2	36 ±2
Anas platyrhynchos	10±0.3	6±0.1	20±0.1	8±0.2	30±0.2	10±0.1	60±1
Gallus domesticus	15±0.2	11±0.1	9±0.3	4±0.4	28±0.2	9±0.2	53±2

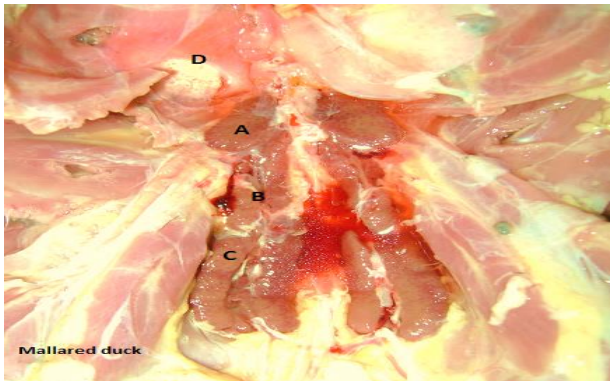
Mean ±Standerd error



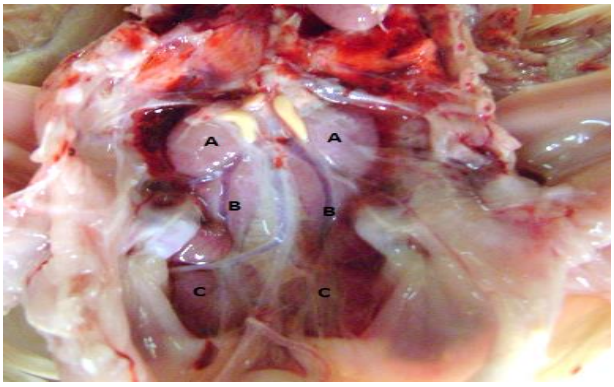
Figure, 1: Anatomical specimen of Harrier shows: (A) kidneys cranial lobe, (B) Kidneys middle lobe, (C) Kidneys caudal lobe, (D) Left ovary, (E) Lungs.



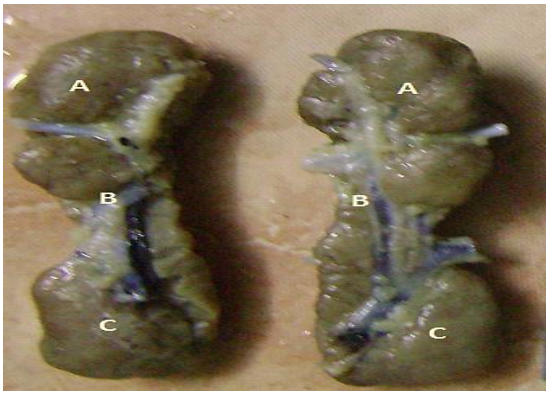
Figure, 2: Left and right kidneys after removal from cadavers shows: (A) Cranial lobe, (B) Midl lobe, (C) Caudal lobe, (Arrow shows oviduct).



Figure, 3: Anatomical specimen of Mallard duck shows (A) kidneys cranial lobe, (B) Kidneys middle lobe, (C) Kidneys caudal lobe, (D) Lung



Figure, 4: anatomical specimen of chicken shows: (A) Kidneys cranial lobe, (B) Kidneys middle lobe, (C) Kidneys caudal lobe.



Figure, 5: left and right kidneys after removal from cadavers' shows :(A) Cranial lobe , (B) Middle lob, (C) Caudal lobe.

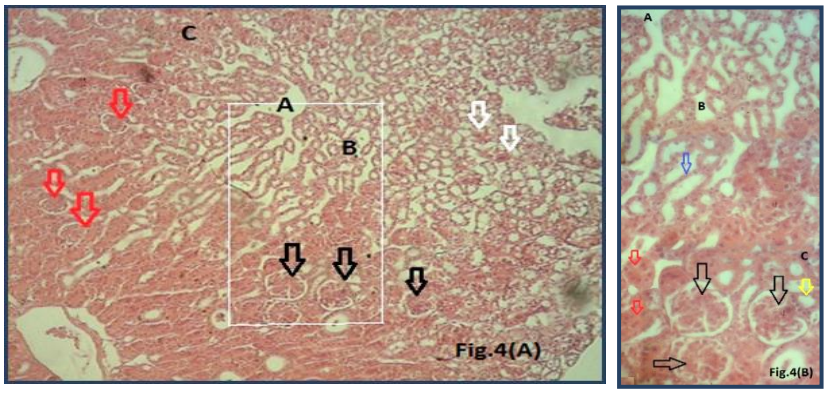
Anatomically the present study showed that, the kidneys of studied birds were similar in general morphology, the left and right kidneys had three lobes (cranial, middle and caudal), and occupied the synsacral fossa,this result was mentioned by (1, 11, 12, 13 and 14).The color of kidney in three species were variable, this result suggest that is may be due to amount of blood they contain this supported by (15). The present study indicated that the mean length of harrier-cranial lobe of kidney statistically was higher ($p<0.01$) than those of Mallard and chicken, this result compatible with report of (12) in coot birds kidneys which

