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Comparative morphological and morphometrically study of the adrenal gland in adult males' squirrel (*Sciurus anomalous*) and hamster (*Mesocricetus auratus*)

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Abstract

Given the physiological significance and the need for further physiological and morphological knowledge of the adrenal glands, the objectives of the current study were to compare morphometric data between the right and left adrenals of male squirrels and hamsters. The study was conducted on five squirrel males and five hamster males. The glands in both animals were removed and fixed in neutral formalin solution. It was found that the squirrel contains two brown-colored right and left adrenal glands connected anteriorly and medially to each cranial pole of the kidney, and the right adrenal gland had a longitudinal shape, while the left gland had an oval shape. Hamsters had two pairs of brown adrenal glands located anteriorly attached to each kidney's cranial pole. The right adrenal gland was round in shape, while the left was oval. The statistical results showed a significant difference between the left and right suitable adrenal glands in both animals, as well as a significant difference between the squirrel gland and the hamster gland, where it was found that the right and left squirrel glands are larger more significant, heavier, longer and thicker than the adrenal gland in hamsters after the following measures were adopted: weight, length, thickness, width, and size.

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Introduction

Rodents are the largest mammal species number, accounting for more than 40% of all mammal species. Rodent biology has become an area of increasing research interest. This may be attributed to their use as a ready source of animal protein, experimental animals, and zoonotic diseases (1). The Caucasian squirrel or Persian squirrel (*Sciurus anomalous*) belongs to Rodent and genus Sciurus. It is found in forests of the Middle East and extreme southwestern Asia. Persian squirrel is a medium-sized rodent weighing 200 to 410 g (2,3). The golden or Syrian hamster (*Mesocricetus auratus)* is a rodent that belongs to the subfamily, Cricetinae. Their natural geographical areas are northern Syria and southern Turkey. The body mass ranges between 100-125 g (4) inch the metabolic rate to about 5% and help the animal stress resistance. Therefore, used in laboratory typical research, especially pharmacological audition of skin and sensitiveness (5,6). Adrenal glands are compound endocrine glands that play a key crucial role in the secretion of chemical substance substances and many types of hormones that help metabolism, fluid and electrolyte balance, and maintenance of life. Structurally, they are comprised of the cortex and medulla (7-9). This work was designed to investigate the morphological characteristics and morphometrically measurements of the adrenal gland in males Squirrel and Hamster and comparing compare between them, to provide information that could lead to

improved knowledge of the adrenal glands of the two animals and to provide a baseline data on the adrenal gland of these animals.

Up to date, there are no available studies in the previous and present literature investigations to the adrenal gland squirrel and hamsters According to this reason and the importance of this animal's species mentioned in the above introduction, the project will be conducted to the morphological structure and morphometrically measurements of Adrenal gland in Adult Males Squirrel *(Sciurus anomalus)* and Hamster *(Mesocricetus auratus)*, and comparison between them.

Materials and Methods

The current study was carried out on ten male Squirrels and Hamsters. After recording the live body weight, the rodents were sacrificed, and the topography and relationship of adrenal glands were recorded. The anatomical parameters of adrenal glands, such as each gland's weight, volume, length, and diameter, were recorded and listed in tables. The statistical analysis was carried out using (*t-test*) for the methods suggested of comparison of parametric variances of the adrenal glands between Squirrel and Hamsters and the significance level was at $P<0.05$ (10).

Results

This study showed that the anatomical findings of the adrenal gland in squirrel and hamsters were paired small glands; left and right, both were situated retroperitoneal in the abdominal cavity. Generally, they were situated on each side of the vertebral column and resting on the superior poles of the corresponding kidney (Figures 1 and 2). In squirrel, the right adrenal was located cranio medial side of the right kidney and enclosed by the caudate lobe of the liver close to the right proper aspect of the aorta and more cranial than the left one (Figures 1 and 3), whereas the left adrenal located to the left side of the abdominal aorta on the anterior pole of the left kidney and related to the stomach greater curvature (Figures 1 and 3).

