Comparative Anatomical Study of Kidney Differences Between the Cat and the Owl (Felis catus and Strix varia)

Studi Anatomi Perbandingan Perbedaan Ginjal Antara Kucing dan Burung Hantu (Felis catus dan Strix varia)

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Abstract. *The aim of the present study is to investigate the anatomical variation of the morphological description of the normal kidneys of two vertebrates, the cat and the owl, which share a diet but differ in habitat. The results revealed the following: The kidney in cats is a solid, bean-like structure, reddish-brown in colour, smooth in surface, not lobed, and enclosed in a thick capsule of connective tissue. In comparison, the kidney of an owl is smooth and divided into three lobes of different sizes and shapes. It is larger in size, oblong, dark red-brown in colour, and enclosed in a thin capsule of connective tissue. The results showed that the kidneys in cats are located in the anterior region of the body cavity, below the diaphragm, and opposite the dorsal body wall, and are in pairs (right and left kidneys). In comparison, the kidneys in owls are in a symmetrical pair connected by a fibrous ligament and are located in a bony depression called the renal fossa, located in the sacral region integrated into the body cavity. Anatomical findings showed that the main blood supply to the kidneys in cats is provided by a pair of renal arteries branching from the aorta, compared to, owl kidneys receive blood from three pairs of renal arteries (anterior, middle, and posterior), which also branch from the aorta.*

Keywords *– owl, cat, kidney*

Abstrak. *Tujuan dari penelitian ini adalah untuk menyelidiki variasi anatomi dari gambaran morfologi ginjal normal dua vertebrata, kucing dan burung hantu, yang memiliki pola makan yang sama namun berbeda habitat. Hasil penelitian mengungkapkan hal-hal berikut: Ginjal pada kucing adalah struktur padat seperti kacang, berwarna coklat kemerahan, permukaannya halus, tidak berlobus, dan terbungkus kapsul tebal jaringan ikat. Sebagai perbandingan, ginjal burung hantu halus dan terbagi menjadi tiga lobus dengan ukuran dan bentuk yang berbeda. Ukurannya lebih besar, lonjong, berwarna merah kecokelatan, dan terbungkus kapsul tipis jaringan ikat. Hasil penelitian menunjukkan bahwa ginjal pada kucing terletak di bagian anterior rongga tubuh, di bawah diafragma, dan berseberangan dengan dinding tubuh bagian punggung, serta berpasangan (ginjal kanan dan kiri). Sebagai perbandingan, ginjal pada burung hantu berada dalam pasangan simetris yang dihubungkan oleh ligamen berserat dan terletak di cekungan tulang yang disebut fosa ginjal, yang terletak di daerah sakral yang terintegrasi ke dalam rongga tubuh. Temuan anatomi menunjukkan bahwa suplai darah utama ke ginjal pada kucing disediakan oleh sepasang arteri ginjal yang bercabang dari aorta, dibandingkan dengan, ginjal burung hantu menerima darah dari tiga pasang arteri ginjal (anterior, tengah, dan belakang), yang juga bercabang dari aorta*.

Kata Kunci *– burung hantu, kucing, ginjal*

I. INTRODUCTION

The kidneys in vertebrates exhibit a uniform construction plan, forming fleshy masses located on either side of the spine. However, despite this uniformity, anatomical differences arise due to variations in vertebrate species, anatomical adaptations, environmental conditions, dietary habits, and their significant role in maintaining the organism's survival under diverse environmental conditions. These differences are particularly evident in the shape of the kidney, arrangement of glomeruli, and complexity of renal tubules [1].

Several anatomical studies, including [2], classified mammalian kidneys based on their external appearance into smooth, non-lobed kidneys, as observed in rabbits, rats, goats, and sheep. These kidneys resemble a kidney bean and

are encased in a thin fibrous capsule[3]. stated that mammalian kidneys are surrounded by brown adipose tissue for protection against extreme cold.

Bird kidneys, however, differ from mammalian kidneys, as they are divided into three lobes: anterior, middle, and posterior [4].

Previous studies on the kidneys of vertebrates inhabiting the Iraqi environment are relatively scarce. Moreover, these studies highlight the morphological differences in kidneys across species and emphasize the importance of kidneys in maintaining internal homeostasis, removing metabolic waste products, and producing urine. Furthermore, kidneys regulate fluid and electrolyte balance in the body [5], and produce the hormones renin and erythropoietin. Renin plays a role in blood pressure regulation, while erythropoietin is a glycoprotein growth factor that stimulates red blood cell production [6].

