Anatomical and Morphometrical Study of Lacrimal Gland in Adult Male Indigenous Gazelle (Gazelle subgutturosa)

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Abstract

In the current study, eight healthy adult male of indigenous gazelle were used after collecting them from local farms, to investigate and describe the anatomical features and blood supply of the lacrimal gland in these species. The mean live weight was about (18 kg) in healthy animals. After slaughtering these animals one after another, lacrimal gland was identified (shape, color, position, dimensions and general description of each left and right glands), photographed and the measurements was recorded in all animals which include weight of the gland, length, width, thickness and volume (water displacement), all these measurements done by using digital Verna, measurement tape, ruler and sensitive balance, also study the blood supply of gland by latex injection technique through common carotid artery.

The lacrimal gland in the gazelle was located on the dorsolateral aspect of the eyeball, extended caudally along the medial surface of the zygomatic process of the frontal bone and frontal process of the zygomatic bone. The lacrimal glands were connected strongly with the periosteum of an internal side of the orbit by periorbital connective tissue. The lacrimal glands in gazelle were consist of two parts, the main part (body) and the accessory part (appendage (, the body of the lacrimal gland has lobulated irregular rectangular shape. It consists of dorsal and ventral surfaces, cranialand caudal border, medial and lateral end, the medial end was narrow while the lateral one was wide and attached with the appendage. The appendage of lacrimal gland in gazelle was large triangular elongated shape, located ventrolaterally to the body of the gland and toward the lateral canthus. The blood supplying of the lacrimal gland in gazelle came through the lacrimal artery which is a branch of the external ophthalmic artery.Due to the scarcity of researches on this gland in this animal and the importance of the lacrimal gland which play an important role in eye health, subsequently animal health in general. This study aimed to study thoughtfully and in details the anatomical features of the lacrimal gland in Adult Male Indigenous Gazelle (Gazelle subgutturosa). The study was done at the department of anatomy and histology of the college of veterinary medicine, University of Baghdad/Abo-Gareeb.

Keywords: *Gazelle, Lacrimal gland, Eye ball, Canthus, Zygomatic process, Blood supply.*

INTRODUCTION

The Gazella subgutturosa, commonly known as Goitered Gazelle, this (Black-Tailed Gazelle) is a member of the family Bovidae and sub family antilopinae [1-3]. Thegoitered gazelles are middle-sized gazelles, which live in semi-deserts, deserts on the Asian Continent and Iraq. Goitered gazelles are herbivores and generally grasses [4-6].Gazelle (Gazella subgutturosa) usually found in northern Azerbaijan, eastern Georgia, part of Iran, parts

of Iraq, southwestern Pakistan, southeastern Turkey, Afghanistan and and in Uzbekistan. Large herds were also present in the Near East [7]. Four subspecies of the goitered gazelle, known collectively as Gazella subgutturosa, have been identified as the Yarkand gazelle (G. s. yarkandensis), the Arabian sand gazelle (G. s. marica), and the Persian goitered gazelle (G. s. subgutturosa), and the Mongolian goitered gazelle (Gazella subgutturosa hilleriana) [5]. There are two subspecies of gazelles in Iraq: the sand gazelle, Marica, which is widespread in the southwest and the Persian gazelle, Subgutturosa, which is widespread in the north and south of the country [8, 9]. The specific name, G. subgutturosa, refers to the male's neck and throat swelling during the mating season [5]. One of accessory structures of the eye is the lacrimal apparatus which located superiorly and laterally to each eyeball. Each lacrimal apparatus consists of the lacrimal gland, lacrimal puncta, lacrimal canalicule, lacrimal sac and nasolacrimal duct [10]. The lacrimal gland is responsible for production and secretion of tears which clean and nourish the cornea and help to maintain its health, as well as protects it from dryness. In cattle and wild buffalo, no difference is observed between left and right glands. Moreover, in these animals no sexual dimorphism is evident in the case of the lacrimal gland [11, 12]. The pink lacrimal gland is located on the dorsolateral side of the eye, releases seromucous secretions (tears) through numerous ducts into the surface of the eyeball (Fornix). The extraglandular duct system that carries out the lacrimal fluid after it washed over the eye, into the nasal cavity [12, 13 and 14]. With the exception of dogs, pigs, and cats, the lacrimal gland was located within the orbit of bovine, caprine, ovine, camel, and horses, between the dorsolateral portion of the eyeball and the supraorbital process of the frontal bone and the frontal process of the zygomatic bone. A little caudal portion of the gland, about 1 cm broad, was only covered by adipose tissue (periorbital fat), fascia, and skin in canine and feline, which resulted in a shallow orbital cavity because of the absence of the frontal and zygomatic processes [15, 16].The lacrimal gland of the camel has two lobes, yet it was seen as a single structure with two surfaces, three edges, and three angles. The bony orbits concavity was mirrored by the convex dorsal surface. The convexity of the eyeball is suited to the ventral surfaces concavity [17].

The three components of the tear film and precorneal film make up the lacrimal fluid [18, 19]. The sebaceous (Zeis) glands, tarsal (Meibom) glands, and ciliary (Moll) gland generate oil in the first layer of the skin. The lacrimal gland and supplementary lacrimal glands produce aqueous material in the second layer (Krause and Wolfring). The lacrimal gland is separated into several lobules by connective tissue septa that cover the gland's capsule. Blood veins, nerves, ducts, and some adipose tissue can be found in the septa. In domestic animals, such as dogs and sheep, the mucous acini of the gland are found along the edge of the gland's lobule [20]. The majority of the aqueous fluid is produced by it, with the miebomian gland (tarsal gland) producing the lipid and conjunctival goblet cells producing the mucin [21, 22]. The study's goal is to provide new anatomical information about the lacrimal gland in order to be in correlation with other science fields like Medicine, surgery, and physiology department. There is no research on the comparative anatomical of the lacrimal glands in local breed gazelles.