In the hamster, the right and left adrenal were embedded in the adipose tissue, and the right gland was slightly different in its location than the right one of squirrel, it had a convex dorsal surface that fits over the craniomedial surface (more medially than of squirrel) of the right kidney and close to the hilus of the right kidney (Figure 2) it's covered by the liver (Figure 4), while the left adrenal rested on the left kidney cranial pole and is more cranially than the right one (Figure 2). In both squirrel and hamster, the adrenal gland was attached to the cranial pole of the corresponding kidney,

In squirrels, the right adrenal was more cranial than the left one (Figures 1 and 3), Whereas in hamsters, the left adrenal gland was located cranially than the right one (Figure 2). In squirrels, the external feature of the right adrenal gland showed a more elongated or (elliptical like) shape than the left one, which has a (bean-like) shape and brownish color (Figure 5), in hamsters, the right adrenal appeared elongated oval to (egg-like) shape, while the left gland displays more rounded (Figure 6).

The right and left adrenal glands in both squirrels and hamster showed soft, crusty, and dark brownish color (Figures 5 and 6), and each of them contains a yellowish outer region which represents the cortex, and the inner dark reddish-brown region represent represents the medulla (Figures 7 and 8).

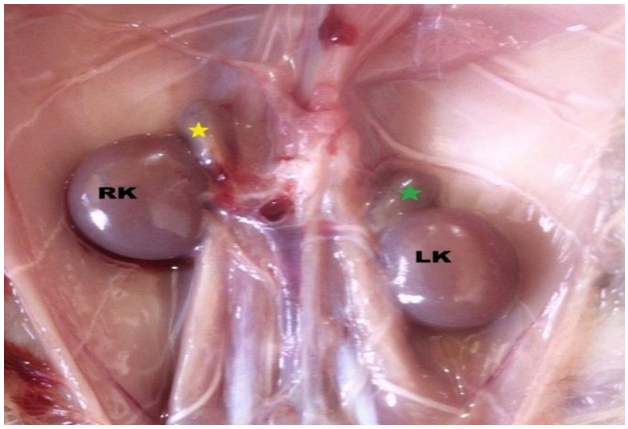

Figure 1: The gross anatomy of the adrenal glands in adult male Squirrel Shows: Right adrenal gland (yellow star) Left adrenal gland (green star) Right kidney (RK), Left kidney (LK).

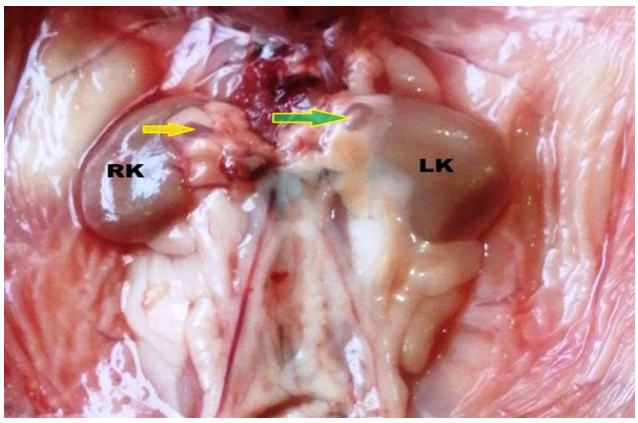

Figure 2: The gross anatomy of adrenal glands in hamster Shows: Right adrenal gland (yellow arrow) Left adrenal gland (green arrow) Right kidney (RK), Left kidney (LK).

