Histomorphplogical study of kidney in Iraqi jerboa (Jaculus jaculus)

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Abstract

The current study was conducted to describe anatomical & histological characteristics of kidney in Iraqi jerboa (Jaculus jaculus) by taking thirty healthy kidneys from fifteen Iraqi jerboa (Jaculus jaculus). The samples were collected from kidney of the jerboa which live in middle of Iraq in najaf desert. Gross anatomical study revealed that the kidney of the jerboa was small relatively, red to brown in color and both kidney are bean like structure located retro-peritoneal in caudal area of upper abdomen on each side of the sub-lumbar region covering by higly attachment fibrous layer of connective tissue with abundant amount of perirenal fat tissue and the right kidney located more cranially than the left one and relatively at same nearest of the medial plan. The histological results revealed that the kidney of jerboa covered by thin capsule. The parenchyma of kidneys had uniform parenchyma at the demarcation between the cortex and medulla. Although, three types were recognized of nephrons, the cortical type which was less numerous and It locates entirely within cortical area. The midcortical nephrons which are moderate in numbers and the mammalian type or medullary type which have numerous of nephron and had a loop of Henle extended deep into medullary area which was characterized by a presence of bundles of tubules.

Key words: anatomical, histolomorphology, description, kidney, jerboa.

دراسة تشريحية نسجية للكلية في الجربوع العراقي على كاظم حمادى الجبورى / كلية الطب البيطرى / جامعة القاسم الخضراء

الخلاصة

اجريت الدراسة الحالية لغرض وصف الخصائص التشريحية, والنسجية للكلية في الجربوع العراقي حيث تم اخذ ثلاثون كلية صحية من خمسة عشر جربوع . العينات من كلى الجربوع العراقي الذي يعيش في صحراء النجف. اظهرت الدراسة التشريحية العيانية بان الكلى في الجربوع صغيرة نسبيا وذات لون بني الى احمر وكلاهما يشبة شكل حبة الفاصوليا تقع خلف البريتونفي المنطقة الخلفية للجزء العلوي للتجويف البطني على كل جانب من المنطقة تحت القطنية ومغطاة بواسطة طبقة ليفية من النسيج الرابط والكلية اليمنى تتموقع اماميا اكثر من اليسرى ونسبيا تبدو اقرب الى المنصف الوسطي. اظهرت الدراسة الكلى مغطاة بواسطة محفظة من النسيج الرابط والكلية اليمن يتموقع الماميا اكثر من اليسرى ونسبيا تبدو اقرب الى المنصف الوسطي. اظهرت الدراسة النسجية بان الكلى مغطاة بواسطة محفظة من النسيج الرابط ويوجد خط فاصل مابين القشرة واللب. يوجد ثلاث انواع من النفرون , النوع الأول ويدعى القشري وتقع ضمن المنطقة القشرية وتكون اقل عددا بينما النوع الثاني يدعى الوسط القشري ويكون ضمن المنطقة الوسطى للقشرة بينما النوع الثالث يسمى اللبي او الذي يحتوي على اكبر عدد من النفرونات وعروة هنلي طويلة جدا تمنا الوسطى للقشرة النفرونات والثلث يسمى اللبي الاذي والذي يحتوي على اكبر عدد من النفرونات وعروة هنلي طويلة جدا تمن

Introduction

The jerboas comprise 33 species in the order Rodentia, superfamily Dipodoidae, family Dipodidae.The superfamily includes the nearest relatives of jerboas, the birch mice (Sicistidae) and jumping mice (Zapodinae), and is a sister taxon to the Muroidae, which includes hamsters, gerbils, true mice, and rats. The jerboas are further divided into four subfamilies—Euchoreutinae (the long-eared jerboa), Cardiocraniinae (the pygmy jerboa), Allactaginae (the four- and five-toed jerboas), and Dipodinae (the three-toed jerboas). The species Jaculus jaculus (the lesser Egyptian jerboa) is in this latter and most derived subfamily of jerboas (1)

