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Anatomical and histological examination of kidneys in ground squirrels

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Abstract

Ground squirrel (*Marmotini*) is a type of squirrel that, unlike other squirrels, lives on the ground or underground. Kidney is one of the vital organs of the body. Despite the wide distribution of this rodent in Iran, no study has been reported on the histological structure of its kidney. This study was conducted with the aim of investigating the histological structure of kidney in ground squirrel. In this investigation, we studied five squirrels that were died due to the road accidents. The freshly samples were collected and fixed in 10% formalin solution and after being transferred to the laboratory, the kidney tissue was separated and was studied anatomically. Then, the samples entered the tissue passage stages, and 5-7 µm thick sections were prepared from the paraffin blocks and stained by the hematoxylin-eosin method. The results of this study showed that the ground squirrel has two kidneys with left and right positions. The right kidney was bean-shaped and the left kidney was heart-shaped and larger than the right kidney. The kidney in this animal is single-lobed and its parenchyma consists of two cortical and central parts. The ratio of the center of the kidney to its cortex is relatively high. The structures in the cortical part included renal corpuscles, proximal and distal convoluted tubules, and cortical collecting tubules. In the central part of the kidney of this animal, the thick and thin tubes of Henle's arch along with the central collecting ducts with simple cubic epithelium were visible. According to the results of the present study, it seems that the kidney structure in this squirrel is similar to other squirrel families, especially the Iranian squirrel.

Keywords: Ground Squirrel, Histology, Kidney

1. Introduction

Ground squirrel (*Marmotini*) is the name of a family of squirrels. Unlike other squirrels, these rodents live on the ground or underground. These animals are medium in size, have a short tail and big eyes and can weigh up to 8 kg. Most of the ground squirrel species live socially and in large groups in the plains. These animals can stand up on their hind legs when they feel threatened. In the standing position, they are more proficient in finding dangers and observing the surroundings. If these animals feel serious danger, they announce the existence of danger to others by producing special sounds [1].

The most important role of the kidney in mammals is to control the volume and concentration of body fluids [2]. Mammal species especially in arid and semi-arid habitats where not only the access to water is limited, but also the time of access to water may be very variable, face the problem of water conservation [3].

Since many years, many studies have been conducted on how to purify and preserve body fluids by kidney tissue, and how animals resist and adapt to low water environments has always been of interest [4, 5].

In connection with the investigation of the histological and anatomical structure of the kidney in the family of squirrels, some studies have been carried out. In a study, the kidney of Iranian squirrel (*Sciurus anomalus*) was examined by histological method and stereological evaluation [6].

So far, there has been no study on the anatomical and histological structure of the kidney in ground squirrel, this study was done in this study.

2. Materials and methods

In the present study, we investigated five squirrels in the early March of 2022 to the late June of 2023. The samples were collected from Zarin-Roud city (Khodabande- Zanjan province) to Kabudarahang city (Hamadan province) road accidents that had died before (Figure 1). Freshly Samples were collected and fixed in 10% buffered formalin solution and after being transferred to the laboratory, the kidney tissue was separated and was studied anatomically. Then, the samples entered the stages of tissue passage (including the dehydration, clarification and impregnation with melted paraffin). Next, paraffin blocks were prepared from the samples and using a microtome, slides with a thickness of 5 to 7 µm were serially prepared and stained by the hematoxylin-eosin (H&E) method. The prepared slides were examined and photographed by optical microscope, Dino Late camera and Dino capture software V. 2 [7].

3.Results

The results of the present investigation showed that the ground squirrel has two kidneys with left and right extraperitoneal position. Bean-shaped right kidney; The left kidney was heart-shaped and larger than the right kidney (Figure 2). The results of measuring the length and width of the kidney in this animal showed that the left kidney has larger dimensions than the right kidney (Table 1).

The kidney in this animal is single-lobed and single-pyramidal, and its parenchyma consists of two cortical and medulla parts. The medulla of the kidney in this animal can be clearly divided into two internal and outer medullas. The ratio of the medulla of the kidney to its cortex is relatively high (Figure 3).

The kidney in this animal is surrounded by a dense connective tissue capsule. The structures in the cortical part included renal corpuscles, proximal and distal convoluted tubules, and cortical collecting tubules. In the medulla of the kidney of this animal, the thick and thin tubes of the arch of Henle along with the central collecting ducts with simple cubic epithelium were visible (Figure 4).