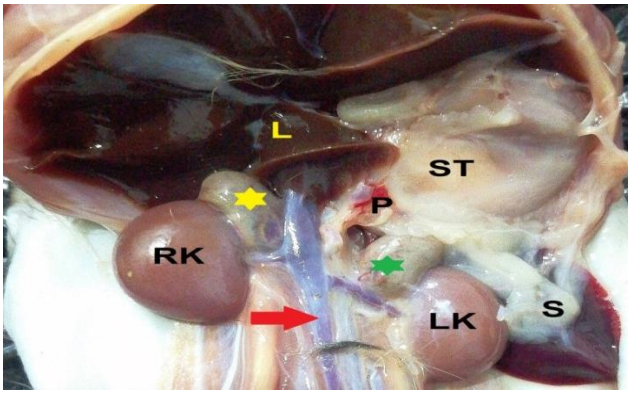

Figure 3: Location of the adrenal glands in squirrel Shows: Right adrenal gland (yellow star) Left adrenal gland (green star), Right kidney RK, Left kidney LK, Liver (L), Stomach (ST), Spleen (S), pancreas (P) and renal vein (red arrow).

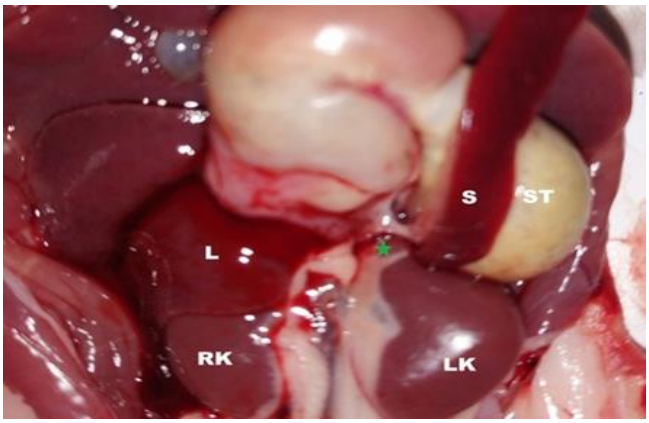

Figure 4: The gross anatomy of adrenal glands in hamster Shows: Left adrenal gland (green star) Right kidney (RK), Left kidney (LK), Liver(L), Stomach (ST), Spleen (S).

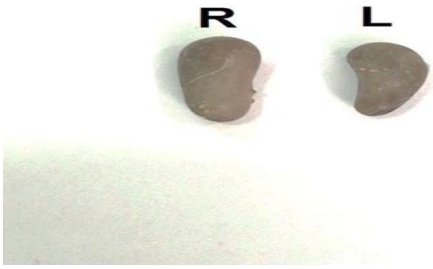

Figure 5: The gross anatomy (external feature) of adrenal glands in squirrel Shows: Right adrenal gland(R), Left adrenal gland (L).

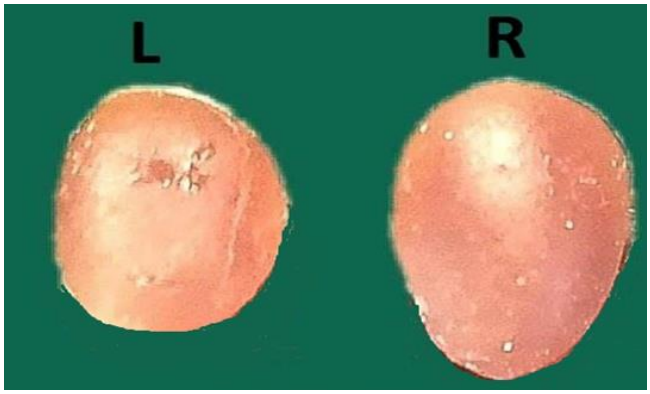

Figure 6: The gross external feature adrenal glands of hamster Shows: Right Adrenal gland (R), Left adrenal gland (L).

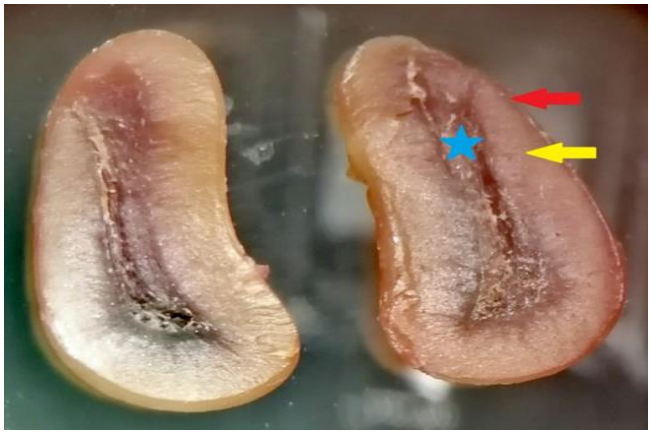

Figure 7: The gross anatomy (internal feature) adrenal glands of squirrel Show: Capsule (red arrow), Cortex (yellow arrow), and medulla (blue arrow).

