

## Morphological description and histological structure of the Hedgehog Kidney (*Hemiechinus auritus*)

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### Abstract

This study was aimed to recognize the morphological description and histological structure of the kidney in hedgehog (*Hemiechinus auritus*). The morphological results showed that the kidney has a small bean shape and reddish brown color. It was situated on both side of the anterior lumbar vertebra in the abdominal cavity behind the peritoneum. The kidney was surrounded by connective tissues capsule. Histological results clarify that the kidney was characterized by two an regions, outer called cortex and inner called medulla. Glomeruli densely distributed in the cortex region with mean diameter of 78  $\mu\text{m}$ , also the cortex contains segments of proximal convoluted tubules and distal convoluted tubules. On the other hand the medulla region consist of both thick and thin segments of Henle's loop in addition to sections of collecting tubules which forms radial structures which are known as the medullary rays. The histological results also showed that, the renal corpuscle is formed by the glomeruli that is surrounded by Bowman's capsule, the proximal convoluted tubules, Henle's loop, the distal convoluted tubules and collecting tubules. The proximal convoluted tubules connected with Bowman's capsule and lined by simple cuboidal epithelial tissue based on a basement membrane while the free surface was covered with brush border. The results demonstrated that thin segments of the Henley's loop were started from the end of the proximal convoluted tubule, extend inside of the medulla and lined by simple squamous epithelial tissue. Whilst the thick segments of the Henle's loop were lined by simple cuboidal epithelial tissue. The current study clarify that, the distal convoluted tubules were lined by simple cuboidal epithelium rested on basement membrane and the free surface covered by small protrusions. Furthermore, the histological examination revealed that the collecting tubules were lined by simple cuboidal epithelium and the free surface of its cells had a cover of a few and short protrusions.

**Key words:** kidney, hedgehog, proximal convoluted tubules, distal convoluted tubules and Henley's loop.

### Introduction

The Hedgehog belongs to a Kingdom: Animalia, Phylum: Chordata, Class: Mammalia, Order: Eulipotyphla, Family: Erinaceidae and Subfamily: Erinaceinae according to Gotthelf Fischer von Waldheim taxonomy, 1814. It is a type of hedgehogs that exists in Central Asian countries and some Middle Eastern countries. The hedgehog lives in burrows, gardens and orchards [1]. The urinary system in the vertebrae plays a sensitive role in the body, and the function of kidney -which represents one organ of urinary system-, is a part of many complex processes by which maintain the stability of the internal environment of the vertebrate bodies via acid-base balancing. The kidney has many functions including its role in removing many harmful and excess substances of body needed as well as the importance of sustaining animal and human life. This organ (kidney) filters the blood passing through the glomeruli into the body tissues in addition to its role in re-absorption of the electrolytes that needed by the body [2,3]. The kidneys in vertebrates have a homologous construction plan that is generally made up of a compact collection of tubules located dorsally within the body cavity on both sides of the vertebral column. In spite of this, the kidneys show differences in the anatomic structure; this is illustrated by the arrangement and number of glomeruli and renal tubules of various types. In terms of embryonic development, three excretory organs -including kidneys- were formed in vertebrae embryo, pronephros, mesonephros and metanephros which all

arise from intermediate mesoderm and all are composed from tubular structures. These three excretory organs are collecting waste from blood capillary vessels [3]. Many studies have dealt with investigate of the anatomical and histological aspect of human and mammalian kidneys. The researchers noted that the kidneys in human, rodents, dogs and cats as well as ruminants had an identical construction plan; it is generally formed of a consolidated mass of tubules as bean shape of reddish brown colour [4], located within the body cavity on both sides of the vertebral column. The kidney is surrounded by a lipid tissue to protect it from the extreme coldness that are exposed to some species of mammalian [5,6]. The kidney is covered with fibrous connective tissue called the capsule and possesses a convex abdomen surface and a concave dorsal surface. The central part of the kidney contains an invaginated area known as hilum which is the point of the ureter connection and the blood vessels and nerves are enters and exits from it [7]. The kidney consists of two main parts, the outer part known as the cortex has a reddish brown color and the inner part is called the medulla and has a striped appearance [8]. The cortex is composed of the renal corpuscle which is consisting of the Bowman's capsule and the glomerulus and many of the proximal and distal tubules and the upper segments of the Henle's loop also the upper segments of collecting tubules. Moreover the medulla of the kidney is divided into conical blocks known as renal pyramids,