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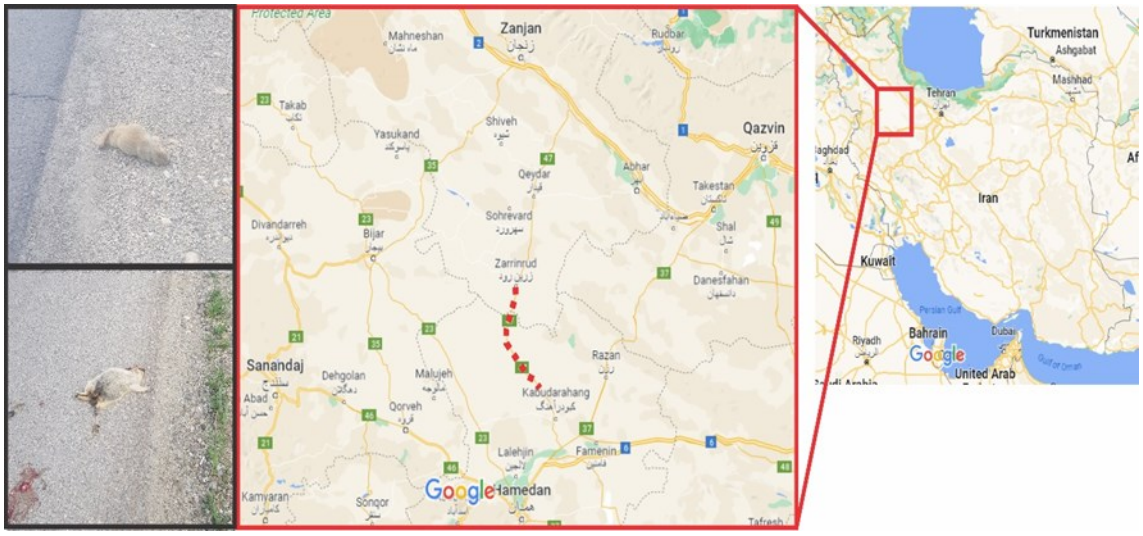

Figure 1: Five died ground squirrels collected in the early March of 2022 to the late June of 2023 (from Zarin-Roud city (Khodabandeh- Zanjan province) to Kabudarahang city (Hamadan province).

Figure 2- Anatomical picture of kidneys in ground squirrels. In this animal, the right kidney is bean-shaped and the left kidney is heart-shaped.

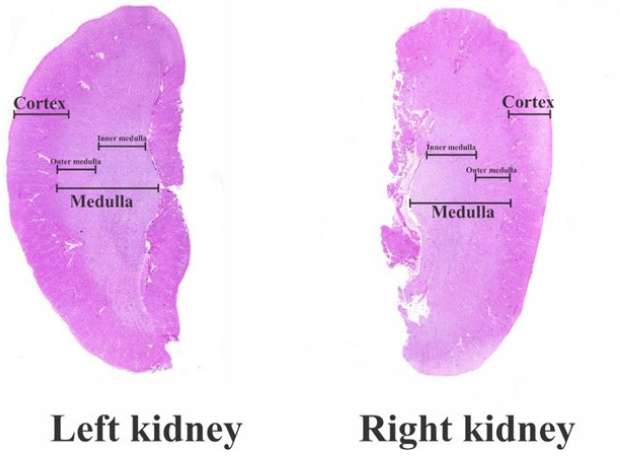

Figure 3- Kidney parenchyma in ground squirrels. H&E staining. Two cortical and central parts can be distinguished in the structure of this organ. Also, the central part can be divided into two internal and outer medulla.