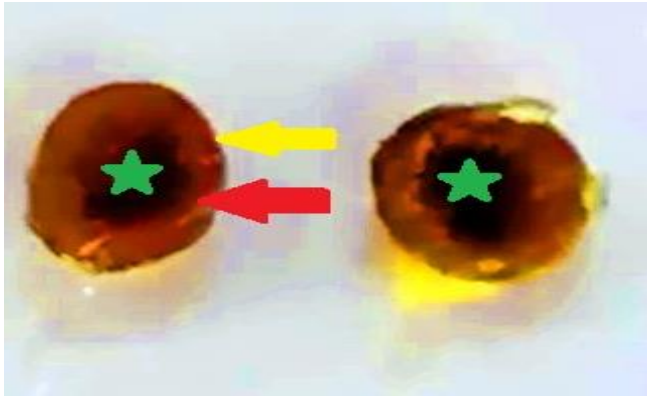

Figure 8: The gross anatomy (internal feature) adrenal glands of hamster Shows: Capsule (yellow arrow), cortex (red arrow), and medulla (green star).

Anatomical measurements of the adrenal gland in squirrel and hamster

The mean average squirrel and hamster weight**,** mean total adrenal weight, mean relative weight, mean total volume was listed in (Table 1). The statistical analysis revealed that mean of these measurements was higher significantly at (P<0.05) in squirrels than those of hamsters (Table 1). These differences may be due to species variations. In squirrel, the mean weight, length, width, thickness, volume values of the right and left adrenal gland were listed (Table 2). The statistical analysis of results displays that the mean of these measurements of the right adrenal gland was higher significantly at (P<0.05) than those of the left one.

In the hamster, statistically, the means of weight, length, width, thickness, and volume of the right and left adrenal gland were listed in (Table 3). These measurements except the width of the left adrenal gland were higher significantly at (P<0.05) than those of the right adrenal gland. The weight, length, width, thickness, and volume of the right gland parts in squirrel and hamster were (Table4). These results showed that all measurements in both right and left adrenal glands were higher significantly at (P<0.05) in squirrels than those of hamsters (Table 4). These differences may be due to species variations.

Table 1: Anatomical parameters of adrenal gland in squirrel and hamster

Measurements	Mean ± SE		T-Test
	Squirrel	Hamster	
Weight of adrenal gland (g)	202.28±18.86	101.17±10.42	0.0005 *
Total weight of adrenal gland (g)	0.083±0.011	0.051±0.017	0.0243*
Relative weight of adrenal gland (%)	0.136±001	0.021±0.001	0.0051 *
Total volume of adrenal gland (ml)	0.160±0.02	0.0471±0.05	0.030*

Table 2: Anatomical measurements of right and left adrenal gland in squirrel

Measurements	Mean ± SE		T-test
	Right adrenal gland	Left adrenal gland	
Weight (g)	0.087±0.01	0.081±0.01	0.432*
Length (mm)	8.76±0.38	8.33±0.32	0.164*
Width (mm)	4.52±0.2	4.36±0.11	0.256*
Thickness (mm)	3.66±0.02	2.89±0.29	0.012*
Volume (ml)	0.81±0.02	0.79±0.03	0.309*

Table 3: Anatomical measurements of right and left adrenal gland in hamster

Measurements	Mean ± SE		T-test
	Right adrenal gland	Left adrenal gland	
Weight (g)	0.046±0.01	0.053±0.017	0.288*
Length (mm)	3.40±0.11	3.43±0.04	0.407^{NS}
Width (mm)	2.40±0.11	2.34±0.10	0.247*
Thickness (mm)	1.84±0.08	2.01±0.16	0.133*
Volume (ml)	0.160±0.02	0.307±0.08	0.084*

