

Morphological and Morphometrical Comparative Study of Thyroid and Adrenal Glands Between Suckling and Adult Local Male Cats (*Felis catus*)

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Abstract | The present study was carried on morphological and morphometric characteristics of the thyroid and adrenal glands in suckling and adult local male cats. In suckling and adult cats, the thyroid gland was consisted of two entirely separated lobes without isthmus and appeared as smooth elongated oval shape with rounded cranial, narrow caudal ends and smooth lateral and medial surfaces. All measurements of left lobe in suckling and adult cats were higher than those of the right one. Statistically, the weight, length, width and thickness of right and left thyroid lobes in adult cats were higher significantly than those in suckling at $p < 0.05$. The adrenal glands in suckling and adult cats contains two creamy small glands, located on each side of vertebral column, the right gland situated on the cranioventral pole of the right kidney, while the left one situated more away from the left kidney anterior pole. Statistically, there were significant difference between right and left adrenal glands in suckling and adult cats. The weight, length, width and thickness of right adrenal gland were greater significantly than those of left adrenal at $p < 0.05$, these variations in may be due to the age of animal that. Concluded, the current study the differences in morphometric measurements between right and left thyroid lobes and adrenal glands in both suckling and adult may be due to age and growth of animal.

Keywords | Morphological, Morphometrical, Thyroid gland, Adrenal gland, Male cats, Weight and length, Endocrine system, Iraq

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INTRODUCTION

One of the seven species of the small cat genus *Felis*, which is a subfamily of the Felidae family that also includes tigers, lions, cougars, and domestic cats, is the domestic cat (*Felis catus*) (Wilson and Reeder, 2005). The domestic cats (*Felis catus* or *Felis domestica*) are used as laboratory animals due to have similar physiological characteristics to laboratory rabbits it is highly used in behavioral and biomedical researches, especially of neurological conditions (James, 1995). In most species thyroid gland consisted of two lobes connected by isthmus.

Its location varied within the same animal, within same species and generally it situated on the trachea cranial part. The isthmus when present appeared as a thin and narrow structure connect the two lobes (Hamad, 2008; Dyce *et al.*, 2010). Adrenal glands are paired complex endocrine organs located inside the craniamedial side of kidneys (Yilmaz and Girgin, 2005). Adrenal showed distinct variations amongst mammals' species in shape, weight and size. and varies in morphological maturation with age (Konig and Liebich, 2011). In rodents, the thyroid gland is situated under sternohyoid and sternothyroid muscles and laterally to the trachea near the base of laryngeal cartilage.

The anterior and ventral sides of the trachea were bridged by a narrow isthmus that joined the right and left lobes. The isthmus is extended from the posterior larynx along the first four or five tracheal rings in rats and the first three or four tracheal cartilage ring in mice (Perle and Dintzis, 2018; Choksi *et al.*, 2003). The aims of the current study of the effector of the age and type of food on the important endocrine gland that include thyroid and adrenal glands and to highlight on morphological and morphometrical comparative of thyroid and adrenal glands local male cats go through suckling and adult periods.

MATERIALS AND METHODS

ANIMALS ETHICS

The Committee on Research Ethics in the Faculty of Veterinary Medicine of the Baghdad, authorized every procedure utilized in this study with the assigned code number PG/ 2335-IN 25/10/2023.

EXPERIMENTAL OF ANIMALS

The current study was carried out on ten healthy sucking and adult local male cats. The suckling groups will be selected from (1-7) weeks of age and the adult group will be selected from (12) months of age, obtained from local supplier of (Al-Samawa city-Iraq). that obtained from local supplier of (Al-Samawa city-Iraq). After recording the body weight in sucking was (464.00 ± 29.63) gm and for adult was (3320.00 ± 204.02) gm.