The kidney is the important part of the urinary system that contributes to the maintenance of heomeostasis by complex process that involves filtration, absorption and secretion .It's also regulates fluid and electrolyte balance of the body and the site of production of renin, a substance that regulate blood pressure and erythropoietin that stimulate the production of erythrocyte (2). "The mammalian kidney had been typical bean-shaped appearance characteristic of the unipolar mammalian kidneys according to one study (3). The rabbit & mice kidney is unipapillary consists of superficial capsule, outer cortex and inner medulla. The outer cortex is highly vascular; the inner medulla is slightly thick and less vascular" (4). The nephron is the functional unit of the kidney; each nephron consists of renal corpuscles, proximal convoluted tubules, loop of Henle, distal convoluted tubules and collecting tubules (5).

No information is available regarding the histoanatomical study of kidney in the Iraqi jerboa (Jaculus jaculus). It is seemed of interest to determine histological and anatomical characteristic of kidney because it has very important in scientific research and environmental balance in our country.

Materials and Methods

The study was performed on thirty healthy kidneys from fifteen Iraqi jerboa (Jaculus jaculus). Each jerboa was sacrificed by anesthetizing with chloroform dropped in cotton pad kept around the face by a paper funnel. The animal was laid on its back and the abdomen was incised longitudinally to obtain the whole kidney, then anatomical parameter recorded and transferred into the appropriative fixative to histological technique. **Anatomical study**, the kidney was removed carefully and the following parameter were recorded [weight of kidneys by using the sensitive balance and dimensions of kidneys (length, width and thickness) by using vernier caliber] (6).

Histological study, for the histological study of the kidney, samples was collected from fifteen adult jerbo. Samples were taken directly after the animals were killed and fixed in 10% formalin to left for 72 hours. After fixation, the tissue was trimmed and the specimens were washed by tap water for 3-4 hours to remove the formalin solution & following transferred to the steps: Dehydration, Clearing & embedded and finally cutting & staining by using the rotary stained routinely microtome and with hematoxylin and eosin (7). A computerized program, the Statistical Package for Social

Sciences [SPSS] version 15 was used to calculate the statistics (8). Finally, Morphometric measurements of different histological sections done by light microscope [MEM1300] digital eyepiece and for microscope installation instructions. The parameters used in this work were measuring renal corpuscle diameter in subcapsular area, cortical area and juxamedullary area under (40x) according to (9)

Results and discussion

Anatomical results Shape and position of kidney

The anatomical result were revealed that the kidney of the jerboa was small relatively, red to brown in color and both kidneys were bean like structure located retroperitoneal in caudal portion of the upper abdomen cavity on each side of spinal cord under the sub-lumbar region covering by highly attachment fibrous layer of connective tissue with abundant amount of perirenal fat tissue and the right kidney located more cranially than the left one and relatively at same nearest of the medial plan (Fig.1, 2). "The result is similar to the result of (10) who reported that the kidneys of the two studied rodents were bean shape and dark red bodies located in the dorsal wall of abdominal cavity. The right kidney was situated more cranially than the left (fig.1); this result is similar to (11). The right kidney is located more cranial than the left kidney".

The kidney of the jerboa was bean like structure, smooth and possess convex and concave borders and had dorsal and ventral surface, medial and lateral borders, the lateral border was convex while, the medial border was concave, indented hilus, and an upper and lower pole (fig.1,2,3,4). This result agreed with (12) whom they noted also that the kidneys of African gaint rat and wistar rat have bean shape and smooth.

The presence of large amount of fat tissue surrounding both kidney which act as a good insulator and one of fixatives of kidney in its position. This is in agreement with (13) who stated that the kidney is a regulatory organ that tends to maintain stability of the internal body environment (Homeostasis) by regulating fluid balance. In para-sagittal section of kidney, appears two areas ; The outer which was darker and granular called cortex , the inner which is reddish – this was the medulla. The reddish discoloration of the jerboa kidney was due to the presence of glomeruli in the cortex (fig.3,4).