consisted of three lobes, a large cranial (its length 28±0.15 mm and its width13±0.08 mm), a small caudal (length 13±0.07mm and its width 4±0.08mm) and a middle lobe (its length 30±0.08mm and its width7.5±0.10mm), while the parameters of present study in chicken and mallard showed that the caudal lobe in these birds were significantly the higher ($p<0.01$) this agree with (1) in pigeon and with (16) in chicken found that the kidney is divided into rounded cranial, more slender middle expanded and irregularly shaped caudal division. Also our study revealed that, the mean total length kidneys in mallared duck was significantly the higher ($p<0.01$) than those in harrier and chicken, this result agree with the report of (17) whom mentioned that, the mean total length of the right kidney (60.6±0.047mm) and left kidney (60.6±0.081mm) in Rhode Island Red chicken. While (14) mentioned that, the total length of the kidney in birds was 7 cm.The present result showed that mean width of kidneys lobes in chicken and mallard was in compatible with result of (14).

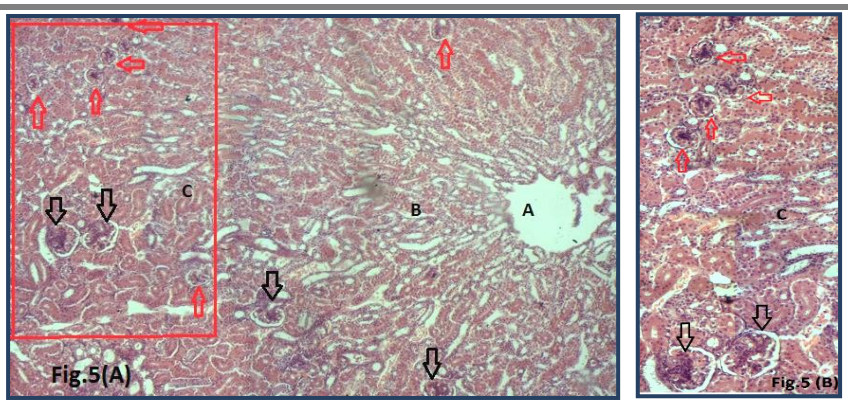
Table, 2: illustrated the total weights of kidneys (left and right) (n=5 in each species)(N=15).

Species	Total kidney weight/g. Mean ±SD	Kidney index
Circus aueroginosus	**5.8±0.20**	**0.632**
Anas platyrhynchos	**8.9±0.11**	**0.445**
Gallus domesticus	**6.8±0.10**	**0.285**

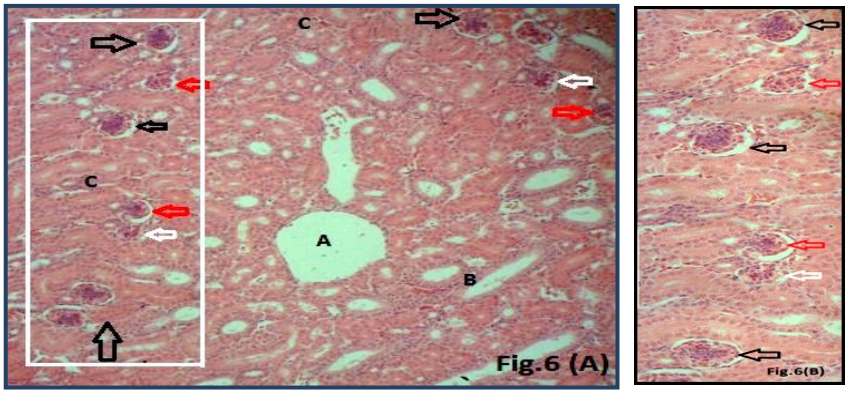
This present result revealed that, the size of kidney was significantly larger ($p<0.01$) in mallared duck than those in harrier and chicken, this result agree with (18) in his study on passerine birds which reported that, the birds possessing active salt glands have relatively larger kidneys than birds lacking active salt glands. The present result showed that, the mean weight of the kidney and its percentage to the total body weight was significantly higher ($p<0.01$) in harrier than those in mallard and chicken, this result suggests that, this differences was associated with birds, size (interspecific variation), this supported by opinion of (17) while this result disagree with (14).



Figure, 6: Histological section of Harrier kidneys: (A) show: (A) Central vein. (B) Medulla. (C) Cortex. (Black arrows show mammalian Glomerulus-Red arrows show intermediate Glomerulus -White arrows show reptilian Glomerulus) H&E stain 100x. (B) is magnifying of white box in left figure shows ;(Red arrows show proximal convoluted tubules- yellow arrow shows distal convoluted tubule- blue arrow shows collecting tubule H&E 400x.