EXPERIMENTAL DESIGN

The cats were killed by the over dose of euthanasia, the thyroid glands of sucking and adult were exposed, its location and relationship was photographed then the thyroid gland was torn out with the trachea for completed other morphological and morphometrical observations which include weight which measured by using digital sensitive balance (Zghair and Khaleel, 2018; Naser and Khaleel, 2020) length, width and thickness by using digital vernier caliber (Khaleel and Salman, 2016) that listed in tables. After abdominal incision, the location and relationship of adrenal gland was recorded, photographed and the morphological and morphometrical parameters of the right and left adrenal gland were recorded and listed in tables.

DATA ANALYSIS

The statistical analysis was carried out using (t-test) for the methods suggested of comparison of parametric variances of the thyroid and adrenal glands between sucking and adult cats and the significance level was used at $P < 0.05$ (SAS, 2018).

MORPHOLOGICAL RESULTS OF THYROID GLAND IN SUCKLING AND ADULT CATS

In suckling cats, the thyroid gland appeared as reddish-brown structure, consisted of two entirely separated lobes (without isthmus) and appeared as smooth elongated oval shape, as reported by (Igbokwe, 2010) in African grass cutter, and with (Al-Aamery and Dauod, 2016b) in adult Hedgehoge, while disagree with (Gosselin *et al.*, 1982) in cat in which observed isthmus. These lobes located at the lateral aspect on each side of trachea embedded in the cervical fascia. The right thyroid lobe extended from the caudal border of thyroid cartilage to reach the eighth tracheal ring, while the left lobe extended from the caudal border of thyroid cartilage to the ninth tracheal ring (Figure 1), these results disagree with (Hammodi and Al-Aamery, 2023) in *Felis catus* in which the two thyroid lobes were located on both sides of the trachea between (1-5) the rings. The lobes have rounded cranial and pointed caudal ends and two smooth surfaces; lateral and medial surface. The lateral surface was convex and related with common carotid artery, jugular vein and sternomastoid muscle, whereas medial surface was flat and related to the trachea (Figures 1, 2, 3) while these results discord with (Parker *et al.*, 1980) who showed that the thyroid gland in pig situated on ventral midline of the trachea at the level of thoracic inlet.

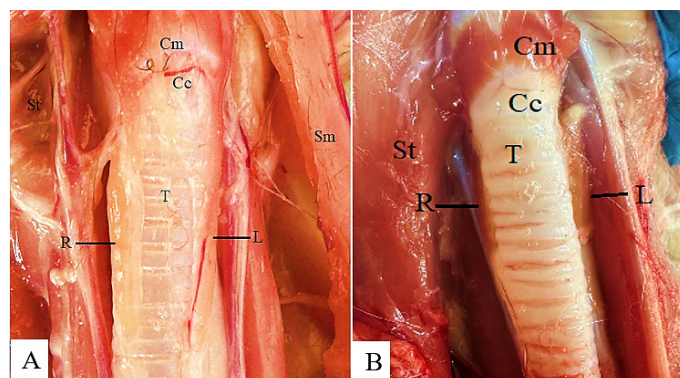


Figure 1: Photograph of the gross anatomy of thyroid gland in male cats. A: In suckling cats; B: In adult cats. R, Right lobe; L, Left lobe; T, Trachea; St, Sternothyroideus muscle; Sm, Sternomastoideus muscle; Cc, Cricoid cartilage; JV, Jugular Vein.

In adult cats the thyroid gland it's appeared as a reddish brown two lobes, consisted of two elongated oval with rounded cranial and narrow caudal end with a smooth (lateral and medial) surface (Figure 1). It's located in the neck region at the lateral surface of the trachea behind the larynx and situated laterally on each side of cranial part of the trachea and larynx (Figure 1) as observed in dogs by (Worth *et al.*, 2005; Julius, 2007). The dorsal border of the gland was thicker than the ventral border.

MORPHOMETRICAL MEASUREMENTS OF THYROID GLAND IN SUCKLING AND ADULT CATS

The mean morphometrical measurements of thyroid gland in suckling and adult cats that includes; animal weight, thyroid weight, relative weight and weight, length, width and thickness of the right and left lobes were listed in (Tables 1 and 2). Statistically, there were a significant difference in the weight of animal's total weight of the gland and relative weight between suckling and adult local male at $p < 0.05$ (Table 1).