Aim of the Study

The current study aimed to identify the anatomical differences in the natural kidney of two vertebrate species that share similarities in diet but differ in environment: the domestic cat and the owl

II. METHODS

1. Sample Collection

This study used six animals From both types of domestic cat and owl. They were selected as active, free from disease and of different ages. All animals were adult males. The owls were obtained from the Al-Ghazl market in Baghdad and the cat was caught in a special trap in Diyala Governorate.

2. Dissection

Before starting the dissection of the animals, they were placed in special cages for five days to ensure their safety and freedom from any disease. Then, the animals were anesthetized for the purpose of euthanasia by injecting a dose of xylazine (4.3 mg/kg) and ketamine (29.1 mg/kg). Cats were injected in the thigh muscle, and owls in the chest muscle, following the protocol of [7].

Then dissected by making a longitudinal incision along the ventral midline from the neck to the lower abdomen , The thoracic and cervical entrances were opened, then the body cavity by careful opening , the ribs are cut from the sides, and the ribs of the ribcage are raised to reveal the heart and the main arteries, then the kidney is removed and several measurements are taken for each kidney to extract the averages (weight, length, and width) while recorded all the notes for each kidney (color, size, and shape).

Latex Injection Process

Each animal sample was injected with a mixture of latex and carmine dye to study the blood supply to the Kidneys. The material was injected with a 10 cc syringe through a rubber tube into the left ventricle of each animal after making an incision in the left ventricle and bleeding the animal. Then normal saline was used first to wash the blood vessels, then a mixture of ammonium hydroxide, latex and carmine dye was used to color the arterial blood supply. Concentrated hydrochloric acid was used to prevent latex leakage.

After the injection, the animal was left for 6 hours, then completely immersed in a fixation solution (10% formalin) for 48 hours, The blood supply to the kidneys was then determined and studied

III. RESULT AND DISCUSSION

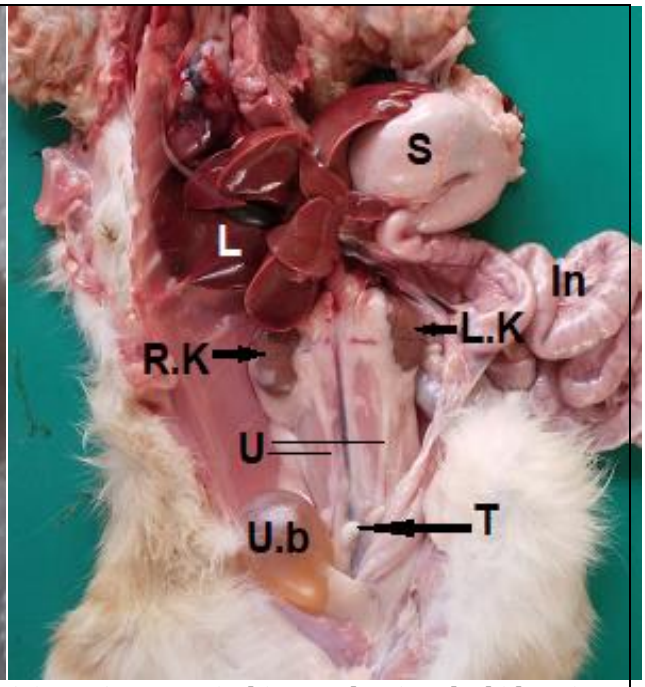
3.1 Morphological Description of the Kidney in Cats

The results showed that the kidney in the cat has a solid structure resembling a bean, with a reddish-brown color, a smooth surface, non-lobulated, and surrounded by a thick capsule of connective tissue. In addition, a network of blood vessels was clearly visible under the capsule. The reason for the appearance of the network of blood vessels may be due to the amount of blood stored in the kidney and the degree of blood supply.

The results showed that the kidney in cats is located in the front half of the body cavity, adjacent to the dorsal body wall, under the diaphragm and in the form of a pair of kidneys, left and right, positioned on either side of the spine and fixed by a fat pad surrounding each kidney.The left kidney is slightly higher than the right due to the presence of the liver and stomach above the right kidney.

The results also showed that each kidney has two surfaces: a convex lateral surface and a concave medial surface containing a hilum, where the ureter emerges, and blood vessels enter and exit. Additionally, each kidney has two poles: cranial and caudal (Figure 1), (Figure 2).