the bases of the pyramids are towards the perimeter of the kidney and the part called urinary papillae is inward and the collecting tubules formed the biggest part of medulla pyramid [9]. The structural and functional unit of the mammalian kidneys is nephron. In general, when reviewing the literatures that related to the kidney structure of vertebrates in the Iraqi environment, it was found to be few and none of the local research has touched the structure of the kidney in the hedgehog (*Hemiechinus auritus*). Therefore, the main purpose of this paper is to provide some basic information about Morphological description and histological structure of the kidney in the hedgehog.

### Methodology

Eight hedgehogs were used and they were obtained from the orchards of Diyala province. The mean weights were  $239.5 \pm 28.3$ g, while the weight of kidney was 1.31g. The anesthetized process of the hedgehogs was performed using chloroform, and after slaughtering the kidney was extirpated. the kidney was placed in formalin solution 10% for 24 hours for fixation, washed with tap water then

transferred to 70% alcohol solution for preservation and histological sections were prepared according to [10]. The samples were passed through ascending series of ethanol starting with 70% ending to 100% then placed in xylene solution to clear the samples finally embedded in paraffin wax. The wax blocks were cut using rotary microtome with a thickness of 7  $\mu$ m. histological sections were coloured using hematoxylin and eosin stain according to method in [11]. Glass slides were mounted using Canada balsam then tested and photographed using light microscopy provided with camera.

### Results and Discussion

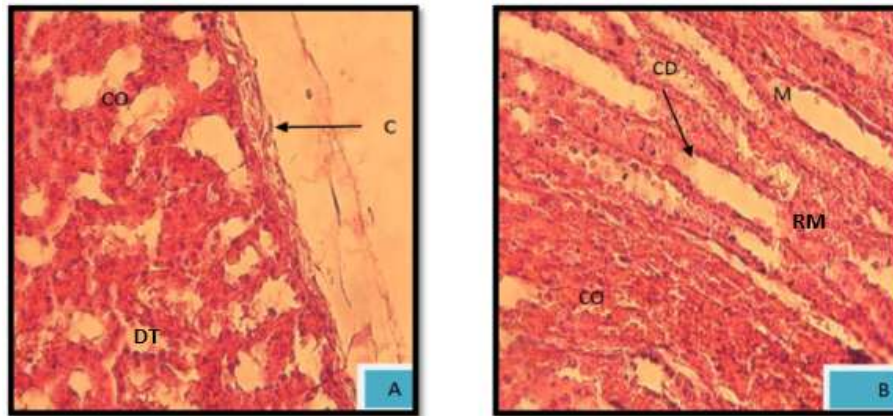
The results of this study showed that the kidneys of hedgehog situated on both sides of the anterior lumbar vertebra in the abdominal cavity behind the peritoneum. They had a small bean shape and smooth surface with the lateral convex border while the medial surface was concave and contains a hilum, the ureter connected with it. The colour of kidneys are dark reddish brown and surrounded by fibrous capsule of areolar connective tissues and its rest on a pad of fatty tissue as in **Figure [1]**.