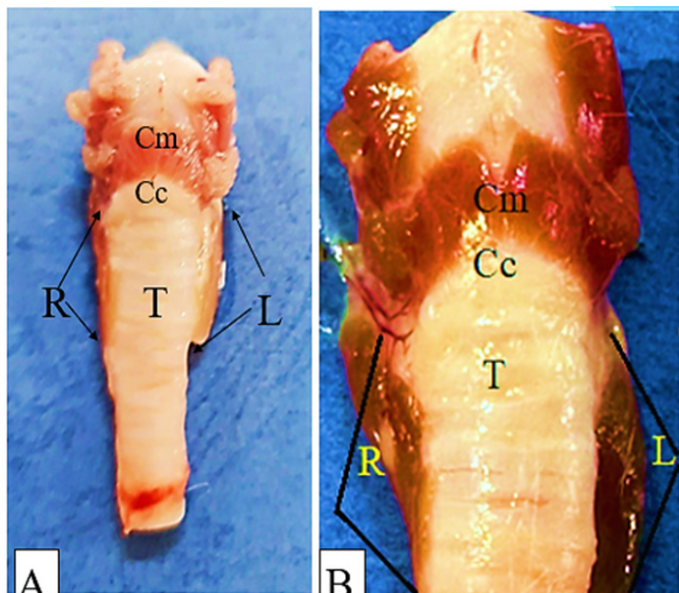


Figure 2: Photograph of gross anatomy of the thyroid glands in male cats. A, suckling cats; B, adult cats. R, Right lobe; L, Left lobe; Cc, Cricoid cartilage; T, Trachea; Cm, Cricoid muscle.

The thyroid gland lobes were separated on each side of trachea without connection by isthmus (Figure 2) as reported by (Batah and Mirhish, 2019) in guinea pig, but disagree with (Tadjalli and Faramarzi, 2016) in adult male mongooses in which the isthmus is a thin and narrow structure connect the right and left lobes at the lobe's caudal end. The cranial end of the right lobe extended from the caudal border of thyroid cartilage to reach the ninth tracheal ring, while the left lobe extended from the caudal border of thyroid cartilage to the tenth tracheal ring (Figures 2, 3). This result disagrees with (Choksi *et al.*, 2003) in mice in which the right and left lobes were extended along the first fifth tracheal rings. This difference may be due to species variation. There are species variation in the mode of attachment of the isthmus to the lobes and their crossing area on the trachea (Vandom and Lane, 1984) similar description was reported in rodents by (Perle and Dintzis, 2018), in guinea pigs by (Batah and Mirhish, 2019), but disagree with (Bone, 1982) where reported in some species as dogs there were an accessory lobe in addition to the left and right lobes, this difference may be due to the species differences.

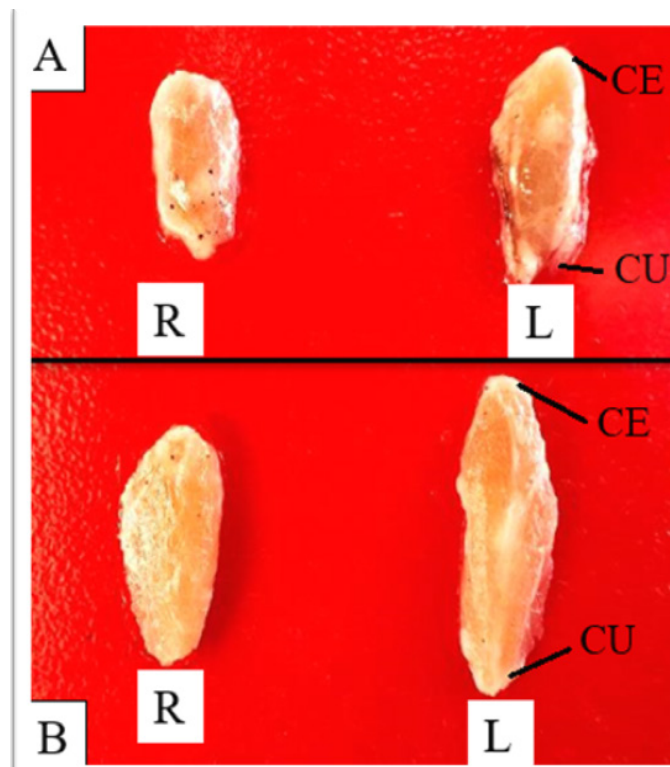


Figure 3: Photograph of gross anatomy of the thyroid glands in male cats. A, In suckling cats; B, in adult cats. R, Right lobe; L, Left lobe; CE, cranial end; CU, caudal end.