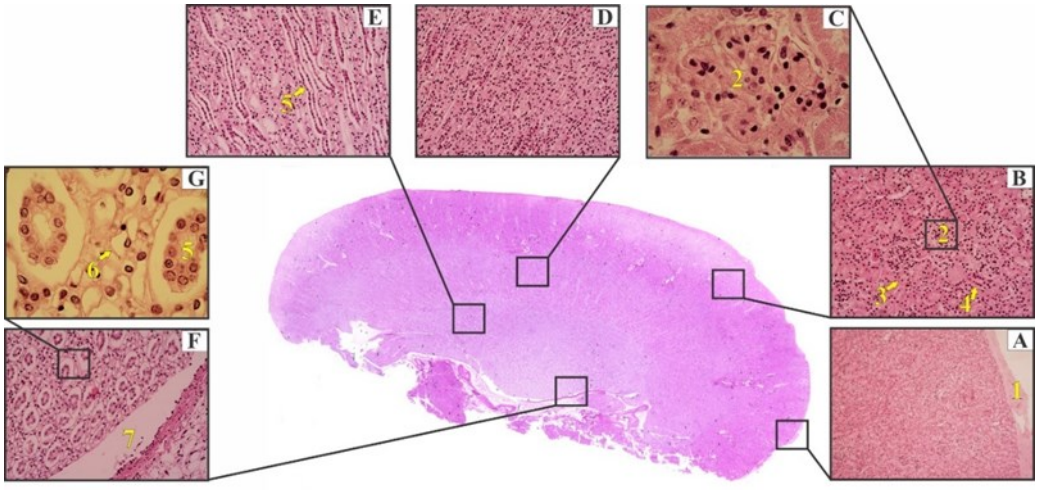

Figure 3- Tissue section of the cortical and central parts of the kidney in ground squirrels. Hematoxylin-eosin staining.
A: kidney cortex, The No.1 represents the dense connective tissue capsule. ×100.
B: kidney cortex, magnification No.2 is the renal corpuscle, No.3 is the proximal convoluted tubule, and No.3 is the distal convoluted tubule. ×400.
C: renal corpuscle (No.2), ×400.
D: Section from the outer center, Thick Henle's tubules were the dominant component in this part of the kidney. ×100.
E: inner center, Thick Henle's tubules, tubules and collecting ducts were visible in this part. No.5 - indicating the central collector tube. ×100.
F: renal pelvis, Thin tubes of Henle along with central collecting ducts were visible in this part. No.7- Pelvic space. ×100.
G: renal pelvis, Thin Henle's tubules (No.6) along with the central collecting ducts (No.5) ×400.

		Kidney width (µm)	Kidney length (µm)	The thickness of the renal cortex	Outer medulla thickness (µm)	Inner medulla thickness (µm)
Left kidney	Mean	10099.32	20162.77	4962.16	2991.50	2193.42
	SD ±	523.53	1056.19	389.58	415.81	245.11
Right kidney	Mean	8735.45	20243.45	4167.62	2231.65	1853.56
	SD ±	478.50	1126.82	402.96	387.43	199.64

Table 1- Results of morphometry and histomorphometry of left and right kidney in ground squirrels.

Discussion

The most important role of the kidney in mammals is to control the volume and concentration of body fluids (2). The role of these organs becomes doubly important in animals that live in tropical and dry habitats [3].

In the present study, which was conducted on the anatomical and histological structure of ground squirrel kidney, it was shown that the left kidney in these animals is heart-shaped, and the right kidney is bean-shaped. While both the left and right kidneys in laboratory rodents such as rats and mice are bean-shaped (8) and hence it is different from the shape of the left kidney of the squirrel. By examining the case studies in this field, no similar case was observed in the rodent family regarding the difference in the shape of the right and left kidney.The study of kidneys, especially in animals of tropical regions with limited access to water, has always been of interest (4, 5).

In a study, the kidney of Iranian squirrel (*Sciurus anomalus*) was examined by histological method and stereological evaluation, and it was stated that the kid—ney in this animal consists of two parts, the cortex and the medulla. The cortical in this animal included kidney corpuscles, proximal and distal convoluted tubules [6]. The result of the mentioned study was consistent with the results obtained in the present study.

In relation to the structures observed in the medulla, which included the thin and thick tubes of the Henle arch along with the collecting tubes, the present study was consistent with the results reported in all Iranian squirrels (6).

Considering the vital role of the medulla of the kidney in the process of maintaining water in the body (9), and considering the tropical climate and low water in the sampled region in most of the year, the thickness of the central part compared to It seems quite logical.

Finally, it can be stated that the histological structure of kidney in ground squirrel is very similar to its reported structure in Iranian squirrel.

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