**Figure 1. Shows kidney in hedgehog (K) kidney**

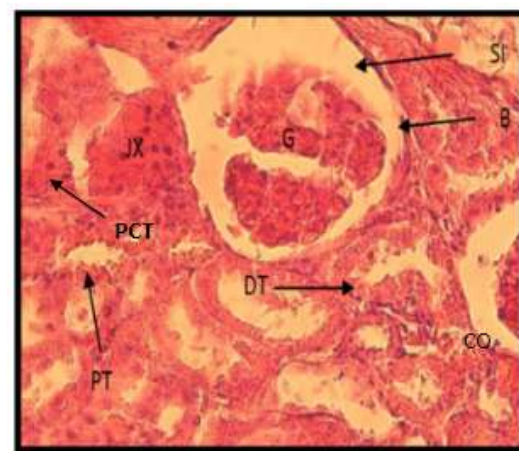
Several studies had elucidated that the kidneys in the mammalian show a wide differences in their shape, size and colour; generally its shape like a grain of beans, as in human or it has a smooth surface as in rodents and cats or it have grooves as in seals and bulls [12]. The results of the study was agreed with the results of [13,14] and the dark red colour of kidneys may be attributed to the abundance of blood supply and functional efficiency of the kidney. The current investigation explained that the hedgehog kidney's was small in size comparing to total body size and the average weight of kidney was about 1.31 g. Onyeansi, *et al* [15] refers that the average kidney's weight in bat (*Pipistrella kuhlii*) was about  $0.03 \pm 0.002$  g. This compatibility may be results from

the precision in the biogenetic design required by the behaviour and activity of these animals. The results also showed that the kidney was covered by thin capsule of areolar connective tissue composed of collagen fibers and smooth muscle scattered fibers **Figure [2A]**. The kidney's similar capsule of dog, horse and pig which the capsules possess some smooth muscle fibers while in ruminants the capsules possess characteristic layer of smooth muscle [16]. The study was illustrated that it can distinct two regions in the kidney, the outer one reddish brown in colour is called cortex while the inner region is called medulla lighter than cortex in colour **Figure [2B]**, which is similar to what is found in all domestic animals [17].



**Figure 2 (A) Parasagittal section in hedgehog kidney showing kidney capsule. (B) Parasagittal section in hedgehog kidney showing (CO) cortex (M) medulla. (DT), the distal convoluted tubule (CD) collecting tubules (RM) medullary rays (C) capsule and collecting duct (3) H&E stain 40×**

The results also show that the cortex region contains glomeruli which are small spherical structure with dark red colour and its average diameter was 78  $\mu\text{m}$  and it consists of a network of blood vessels capillary. The glomeruli are distributed randomly in the peripheral area of the cortex. Sections of proximal convoluted tubules and distal convoluted tubules are also founding in the cortex region. In the medulla region of kidney, thick and thin segments of Henle's loop and collecting tubules exist which arranged radially forming the medullary rays **Figure [3]**. This result agreed with the previous studies [18,19]. When comparing with other mammalian there was no significant difference in the histological structure of the renal corpuscle (glomerulus) in the kidney cortex, except the difference in diameters of glomeruli and proximal and distal convoluted tubules. The results of previous studies revealed that the mean diameter of glomeruli is 220  $\mu\text{m}$  in horses, 120  $\mu\text{m}$  in cats [20] and [71 $\pm$ 0.3] in bats (*Pipistrella kuhlii*) [15]. This may be due to the functional requirements and has an important beneficial in determine the liquid flow rate through that tubules. The histological examination elucidated that the glomerulus in the hedgehog kidney surrounded by Bowman's capsule which is consisted of parietal layer and visceral layer. Parietal layer is lining with simple squamous epithelium whilst visceral layer was contained highly specialized epithelium cell called podocytes. Between these two layers Bowman's space is founded **Figure [3]**.