(Figure1) A picture showing the right and left lobes of the kidney in a cat.
Right Kidney(RK), Left Kidny(LK)



(Figure2) Anatomical image showing the kidney in a cat.
Right Kidney(RK),Left Kidny(LK),Ureter (U),urinary bladder(Ub),testis(T),Intestinl (In),Liver(L),Stomach(S).

The study found that the left kidney was heavier, longer, and wider than the right kidney. The average weight of the left kidney was 24.777 grams, with an average length of 47.17 mm and a width of 31.16 mm. In contrast, the average weight of the right kidney was 20.659 grams, with a length of 46.24 mm and width of 26.95 mm (shown in Table 1).

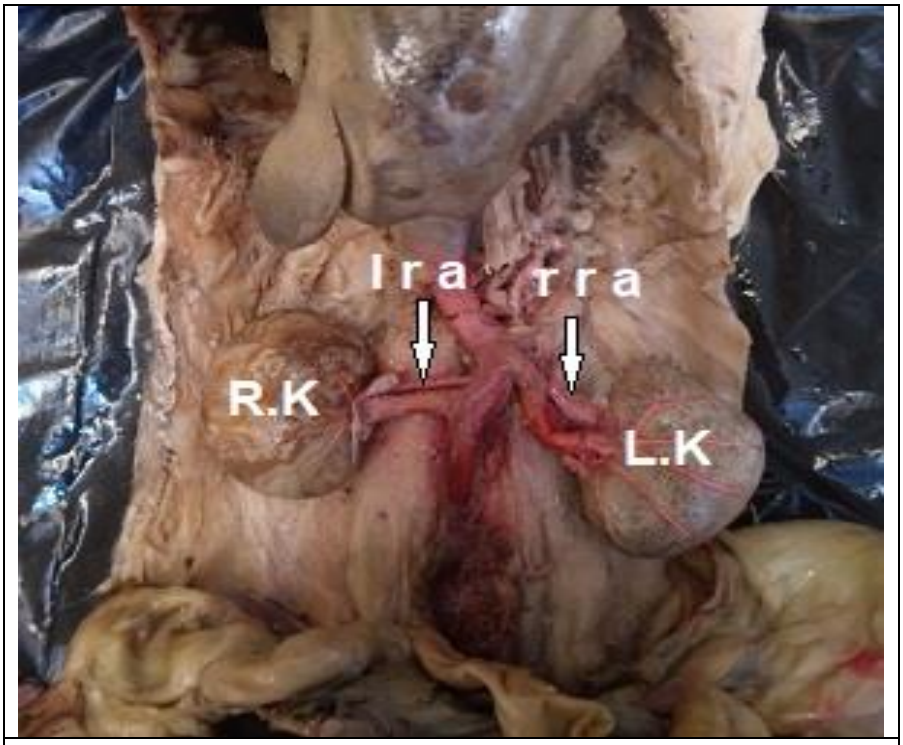
The findings of this study aligned with the results of previous studies on the morphological description of kidneys in various mammals, including [8], on bat kidneys, [9], on hedgehog kidneys (Hemiechinus auritus), and [10], on African squirrel kidneys (Epixerus ebii). These studies also reported that kidneys are located in the anterior half of the abdominal cavity beneath the diaphragm, with the left kidney positioned lower than the right due to the liver's presence. They also confirmed the kidney's bean-like shape, smooth surface, and encapsulation by connective tissue.

The current study also aligns with the findings of [3], on the kidneys of the Indian fruit bat (Rousettus leschanaulti), which reported that the kidneys rest on a fatty cushion.

However, the present study differed from these previous studies regarding the thickness of the capsule. While earlier studies described the capsule as thin, this study found it to be thick. Additionally, the visible network of blood vessels beneath the capsule observed in this study was not reported in the earlier research.

3.2 Blood Supply to the Kidney in Cats

Macroscopic anatomical analysis revealed that the primary blood supply to the kidneys in cats is provided by a pair of main renal arteries, which supply the right and left lobes of the kidney and branch off from the aorta (Figure 3).