The left Kidney: The left kidney related with spleen and parietal layer of stomach, the descending colon and the body of the pancreas and jejunum, the left kidney being posterior in their location to the right kidney and slightly away from the axial plan while the cranial extremity of left kidney related with the left adrenal gland (Fig.1, 2). The right kidney: the right kidney was larger, more elongated, nearest of median plane and heavier than left kidney. It was elongated, bean in shape and flattened dorsoventrally. The right kidney covers partially by the right lobe of liver.

Weight and dimensions of kidney, the present study was revealed that there was a slight difference in the weight of the two kidneys, the left kidney was weighted about (1.196±0.35) gram while the right one about (1.175±0.41) gram (Table.1). This result in variance with (27) who observed that new Zealand white rabbit had a mean kidney of (0.510 ± 0.012) weight gram. These differences in values could be due to variation in age, breed and environmental factors. The results appear that the dimensions of kidney were varied in the two kidneys (right and left). The length of right kidney was about (14.62 \pm 0.174) mm, while the length of the left kidney ranged about (12.55 ± 0.183) mm (Table.1). The width of the two kidney were varied, the width of the right kidney are about (5.57 \pm 0.349) mm, while the left kidney are about $(5.60 \pm 0.045) \text{ mm} (\text{Table.1})$.

Also the present results were showed that the thickness of the kidney was different between the two kidneys, the right thickness about (4.88 ± 0.212) and left one about (5.19 ± 0.201) (Table.1). High weight of the right kidney may be due to the presence of important organs in the right side of the abdomen like liver, pancreas and may be due to the cranial location of the right kidney which affected by high blood pressure as it is nearer to the heart than the left one.

The kidneys of the jerboa were consist of unipyramidal two morphoanatomical regions, the cortex located outer and is reddish brown in color and medulla which located inner, both terminate by a single elongated renal papillae(fig.3,4), this result agreement with (14) in true desert rodents and (15) in albino rats and (16) in spiny mice, who mentions the renal papilla was markedly sharp pointed, longer and extended down into the renal pelvis comparing to the corresponding papillae of both the hedgehogs and the guinea pigs which were relatively shorter and blunt and also with (17), who mention, the kidneys of the argentine desert rodents has single renal papillae and a medulla divided in two zones and the delicate mouse, Salinomys delicatus, (murid) and red vizcacha rat, Tympanoctomys barrerae, among the octodontids, has the most elongated papillae but in Octomys mimax (octodontid) and Akodon molinae (murid) has shorter less development renal papillae are associated with lower renal indices. The broad (blunt) papillae may be necessary to produce a large urine volume, whereas a narrow pointed papilla may be better adapted to concentrate urine down to a small volume (16).

The present study showed the renal pelvis has single cavity and not divided into major and minor calyces and has pelvic recesses extended between the cortex and medulla (fig.3,4). This result agreement with (15) in albino rats and (16), which mentions, the renal pelvis appeared as dilated cavity of the proximal end of the ureter, lodged in the sinuses and facing the renal papilla which are complex and well- developed secondary fornices (pelvic recesses) in hedgehogs, and highly developed evaginations that extended between cortical and medullary tissues as in the spiny mice.

Histological results

The present study is performing on adult male and female jerboa (Jaculus jaculus) to give more details and information about anatomical and histological structures of kidney. The jerboa kidneys were covered by a thin dense connective tissue capsule with adipose tissue that was adherent to sub capsular connective tissue (fig.5).

The present study claimed that the capsule of the jerbo's kidney was thin composed of thin layer of fine collagen and reticular fibers (Fig.5) in comparison to thick capsule of other animals like camel (18). This is agreed with the findings of (19,20) in sheep, goat , cow and in contrast with (21) in camel. This great variation in thickness may play a renal functional role.

Kidney cortex

In cross section of both kidneys in jerboa revealed that composed mainly of renal corpuscles, convoluted tubules and cortical straight loops of Henle. The sections extend from the capsule to the medulla showing variations in distribution of renal corpuscle from the superficial which has little renal corpuscles to the mid-cortical region which has moderate number renal corpuscle comparison to juxtamedullary region which has mores renal corpuscles than the mid cortical and cortical region (Fig.5,6).