Table 4: The anatomical measurements of adrenal gland in squirrel and hamster

Parts of glands	Parameters	Squirrel	Hamster	T-test
Right	Weight (g)	0.087 ± 0.01^{A}	0.046 ± 0.011^{B}	2.094
	Length (mm)	8.76 ± 0.38^{A}	3.40 ± 0.011^{B}	1.674
	Width (mm)	4.52 ± 0.2^{A}	2.40 ± 0.11^{B}	0.021
	Thickness (mm)	3.66 ± 0.2^{A}	1.84 ± 0.08^{B}	0.243
	Volume (ml)	0.81 ± 0.02^{A}	0.160 ± 0.02^{B}	2.060
Left	Weight (g)	0.081 ± 0.01^{A}	0.053 ± 0.017^{B}	0.033
	Length (mm)	8.33 ± 0.32^{A}	3.40 ± 0.04^{B}	6.522
	Width (mm)	4.36 ± 0.11^{A}	2.34 ± 0.10^{B}	0.0003
	Thickness (mm)	2.89 ± 0.029^{A}	2.01 ± 0.16^{B}	1.648
	Volume (ml)	0.79 ± 0.03^{A}	0.307 ± 0.08^{B}	6.579

Discussion

This study showed that the anatomical findings of the adrenal gland in squirrel and hamsters were paired small glands; left and right, both were situated retroperitoneal in the abdominal cavity. Generally, they were situated on each side of the vertebral column and resting on the superior poles of the corresponding kidney. Similar to that observed in

domesticated cats and dogs by Ribes *et al*. (11) but disagree with Abbas and Shakir (12), who found packrat that the adrenal glands were located on the lower pole of the kidneys in Mexican packrat.

In the hamster, the right and left adrenal were embedded in the adipose tissue, and the right gland was slightly different in its location than the right one of squirrel, it had a convex dorsal surface that fits over the craniomedial surface (more medially than of squirrel) of the right kidney and close to the hilus of the right kidney. the liver covers it while the left adrenal rests on the left kidney cranial pole more cranially than the right one. These results were not agreeing with Abbas and Shakir (12) in Mexican pack rats in which the adrenals were located at the lower poles of the corresponding kidneys. In both squirrel and hamster, the adrenal gland was attached to the cranial pole of the corresponding kidney, similar to that reported in a cat by Laforgia *et al*. (13) and in spixs yellow –tooth *Galea spixii* (14), but disagree with Machado *et al*. (15) in *Rattus norvegicusl* in point that adrenal was separated from the kidneys. Also disagree with Mitani (16) in Albino Rats, the gland was situated interior cranial pole of the kidney and embedded in fat tissue.

In squirrel, the right adrenal was more cranial than the left one, the same as that observed in plum mouse *Myocastar caypus* by Murad (17), albino rats, and guinea pig by Mitani (16) in which the right adrenal was located more cranial than the left one. Whereas in hamsters, the left adrenal gland was located cranially than the right one, this finding was disagreed disagree with that reported by Mitani (16) in albino rats and guinea pigs in which the right adrenal was more cranial than the left one, In African giant rats, the left adrenals were located on Percy and Bartholdi's kidneys (18).

In squirrels, the external feature of the right adrenal gland showed a more elongated or (elliptical like) shape than the left one, which has a (bean-like) shape and brownish color, hamster the right adrenal appeared elongated oval to (egg-like) shape, while the left gland displays more rounded. The adrenal glands gland shapes varied in different animals (16) recorded in albino rats, the left adrenal had an oval shape, and the right adrenal gland had a bean shape. (19) and (20) were found in a study on rats which that had flattened and pyramidal shape adrenal glands. In the female guinea pig, the right adrenal appeared bean shape structure. the right adrenal gland was ovoid to a rounded shape (21,22). While Murad (17) reported that in rabbits *(Oryctolagus cuniculus)*, the right adrenal was more elongated whereas the left was oblong, these variations may be due to species differences.