(Figure 3) A picture showing the blood supply to the right and left lobes of the kidney in a cat.
Right Kidney(RK), Left Kidny(LK), Right Renal Artery(r r a), left Renal Artery(l r a)

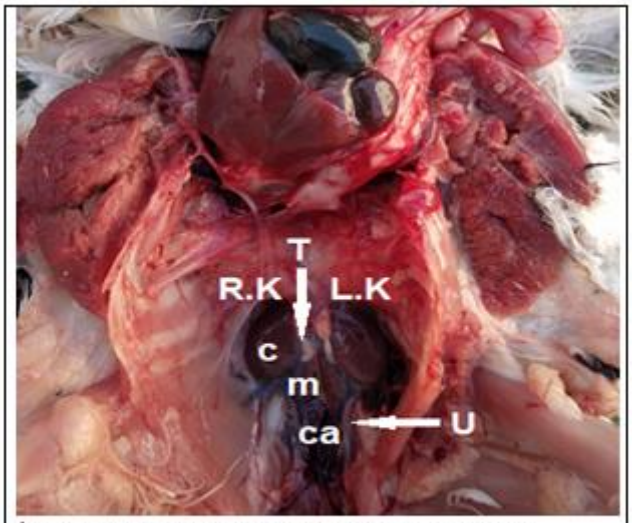
The results of the current study agree with studies by several researchers in their study of the blood supply to the kidney in a number of mammals, including the study [11], on rat kidneys, [12], on rabbit kidneys, [13], on sheep kidneys, All of these studies indicated that the blood supply to the kidneys comes from the main renal arteries branching from the aorta.

Morphological Description of the Owl Kidney

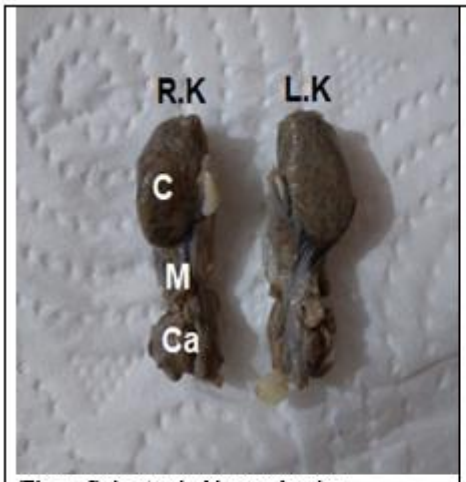
The results showed that the kidneys in the owl have a smooth structure, large lobed, elongated and irregular in shape. Its color ranges from dark red to dark brown. Each kidney is surrounded by a thin capsule of connective tissue and is located symmetrically as a pair (right and left) on either side of the spine, connected by a connective tissue ligament. The kidneys are situated in bony depressions known as renal fossae within the fused sacral region of the body cavity. Each kidney extends cranially within the body cavity from the lower edge of the lungs to the caudal end of the fused sacral region.

The results showed that the kidneys are divided into three lobes, each covered by a serous membrane. These include the cranial lobe, which is the largest and oval-shaped, followed by the middle lobe, which is narrow and elongated with a deep groove on its lateral surface, and the caudal lobe, which is smaller than the other two lobes and approximately triangular.

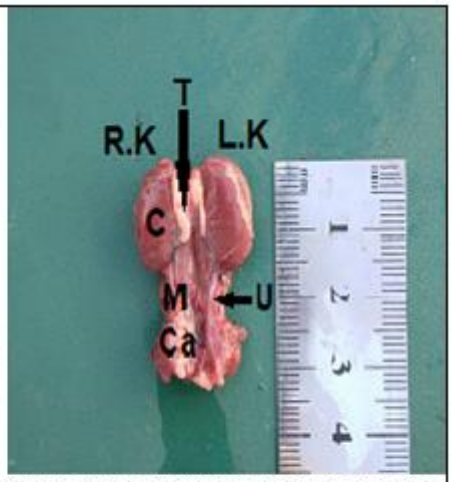
The study found a pair of ureters extending from the anterior lobe through the middle and caudal lobes, with the testes observed to be attached medially to each kidney as shown in (Figure 4) (Figure 5) (Figure 6).



(Figure 4) Anatomical image showing the kidney in the owl.
Right Kidney(RK), Left Kidny(LK),Cranial Renal(c), Middle Renal (m), Cranial Renal (c.a), Ureter(U), testis(T),



(Figure 5) Anatomical image showing the right and left kidney lobes in an owl.
Right Kidney(RK),Left Kidny(LK),Cranial Renal(c), Middle Renal (m), Cranial Renal (c.a).



(Figure 6) Anatomical image showing the lobes of the kidney in an owl.
Right Kidney(RK),Left Kidny(LK),Cranial Renal(c), Middle Renal (m), Cranial Renal (c.a), Ureter(U), testis(T).