Kidney medulla

The medullary region in cross section of straight appeared consists tubules. collecting ducts, and a special capillary network, vasa recta. The straight tubules of the nephrons and the collecting ducts continue from the cortex into the medulla. They are accompanied by a capillary network, the vasa recta, that runs in parallel with the various tubules (fig.5,6). The tubules in the medulla, because of their arrangement and differences in length, collectively form a number of conical structures called renal pyramids. Renal pyramid is conical in shape. Its broad base lies toward cortex, and its apex called renal papillae, the apical portion of each pyramid, which is known as the papilla, projects into a calyx, a cup-shaped structure that represents an extension of the single renal pelvis. (fig.3,4,5,6,7)

Renal corpuscle

The renal corpuscle consists of a tuft of capillaries, the glomerulus, surrounded by a double layered cup – shaped Bowman's

capsule. The afferent arteriole give rise to the capillary loops, the outer or partial layer of Bowman's capsule was simple squamous epithelium which reset on visible basement membrane. The inner or visceral layer appears as globe-like structure represented by the podocytes nuclei. Between the two layers of Bowman's capsule was the Bowman space , which at the urinary pole leads into the proximal tubule (Fig.8). This is similar to the findings of (22) in domestic animals.

The diameter of renal corpuscles range between (7 to 10 um) and this vibration depend on location of renal corpuscle in cortical or midcortical or juxtamedullary. This variation in size leads one to suspect that the glomerular filteration surface would be much greater in the large juxtamedullary population of glomeruli, this could lead to preferential filtration in these nephrons and because they have long loops many results indicated maximal concentrating capacity. "This finding agrees with (23) who stated that, the glomerular filtration rate of the juxtamedullary nephron is approximately eight times that of nephron in the outer cortex".

proximal convoluted tubules

The present study revealed that the proximal convoluted tubules in rabbit is the lined by tall cuboidal epithelial tissue possess a round to elliptical nucleus light in color and central in location reset on visible basement membrane, the lumen narrow in diameter and appear occupied by brush border was homogenous and represented the future of this segment and contain 2-3 cells in cross-section. The P.C.T. of jerboa has clear brush border and more acidophilic appearance, this may lead to increase the tubular re-absorption and accordingly decrease the tubular excretion from the kidney of jorbo and this variation due desert environment of this animals. to (fig.8,9,10)

Loop of Helene

The current study in jerbo kidney conforms that the Helene loop consists of the thin and thick limb of the heel loop are long and more evident in medulla. the thin segment of Henle loop was lined by simple squamous epithelium tissue with cells reset on visible basement membrane which appear in crosssection compose of two cells number, spindle-shaped with prominent oval nuclei which bulging to inside of tubule forming narrow lumen and cells reset on visible basement membrane with oval nuclei central location (fig.10). These findings in disagreement with those reported by (4,20) in domestic animals and difference with results that confirmed by (28) in fish that the Henle loop absent in fish. This variation due to aquatic environment for these animals. The jerbo kidney have relatively more ratio of long Henle loop and this is because the jerboa need high re-absorption of water as compared with aquatic animals like whose excrete unconcentrated urine. This is due to the ability of jerboa to stand extended periods without water and produce highly concentrated urine. This higher level of development in the jerboa compare with other mammals species is likely to be advantageous in the hot weather which may be reach to (50°C), high dryness, arid desert, and rocky environment these animals naturally inhabit.

Distal convoluted tubule

Distal convoluted tubules in jerbo kidney are short and not encountered as frequently in sections as proximal tubules. These results were compatible with (24) whom they seen that the distal convoluted tubules in rabbit kidney is long and this will leads to increase the water re-absorption. This description of distal convoluted tubule in current study in disagreement with finding of (25) in buffaloes.