The weight, length, width and thickness of the left lobe was higher significantly at $p < 0.05$ than of the right one in suckling and adult cats (Table 2). These results were in line with (Al-Aamery and Dauod, 2016a) in the adult Weasel, but disagree with (Abd-Alameer, 2014) in local rabbits in which the length, width and thickness of the right lobe was greater than left one.

Table 1: Morphometrical measurements of thyroid gland in suckling and adult local male cats. N=10.

Morphometrical measurements	Suckling local male	Adult local male	T-test
	Mean \pm SE	Mean \pm SE	
Weight of animal (g)	464.00 \pm 29.63 B	3320.00 \pm 204.02 A	428.92 *
Total weight of gland (g)	0.192 \pm 0.01 B	0.953 \pm 0.01 A	0.0157 *
Relative weight	0.041 \pm 0.005 B	0.028 \pm 0.004 A	0.0093 *

The different letters mean there were signific difference between sucking and adult male cats ($P < 0.05$).

Table 2: Morphometrical measurements of thyroid right and left lobes in suckling and adult local male cats. N =10.

Type of animal	Morphometrical measurements	Right Lobe	Left Lobe	T- test
		Mean \pm SE	Mean \pm SE	
Suckling local male	Weight (g)	0.063 \pm 0.001 B	0.134 \pm 0.06 A	0.0164 *
	Length (mm)	9.30 \pm 0.47 B	12.10 \pm 0.23 A	0.741 *
	Width (mm)	4.14 \pm 0.01 B	4.28 \pm 0.03 A	0.095 *
	Thickness (mm)	3.06 \pm 0.003 B	3.12 \pm 0.012 A	0.079 *
Adult local male	Weight (g)	0.427 \pm 0.005 B	0.525 \pm 0.005 A	0.132 *
	Length (mm)	12.80 \pm 0.24 B	14.80 \pm 0.25 A	1.107 *
	Width (mm)	4.58 \pm 0.02 B	4.79 \pm 0.03 A	0.059 *
	Thickness (mm)	3.38 \pm 0.01 B	3.68 \pm 0.04 A	0.027 *

The different letters mean there were signific difference between sucking and adult male cats (P<0.05).

Table 3: Morphometrical measurements of thyroid right and left lobes in suckling and adult local male cats. N =10.

Part of gland	Morphometrical measurements	Suckling local male	Adult local male	T- test
		Mean \pm SE	Mean \pm SE	
Right Lobe	Weight (g)	0.063 \pm 0.001 B	0.427 \pm 0.005 A	0.109 *
	Length (mm)	9.30 \pm 0.47 B	12.80 \pm 0.24 A	1.66 *
	Width (mm)	4.14 \pm 0.01 B	4.58 \pm 0.02 A	0.407 *
	Thickness (mm)	3.06 \pm 0.003 B	3.38 \pm 0.01 A	0.215 *
Left Lobe	Weight (g)	0.134 \pm 0.06 B	0.525 \pm 0.005 A	0.102 *
	Length (mm)	12.10 \pm 0.23 B	14.80 \pm 0.25 A	1.17 *
	Width (mm)	4.28 \pm 0.03 B	4.79 \pm 0.03 A	0.210 *
	Thickness (mm)	3.12 \pm 0.012 B	3.68 \pm 0.04 A	0.114 *

The different letters mean there were signific difference between sucking and adult male cats (P<0.05).

Statistically the weight, length, width and thickness of right and left lobes in adult cats were greater significantly than those in suckling at p <0.05 (Table 3), this difference may be due to ages and weight of animal which correlated to the overall size of the animal, the heaviest animal had heaviest gland.