The right and left adrenal glands in both squirrels and hamsters showed soft, crusty, and dark brownish color and each of them contains a yellowish outer region which represents the cortex, and the inner dark reddish-brown region represents the medulla, as reported in most mammals as a guinea pig and albino (16). These findings were in discord with Abbas and Shakir (12), who observed that the adrenal gland in the Mexican Packrat has a light grey color, and in Kangaroo-rat, the adrenal gland has a gray color.

The mean average squirrel and hamster weight**,** mean total adrenal weight, mean relative weight, mean total volume was listed. The statistical analysis revealed that the mean of these measurements was significantly higher at ($P<0.05$) in squirrels than of hamsters, these differences may be due to species variations. In squirrel, the mean weight, length, width, thickness, volume values of the right and left adrenal gland glands were listed. The statistical analysis of results displays that the mean of these measurements of the right adrenal gland was higher significantly at ($P<0.05$) than those of the left one. Similar results were reported by Sheikhian *et al.* (23) in wild rat *Rattus sikkimensis*.

In the hamster, statistically, the means of weight, length, width, thickness, and volume of the right and left adrenal gland glands were listed. These measurements except the width of the left adrenal gland were higher significantly at ($P<0.05$) than those of the right adrenal gland. This finding coincided with Lerwill and Makings, (3) Sanjeev *et al.* (21) The mean width of the right adrenal was higher significantly, this finding was accorded with (24) in *Logatomes Maximus Maximus* and (15,21,25) in hamster and guinea pig. The weight, length, width, thickness, and volume of the right gland parts in squirrel and hamster were. These results showed that all measurements in both rights and left adrenal glands were higher significantly at ($P<0.05$) in squirrels than those of hamsters. These differences may be due to species variations.

Conclusions

The statistical results showed a significant difference between the left and right suitable adrenal glands in both animals, as well as a significant difference between the squirrel gland and the hamster gland, where it was found that the right and left squirrel glands are larger, heavier, longer and thicker than the adrenal gland in hamsters after the following measures were adopted: weight, length, thickness, width, and size.

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Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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مقارنة مورفولوجيا ومورفومترية للغدة الكظرية بين ذكور السناجب البالغة وذكور الهامستر البالغة

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الخلاصة

نظرًا للأهمية الفسيولوجية والحاجة إلى مزيد من المعرفة الفسيولوجية والمورفولوجيا لِلغدد الكظرية، كانت أهداف الدراسة الحالية هي مقارنة البيانات الشكلية بين الغدة الكظرية اليمنى واليسرى لذكر السنجاب والهامستر. أجريت الدراسة على خمسة ذكور سنجاب وخمسة ذكور هامستر. تمت إزالة الغدد في كلا الحيوانين وتثبيتها في محلول فورمالين متعادل. وجد أن السنجاب يحتوي على غدتين من الغدد الكظرية اليمنى واليسرى بلون بني متصلين من الأمام والوسط بكل قطب قحفي للكلية، والغدة الكظرية اليمنى لها شكل طولي، بينما كان للغدة اليسرى شكل بيضاوي. كان للهامستر زوجان من الغدد الكظرية البنية الموجودة من الأمام متصلة بكل قطب قحفي من الكلية، وكانت الغدة الكظرية اليمنى مستديرة الشكل، بينما كان اليسار بيضاوي الشكل. أظهرت النتائج الإحصائية وجود فرق معنوي بين الغدد الكظرية اليمنى واليسرى في كلا الحيوانين، بالإضافة إلى اختلاف معنوي بين غدة السنجاب وغدة الهامستر، حيث وجد أن غدد السنجاب اليمنى واليسرى أكبر وأثقل وأطول. وأسمك من الغدة الكظرية في الهامستر بعد اتخاذ التدابير التالية: الوزن، والطول، والسماكة، والعرض والحجم.