Their luminal diameters are greater than in proximal tubules and narrower than collecting tubules and the brush border is not seen. the distal tubules lined by low cuboidal epithelium cells with rounded or oval nucleus central in location reset on visible basement membrane, more nuclei in cross-section, the cells less acidophilic than proximal convoluted tubules.(fig.8,9,10)

Collecting tubules and duct

The collecting tubules continues from terminal part of distal tubule and converge in the renal cortex to form bundles of tubules called medullary rays. The collecting segment was short segment that joins the distal tubule with collecting duct system. The collecting tubules lined by cuboidal epithelial tissue with relatively large nucleus occupy all the cell and reset on visible basement membrane. The cytoplasm of cuboidal cells was pale and has dark oval nucleus.

The contemporary study similar with (19) in domestic animals who illustrated that collecting tubules lined by cuboidal epithelium with cytoplasm is pale and has a dark, spherical nucleus and (26) in human who mentioned that the smaller collecting tubules are line with cuboidal epithelium.

The collecting duct begins in the cortex and descends to reach the tip of the papilla and during it is course, there is an increase in diameter from cortical portion to terminal segment at the area cribrosa and divided into cortical collecting duct and medullary collecting duct. The Cortical Colleting duct lined by cuboidal epithelium tissue and the medullary collecting duct by tall columnar epithelium tissue.

The medullary collecting duct represent the terminal portion of collecting duct called papillary duct and increase gradually in diameter and lined by tall columnar epithelium cells in terminal portion of medulla and gradually altered into transitional near renal papilla.(fig.7,11,12)



| Fabla | [1] | chowi | ng tha | woight | longth | width a | nd thickno | ee of righ | t and laft | kidnov |
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| parameter kidney | Weight [gram] | Length [mm] | Width [mm] | Thickness [mm] |
|---------------------|---------------|-------------------|--------------|----------------|
| Right kidney | 1.175±0.41 | 14.62 ± 0.174 | 5.57 ± 0.349 | 4.88±0.212 |
| Left weight | 1.196±0.35 | 12.55 ± 0.183 | 5.60 ± 0.045 | 5.19±0.201 |

Values represent mean \pm S.E at [P \leq 0.05].



Figure (1) Photograph illustrates anatomical structures of urinary system (Kidney, ureter and urinary bladder) in jerbo. A- Left kidney B- Right kidney C- liver D- Urinary bladder F- Adipose tissue



Figure (2) Photograph illustrates anatomical structures of urinary system (Kidney, ureter and urinary bladder) in jerbo. A- Left kidney B- Right kidney C- Ureter D- Urinary bladder E-Adernal gland



Figure (3) Photograph illustrates anatomical structures of kidney in jerboa showing . A-Left kidney B-Right kidney C-Hilus



Figure (4) Photograph illustrates anatomical structures of kidney in jerboa (parasagittle-section) showing . A- cortex B- medulla C- renal pelvis E- ventral border F-ventral border



Figure (5) Parasagittal-section through kidney showing cortex and medulla in jerbo. A- capuscle B- Crtex C- Medulla **(H&E.X4)**



Figure (6) Parasagittal-section through kidney showing cortex and medulla injerbo. A- capuscleB- CrtexC- MedullaD-cortical renal corpuscleE-midcortical renal corpuscleF-juxtamedullary renal corpuscle (H&E.X4)



Figure (7) Parasagittal-section showing medullary region of kidney showing. A- Renal papilla B- Papillary duct C- Cavity of renal pelvis (H&E.X40)X4)



Figure (8) Cross-section showing renal corpuscle and tubules of kidney injerbo.A- Proximal convoluted tubulesB- Distal convoluted tubulesC- urinary spaceD- parietal layer (H&E.X40)



Figure (9) Cross-section showing renal tubules of kidney in jerbo. A- Proximal convoluted tubules B- Distal convoluted tubules C- Brush border (H&E.X40)



Figure (10) Cross-section showing renal tubules of kidney in jerboa. A- Proximal convoluted tubules B- Distal convoluted tubules C- Henele loop (H&E.X40)



Figure (11) Cross-section showing renal tubules of kidney in jerboa.A- cortexB- medullaC- collecting duct (H&E.X10)



Figure (12) Cross-section showing medullary collecting duct and tubules of kidney in jerboa. (H&E.X40)

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