The study also indicated no significant difference in the weight or length of the left and right kidneys. The average weight of the left kidney was 1.510 grams, with an average length of 13.96 mm, while the average weight of the right kidney was 1.390 grams, with an average length of 13.41 mm (as shown in Table 1).

There were observed differences in the length and width of each kidney lobe. The cranial lobe had an average length of 14.91 mm and a width of 11.15 mm. The middle lobe had an average length of 8.61 mm and a width of 7.48 mm. The caudal lobe measured an average length of 7.34 mm and a width of 8.62 mm (as shown in Table 2).

The current findings on owl kidneys align with those of several researchers who have described the morphological features of bird kidneys. These include studies by [14], on the kidneys of the golden eagle (Aquila chrysaetos), [15] study on the kidney in the buzzard (Seteppe buzzard), [16] [17], study on the kidney in some birds.. These studies agree that bird kidneys are divided into cranial, middle, and caudal lobes with shapes varying based on the anatomical structure of the bird's body. Bird kidneys are symmetrically located on either side of the spine in the fused sacral region, with smooth surfaces and surrounded by a thin connective tissue capsule.

Blood Supply to the Owl Kidney

Macroscopic anatomical findings revealed that the main blood supply to the owl kidney consists of three pairs of arteries feeding the three kidney lobes. The first pair branches from the aorta and supplies the cranial lobe (cranial renal artery). The second pair supplies the middle lobe (middle renal artery), and the third pair supplies the caudal lobe (caudal renal artery). The latter two branch from the ischiadic artery, which originates from the aorta as shown in (Figure 7).

(Figure 7) Image showing the blood supply to the kidney lobes in the owl.
Right Kidney(RK), Left Kidny(LK), Cranial Renal (c), Middle Renal (m), Cadual Renal (c.a), Aorta (A), Ischiadic artery(is.a), Right Cranial Renal Artery (r c r a), Left Cranial Renal Artery (l c r a) Middle Renal Artery (m r a), Cranial Renal Artery(c r a), Ureter(U), testis(T).

The findings of this study align with those of several researchers who studied kidney blood supply in various birds, including [18], on bird kidneys, [14], on pigeon kidneys (Columba livia), [19], on the long-legged buzzard (Buteo rufinus). These studies noted that the cranial lobe receives blood via the cranial renal artery, while the middle and caudal lobes are supplied by the ischiadic artery. However, the current study does not align with [20], who reported that the middle and caudal lobes receive blood via the femoral artery rather than the ischiadic artery.

(Table 1) Medium of some morphological parameters of the Kidneys in the study animals Cat and Owl.

Type of animal / parameters	Cat Mean ± SE	Owl Mean ± SE
Right lobe weight of kidney	20.659 ± 0.002 g	1.390 ± 0.003 g
Left lobe weight of kidney	24.777 ± 0.001 g	1.150 ± 0.001 g
Right lobe length of kidney	46.24 ± 0.06 mm	13.41 ± 0.34 mm
Left lobe length of kidney	47.17 ± 0.21 mm	13.96 ± 0.24 mm
Right lobe width of kidney	29.62 ± 0.56 mm	8.74 ± 0.93 mm
Left lobe width of kidney	31.16 ± 1.62 mm	9.15 ± 1.10 mm

(Table 2) Medium of some morphological parameters of the Kidneys in the study Owl.

Parameters / species lob	Length Mean ± SE	width Mean ± SE
Cranial lob	46.24 ± 0.06 mm	13.41 ± 0.34 mm
Middle lob	47.17 ± 0.21 mm	13.96 ± 0.24 mm
Caudal lob	29.62 ± 0.56 mm	8.74 ± 0.93 mm

IV. CONCLUSION

1. The kidney in cats differs from that of owls in terms of the number of lobes, shape, size, and location within the body cavity.
2. The kidney in cats is surrounded by a thicker capsule compared to the thin capsule of the owl kidney.
3. The blood supply to the kidney in cats differs from that of owls in terms of the number of arteries branching from the aorta, depending on the number of kidney lobes.

V. RECOMMENDATIONS

It is recommended to:

1. Conduct comparative anatomical studies to explore the distribution of veins and arteries within the kidney.
2. Undertake comparative biochemical studies to investigate kidney hormones.
3. Perform comparative physiological studies to understand kidney functions.

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