Figure,7: Histological section of mallard kidneys: (A) show: (A) Central vein. (B) Medulla. (C) Cortex. (Black arrows how mammalian glomeruli-Red arrows show reptilian type H&E stain 100x. (B) is magnifying of red box in left figure 400 x.



Figure, 8: Histological section of Chicken kidneys: (A) show: (A) Central vein. (B) Medulla. (C) Cortex. (Black arrows show mammalian Glomerulus - Red arrows show intermediate Glomerulus - White arrows show reptilian Glomerulus) H&E stain100x. (B) is magnifying of white box in left figure- 400x.

Histologically, the study indicated that, there were three types of nephrons in the kidneys of chickens; this result was similar to result of (13, 15 and 18) and disagree with (1) in pigeon. Also in harrier there were three types of nephrons had been seen, this result suggest that, more numerous of mammalian and intermediate types of nephrons (looped nephrons) in these species are associated with food habits of these birds (watered on fresh water) this suggest that, these nephrons play an important role conserving body water, this supported by opinion of (19). While our study revealed that, in mallard duck there were numerous of both mammalian and reptilian types of nephrons, this suggests that, this type of birds which watered on sea water required more of reptilian type of nephrons which responsible for limited of urine concentration in order to expelled more of NaCl and assists supra orbital salt glands in their function (20). The distribution of these nephrons in kidneys of studied birds were different, the mammalian and intermediate types of nephrons were more numerous types in both chicken and harrier and both types of nephrons were located in medulla, while reptilian type was less numerous mostly located in sub capsular region of renal lobule, this result agrees with result of (12) in coot bird, while it disagrees with (7 and 15) who reported that, the reptilian type (with no loops of Henle) are located in the cortex, and a mammalian type (with long or intermediate length loops) are located in the medulla , also they reported that, in birds, only a small percentage of nephrons (15-25%) contain a loop of Henle (looped nephrons).

In terms of volume the avian kidney consists of cortex which involves about 71-81%, and small medulla which range 5-15% (21), the present study showed that, in chicken the volume of cortex ranged from 75-82% and medulla ranged from 10-15%, this agree with

result of (21), while in harrier the kidney lobules consist of about 60-70% cortex and 28-38 % the medulla, in mallared the kidney lobules consist 50-55 % cortex and medulla was 38-42%, this suggest that these variations are may be due to inter specific differences. According to findings of present study,it could be concluded that the gross anatomical parameters of the kidney were higher in harrier than chicken and mallard, whereas the histological parameter of the kidney were higher in chicken than others.

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الصفات التشريحية والنسجية للكلية في المرزة (*Circus aueroginosus*) و *الدجاج Gallus* (*domesticus*) والخضيري(*Anas platyrhynchos*)

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الخلاصة

اجريت الدراسة للمقارنة في الصفات التشريحية والنسجية للكلية في ثلاث انواع من الطيور. بينت الدراسة ان الفص الامامي للكلية في سلالة المرزة كان الاكبروذو شكل مستطيل .ان الفص الامامي للكلية صغير ودائري-بيضوي الشكل بينما الفص الاوسط والخلفي مفصص وكبير.وفي الدجاج فإن الفص الخلفي للكلية الاكبر حجما. احصائيا في سلالة المرزة بلغ معدل طول الفص الامامي للكلية (20±0.1 ملم) ومعدل عرض الفص الاوسط للكلية (5±0.5 ملم) حيث كان ذا مستوى معنوي اعلى من 10±0.3ملم طولا و 8±0.2 ملم عرضا في البط و 15±0.2 ملم طولا و 4±0.4 ملم عرضا في الدجاج الخضيري. واظهرت معدلات اوزان الكلى (5.8±0.20غرام) في المرزة وذات مستوى اعلى من البط 8.9±0.11غرام ودجاج الخضيري 6.8±0.10 غرام بالمقارنة الى وزن الجسم. وأما نسجيا, بينت الدراسة في سلالة المرزة كبر منطقة القشرة للفصيص الكلوي وان منطقة اللب كانت غزيرة بالوحدات الكلوية من النوع الخاص باللبائن بينما كانت الوحدات الكلوية من النوع الخاص بالزواحف قليلة وتتواجد في منطقة تحت المحفظة. وفي البط اظهرت النتائج ان الفصيص الكلوي نسبيا مقسم بالتساوي الى منطقتي القشرة واللب وان الوحدات الكلوية على نوعين وهما النوع الخاص باللبائن والنوع الخاص باللزواحف وكلاهما على نفس المستوى من الغزارة وتتواجد في منطقة اللب ومنطقة النطاق االاوسط بين القشرة واللب. في الدجاج كانت منطقة القشرة الكلوية الاكبر بالمقارنة مع حجم منطقة اللب والتي كانت غزيرة بالوحدات الكلوية من النوع الخاص باللبائن وقليل من النوع الخاص بالزواحف.

الكلمات المفتاحية: الكلية، تشريح، انسجة، المرزة، الدجاج، الخضيري.