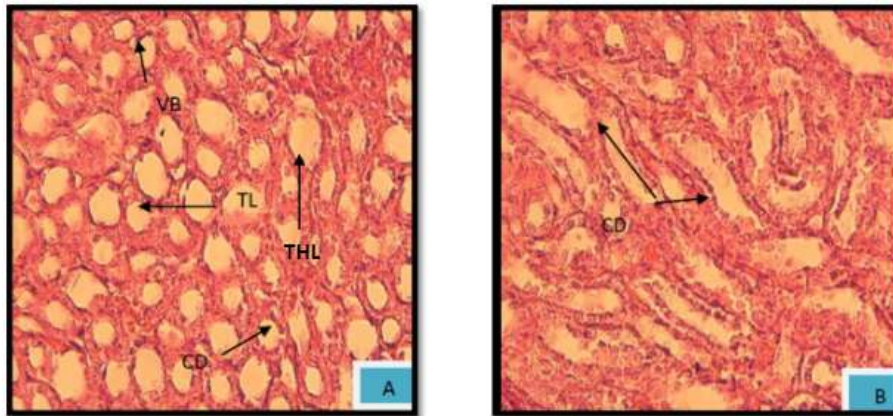
**Figure 3 Parasagittal section in hedgehog kidney showing (CO) cortex (JX) Juxtaglomerular cells. (DT) the distal convoluted tubule (PT) proximal convoluted tubules (G) glomerulus (B) Bowman's capsule and (SI) Bowman's space H&E stain 40×**

The results of the current study are largely coincided with the result of many researchers have been studied kidneys in different vertebrates [21,22]. The results of present study showed that the Bowman's capsule connected with the first part of renal tubule represented by proximal convoluted tubule which is considered the main component in the cortex. The lining of proximal convoluted tubule characterized by simple cuboidal epithelial tissue based on a basement membrane and the nuclei of the lining epithelial cells has dark color staining with a central position and round shape. The free surface of it covers with brush border which are not enlarged and contains small fine microvilli **Figure [3]**. Previous studies indicated that, there was a variation in epithelial tissue that lining to proximal convoluted tubule in various vertebrates. This contrast was ranging from simple squamous epithelium to simple columnar epithelium. Tisher [23] indicates that, the lining of proximal convoluted tubule was between simple squamous epithelium to simple columnar epithelium and provided by brush border in both cases. While Patil and Janbandhu [24] noted that the lining of proximal convoluted tubule



represents by simple columnar epithelium contain of round central nuclei and the free surface has brush border, in kidney of Indiana bat (*Myotis sodalis*). The presence of round nuclei is a characteristic of cuboidal epithelial cells. The results of present study are not consistent with what the researchers mentioned above regarding the proximal convoluted tubule lining, while the results of the current study matched with the findings of many researchers in their studies on kidneys of different mammals [19,21,24] but not agreed with them on the brush border. This variation between these results may be attributed to the functional requirements of proximal

convoluted tubule. The results of the present study also showed that the Henley's loop extends from the cortex to the medulla where the thin segment of the Henle's loop begins from the end of the proximal convoluted tubule and extends inside the medulla. As a result, the nephrons appear to contain long loops in the hedgehog which perform sharp curves into the inner medulla. The upper thin segments of Henley's loop lining by squamous epithelium of with a large darkly stained nuclei and light cytoplasm. The thick segment of Henle's loop is lining with cuboidal epithelium cells of darkly stained nuclei [Figure 4].



**Figure4 (A,B) hedgehog kidney showing (TL) Thin Henley's loop (VB) capillary blood vessel (CD) collecting tubules. (THL) thick Helen's loop. H&E stain 40×**

This is confirmed by the results of studies [24,25] and which was agreed with the results of this study. According to the results of current study, the distal convoluted tubule in the hedgehog was lined by simple cuboidal epithelial tissue based on a basement membrane and its cells are lighter and shorter than the cells in proximal convoluted tubule and the free surface is covered by small and fine protrusions **Figure [3]**. The result of the study was not consistent with many researchers in their studies on the kidneys of different mammals regarding with the histological structure of distal convoluted tubule [3, 25]. The histological study shows that the collecting tubules in the hedgehog kidneys of were lined with simple cuboidal epithelia tissue, its cell characterized by light cytoplasm and dark spherical nucleus. The free surface of the cells is covered by small, fine few protrusions. The collecting tubules found in the **References**