MORPHOLOGICAL RESULTS OF ADRENAL GLAND IN SUCKLING CATS IN ADULT CATS:

The adrenal glands in suckling cats were two creamy small glands located in abdominal cavity. The right adrenal situated on the side of vertebral column on the cranioventral pole of the right kidney, while the left one situated on the other side of vertebral column but more away from the left kidney anterior pole. The right adrenal gland fits over the craniomedial surface of the right kidney had clear triangular shape have a convex dorsal surface, ventrally the right adrenal gland related to the liver while left adrenal was elongated triangular shape presents convex dorsal surface. Its ventromedial surface in contact with the spleen and major curvature of stomach (Figure 4). The right and left adrenal glands of adult cats in this study were located at same level in the abdominal cavity (Figure 4). These results agree with (Raju and Rao, 1982) in dog and cat, while disagree with (Khaleel, 2021) in adult squirrel, (Ahmed and Dauod, 2016) in Plum mouse, who mentions

the right adrenal gland is more cranial than that the left one, (Batah and Mirhish, 2019) in guinea pig and albino rats.

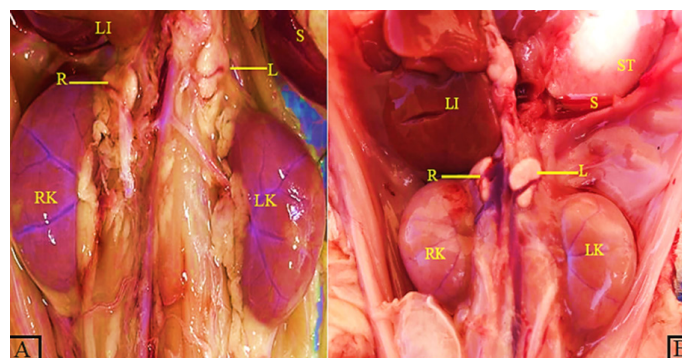


Figure 4: The gross anatomy of adrenal gland in male cats. A: Suckling cats; B: Adult cats.

R, Right adrenal gland; L, Left adrenal gland; RK, Right kidney; LK, Left kidney; LI, liver; S, spleen; ST, Stomach.

The adrenal in adult cats are two left and right small, triangular, soft and creamy color glands. Situated in the abdominal cavity on each side of the vertebral column. The right adrenal appeared ovoid to elongated structure rested anterior to cranial pole of the right kidney close to the right side of aorta caudal vena cava and enveloped by caudate lobe of the liver (Figure 5). As observed in squirrel and hamster

by (Khaleel, 2022), but discord with (Percy and Barthold, 2013) who reported that the adrenal gland of Mexican Pack rat was light grey were firm, intricate, multifaceted glands these differences due to species variation.

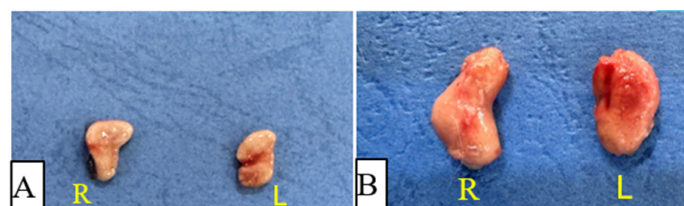


Figure 5: Photograph of the gross anatomy (external surface) of adrenal glands in male cats. A: Suckling cats; B: Adult cats. R, Right adrenal gland; L, Left adrenal gland.

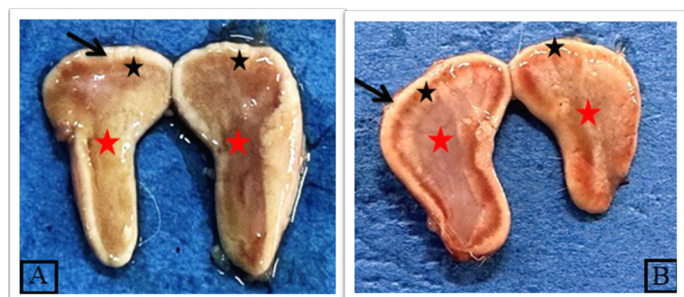


Figure 6: Photograph of the gross anatomy (internal surface) of right adrenal glands shows. A: In suckling cats: no clear limitation between cortex and medulla, B: n adult cats: clear limitation between cortex (black star) and medulla (Red star), Capsule (black arrow).

The left adrenal gland was pyramidal or conical in shape located close to the left side of abdominal aorta, separated in a distance from the left kidney and slightly pressed by greater curvature of the stomach and spleen (Figure 5). The shape of adrenal glands was varying in different animal species and within the same animal, in the plum mouse, the right adrenal gland was circular, while the left appeared elongated (Machado *et al.*, 2002). Khaleel (2022) reported the right adrenal gland in squirrel was elongated and left adrenal has bean shape, and in hamster the right adrenal gland was elongated oval and the left one was rounded. The left adrenal was separated in a distance from the left kidneys, as reported by (Ezumi *et al.*, 2007) in rats, but disagree with (Rosol *et al.*, 2001) in most mammals, (Berberet, 2010) in cat and dog and (Santos *et al.*, 2016) in spixs, That the adrenal glands were attached to the anterior pole of corresponding kidney, The gap between the gland and the kidney was varying between the species and, also among the individuals of the same species (Andrew, 1991).

the kidney was varying between the species and among the individuals of the same species (Andrew, 1996). The left adrenal located cranial then the right one, similar to that observed by (Khaleel, 2022) in adult hamster differ from that observed in adult squirrel by the same researcher.

The internal feature of adrenal glands in suckling male cats appeared brown color represent the cortex and medulla and no limitation between them and can not to distinguish between them, while in adult male cats the internal feature was divided in to brown color outer region then whitish color region then whitish s which they represent the cortex and large brown region which represent the medulla (Figure 6). This finding was differed from that observed in most mammals as in guinea pig (Abass, 2017), in albino rats and by (Batah and Shakir, 2019) in guinea pigs in which the internal feature consists of yellowish outer region representing the cortex and inner dark reddish brownish region representing the medulla. Also differ from that observed in hamster in which the internal feature of adrenal glands consists of dark reddish brown outer region representing the cortex and inner white region representing the medulla. These differences due to species variation.

The left adrenal glands in both suckling and adult male cats were separated in a distance from the corresponding kidneys (Figure 4), this finding was previously reported by (Batah and Mirhish, 2019) in albino rats, (Ezumi *et al.*, 2007) in rats, but disagree with (Rosol *et al.*, 2001) in most mammals, (Berberet, 2010) in cat and dog and (Santos *et al.*, 2016) in spixs, That the adrenal glands were attached to the anterior pole of corresponding kidney, The gap between the gland and the kidney was varying between the species and, also among the individuals of the same species (Andrew, 1991).

MORPHOMETRICAL MEASUREMENT OF ADRENAL GLAND IN SUCKLING AND ADULT CATS

In suckling and adult male cats, the weight of the two adrenal glands and relative weight were listed in (Table 4). The means of weight, length, width, thickness and of right and left adrenal gland were listed in (Table 5). The statistical analysis revealed there were significant difference in suckling and adult cats in all measurements between right and left lobes (Table 5).

Table 4: Morphometrical measurements of adrenal gland in suckling and adult local male cats, N =10.

Morphometrical measurements	Suckling local male	Adult local male	T- test
	Mean \pm SE	Mean \pm SE	
weight of animal (g)	464.00 \pm 29.63 B	3320.00 \pm 204.02 A	428.92*
Total Weight of gland(g)	4.37 \pm 0.31 B	4.83 \pm 0.25 A	0.712*
Relative weight	0.941 \pm 0.27 B	0.145 \pm 0.02 A	0.215*

The different letters mean there were signific difference between sucking and adult male cats (P<0.05).

Table 5: Morphometrical measurements of right and left adrenal gland in suckling and adult local male cats. N =10.