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medulla region **Figure [4]**. The results of the current study confirmed to the results of Al-Samawy [19]. The review of the previous literatures showed a variation in the form of cells lining of the collecting tubules in the kidneys of different vertebrates. The Al-Zubaidy [26] explained that the lining cells of collecting tubules is lower columnar epithelia tissue in Guinea pig (*Cavia porcellu*), while in the Indiana bat appear as a simple vertical epithelial tissue [27]. The histological sections in hedgehog showed the presence of distinct cells with an elliptical nucleus called Juxtaglomerular cells which are in touch with macula densa whose cells tend to be busier and longer than the rest of the cubic cells in the tubules. The cells also found at the junction of the distal tubules with afferent arterioles as in **Figure [3]**. The results of the current study are identical with the results of the researcher [28].

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## الوصف العياني والتركيب النسجي للكلية في القنفذ طويل الأذن Hedgehog (*Hemiechinus auritus*)

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### الملخص

هدفت الدراسة الحالية إلى التعرف على الوصف العياني والتركيب النسجي للكلية في القنفذ طويل الأذن (*Hemiechinus auritus*). وبينت نتائج الدراسة أن الكلية تكون ذات شكل صغير يشبه حبة الفاصولياء ذو لون أحمر داكن مائل إلى البني، وتقع على جانبي الفقرة القطنية العليا في تجويف البطن خلف الصفاق. وتكون الكلية محاطة بمحفظة ليفية رقيقة من النسيج الضام. أظهرت نتائج الفحص النسجي أن الكلية تتميز إلى منطقتين متميزتين، منطقة خارجية تدعى بالقشرة Cortex ومنطقة داخلية تسمى باللب Medulla، تحتوي القشرة على الكبيبات ويكون متوسط قطرها حوالي 78 مايكرومتر وهي منتشرة بشكل كثيف في منطقة القشرة، ويوجد في منطقة القشرة أيضاً مقاطع من النيببات الملنوية الدانية والنيببات الملنوية القاصية بينما منطقة اللب تحتوي على القطع النحيفة والسميكة لعري هنلي إضافة إلى مقاطع القنوات الجامعة التي تكون بشكل تراكيب شعاعية تعرف بالأشعة اللبية. أظهرت نتائج الفحص النسجي أيضاً أن كل جسيم الكلوي يتكون من الكبيبة المحاطة بمحفظة بومان، والنيببات الملنوية الدانية، وعري هنلي والنيببات الملنوية القاصية، والقنوات الجامعة. يتصل بمحفظة بومان النيبب الملنوي الداني ويكون مبطن بنسيج ظهاري مكعب بسيط يستند على غشاء قاعدي ويغطي السطح الحر لها بالحافة الفرشائية Brush border. بينت نتائج الدراسة أن النيببات الرقيقة من عروة هنلي تبدأ من نهاية النيبب الملنوي الداني وتمتد إلى داخل اللب، وتكون مبطنة بنسيج ظهاري حرشي، بينما القطعة السميكة لعروة هنلي تكون مبطنة بنسيج ظهاري مكعب بسيط. كما أظهرت نتائج الدراسة أن النيبب الملنوي القاصي يبطن بنسيج ظهاري مكعب بسيط يستند على غشاء قاعدي ويغطي السطح الحر لخلاياه بنتوءات قصيرة. من جانب آخر فقد أظهر الفحص النسجي أن القنوات الجامعة تبطن بنسيج ظهاري مكعب بسيط، وأن السطح الحر لخلاياه تغطي بنتوءات قصيرة وقليلة.

**الكلمات المفتاحية:** الكلية، القنفذ طويل الأذن، النيببات الملنوية الدانية، النيببات الجامعة، عروة هنلي