Type of animal	Morphometrical measurements	Right adrenal gland	Left adrenal gland	T- test
		Mean \pm SE	Mean \pm SE	
Suckling local male	Weight (g)	0.463 \pm 0.004 A	0.415 \pm 0.002 B	0.011 *
	Length (mm)	10.10 \pm 0.27 A	7.90 \pm 0.23 B	0.783 *
	Width (mm)	6.60 \pm 0.16 A	5.40 \pm 0.16 B	0.731 *
	Thickness (mm)	5.30 \pm 0.15 A	4.40 \pm 0.09 B	0.568 *
Adult local male	Weight (g)	0.509 \pm 0.004 A	0.464 \pm 0.003 B	0.010 *
	Length (mm)	12.10 \pm 0.27 A	10.80 \pm 0.25 B	0.760 *
	Width (mm)	7.50 \pm 0.27 A	6.60 \pm 0.22 B	0.485 *
	Thickness (mm)	5.70 \pm 0.21 A	5.50 \pm 0.16 B	0.469 *

The different letters mean there were signific difference between sucking and adult male cats (P<0.05).

Table 6: Morphometrical measurements of right and left adrenal gland in suckling and adult local male cats. N =10.

Part of gland	Morphometrical measurements	Suckling local male	Adult local male	T- test
		Mean \pm SE	Mean \pm SE	
Right adrenal gland	Weight (g)	0.463 \pm 0.004 B	0.509 \pm 0.004 A	0.108 *
	Length (mm)	10.10 \pm 0.27 B	12.10 \pm 0.27 A	0.873 *
	Width (mm)	6.60 \pm 0.16 B	7.50 \pm 0.27 A	0.662 *
	Thickness (mm)	5.30 \pm 0.15 B	5.70 \pm 0.21 A	0.276 *
Left adrenal gland	Weight (g)	0.415 \pm 0.002 B	0.464 \pm 0.003 A	0.204 *
	Length (mm)	7.90 \pm 0.23 B	10.80 \pm 0.25 A	1.18 *
	Width (mm)	5.40 \pm 0.16 B	6.60 \pm 0.22 A	0.702 *
	Thickness (mm)	4.40 \pm 0.09 B	5.50 \pm 0.16 A	0.538 *

The different letters mean there were signific difference between sucking and adult male cats (P<0.05).

Statistically, there were significant difference between right and left adrenal glands, the weight, length, width and thickness of right adrenal gland were greater significant than those of left adrenal gland at p <0.05 (Table 6). As reported by in rats and (Chattopadhyay and Manna, 2018) in wild rat *Rattus sikkimensis*, but in guinea pig in which the left adrenal had higher morphometrical measurements than those of right one. The variations in morphometrical measurements of the animals due to many factors such as species, age, sex, season, population density and physiological status which provide information for estimating the functional status of the gland (Andrew, 1996; Bielohuby et al., 2007). There was a direct relationship between adrenal weight, body weight and the adrenal weight increase with animal body weight (Fazakas, 1996).

CONCLUSIONS AND RECOMMENDATIONS

The differences in morphometric measurements between right and left thyroid lobes in both suckling and adult may be due to the activity of the left lobe, while the differences in morphometric measurements between suckling and adult cats may be due to age and growth of animal. The variation in morphometric measurements between right

and left adrenal gland may be due to the activity of the right gland, while the difference between suckling and adult may be due to age differences related to the physiological status of the glands. In this current study, we recommend anatomical, histological studies and hormonal assay of thyroid and adrenal glands related to seasonal changes in suckling and adult cats.

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NOVELTY STATEMENT

The novelty of the study is focus on differences in morphometric measurements between right and left thyroid lobes and adrenal glands in both suckling and adult local male cats and the difference between both cats may be due to age differences related to the physiological status of the glands.

Carried out all lab tasks and handled and cared for the animals in an equal manner. The entire piece was designed by the authors, who also worked in tandem to gather and statistically evaluate the data.

DATA AVAILABILITY

All data will be provided by the authors upon reasonable request. A conflict of interest There is no conflict of interest disclosed by the writers.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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