Material and Methods

Five healthy gazelles (1.5-2 years old) were taken from natural farms (reserves) for the anatomical study after examined them to ensure

that their eyes and nasal cavities were clear of any pathological lesions. Three gazelles were used for the anatomical study which includes (morphology, morphometrics and latex of the blood supply), and the other two animals for blood supply. The five fresh heads were removed from the body at the level of the atlanto-occipital joint as soon as the gazelle was slaughtered. The head is cleaned in the first step by being washed carefully with tap water and stored in clean plastic containers [6]. The samples were taken directly after slaughtering within 15-20 minutes; it was brought inside the lab so that the necessary connection between the device and the biometric measurement could be made [23]. The specimen should be directly dissected and stripped of its skin, muscles, and bones to reveal its lacrimal apparatus (lacrimal gland and duct system). The superior orbital skin, the zygomatic process of the frontal bone, and the frontal processes of the zygomatic bone should be dissected in order to analyze the lacrimal gland. Finally, the glands were photographed and examined accurately in situ, then gland was carefully separated from the surrounding tissue. Last but not least, a description of the morphological characteristics of the lacrimal gland from three heads, including its size, position, relationship, and color. Using a digital Vernia, measuring tape, ruler, and sensitive balance, measures of the lacrimal gland's weight, length, width, thickness, and volume (water displacement) were taken immediately [24]. Forstudying the blood supply of the gland used the other two heads just after the slaughtering. The common carotid arteries of the left and right sides of the gazelle were thoroughly cleaned with tap water before the specimens were injected through the same arteries with red latex (2:3) latex with ammonia mixed with carmine stain) using a 50 ml syringe and plastic catheter that was inserted inside the lumens of the common carotid artery on each side [24, 25]. Glacial acetic acid and cotton were used to apply pressure to the area where the latex was oozing in order to stop any leakage. This was done to stop any bleeding from a tiny artery that had been severed. Using artery forceps, the common carotid artery should be sealed after the injection is finished. The specimens were then submerged for 24 to 48 hours in a substantial volume of 10% formalin to fix the tissue and set the injected substance [25-27].

The lacrimal gland and snapshot are supplied by arteries that were exactly exposed during the careful dissection of the preserved specimens (right and left). Ethical approval was sought and obtained from the Veterinary medicine College, Baghdad University Research Ethics Committee. Approval to conduct the study was given with the Approval no.389/PG.

Results

In gazelle, lacrimal gland was located on the dorso-lateral aspect of eyeball and it extended on the dorsal ocular rectus muscle and the lateral ocular rectus muscle. The gland was caudally extended along the medial side of zygomatic process of the frontal bone, and frontal process of the zygomatic bone (Figure 1, 2). The lacrimal glands were connected strongly by periorbital connective tissue, with the periosteum of an internal side of the orbit. It was bounded by periorbital connective tissue and adipose tissue (Figure.3). It is light brown or pinky in color, covered by capsule and bounded by adipose tissue. The lacrimal gland in gazelle was consisting of two parts, the (body) which is the main part and (appendage) theaccessory part.The body of the gland has irregular oval flattened shape, lobulated and the medial end was narrow whereas the lateral end was wide and attached with the appendage

(Figure 4, 5). The dorsal surface opposite the inner surface of the orbit therefore it was convex in shape andtakes the shape of this inner surface. While the ventral surface was concave opposite the convexity of the (upper) dorsal surface of the eyeball so it takes the fitting shape of it. The cranial border was thin while the caudal border is thicker and more rounded (Figure.4, 5). The gland also has medial and lateral extremities (end). Thelacrimal gland's appendage of in gazelle was large triangular elongated shape, located ventro-laterally to the body of the gland and near the lateral canthus. The current study, reported the mean weight, length, width, thickness and volume of body of right lacrimal gland which it was 1.331±0.191gm, 34.599±1.67 mm, 19.025.±1.05mm, 3.49±0.313mm and 2.6±0.192mm3 respectively, while the mean weight, length, width, thickness and volume of body of left lacrimal gland, was 1.348±0.150 gm, 34.057±0.941 mm, 18.288±0.879 mm, 3.393±0.317 mm and 2.6±0.192 mm3 respectively (Table 1). The mean weight, length, width, thickness and volume of right appendage of lacrimal gland were as following 0.16±0.017 gm, 12.74±2.147 mm, 5.098±0.985 mm, 1.914±0.147 mm and 0.013±0.168 mm3 respectively, as well as the mean weight, length, width, thickness and volume of appendage the left lacrimal gland was 0.156±0.016 gm, 12.19±1.612 mm, 4.028±0.749 mm, 1.804±0.255 mm and 0.013±0.159 mm3 respectively (Table 2). The current results identified present of 4-5 excretory ducts of the lacrimal gland in the gazelle had a small opening on the dorsal fornix which were difficult recognize because they were very minute opening. They were originated from the cranial borders of the body and appendage (Figure 6, 7).

The blood supplying of the lacrimal gland in gazelle came through the lacrimal artery which is a branch of the external ophthalmic artery (Figure 8). The lacrimal artery reaches the gland from the lateral extremity (end) near the junction of the body with appendage it passes between dorsal rectus ocularis muscle and the ventral surface of the gland to ramify into numerous small branches penetrated the ventral surface of the gland and distributed inside the parenchyma of the gland (Figure 9, 10).

Figure.1: Lacrimal gland inside the orbital cavity of gazelle show: A- Zygomatic process of frontal bone, B- preorbital connective tissue, C-cranioVentral border of lacrimal gland, D- Medial canthus, E- Eye ball, F- Lower eyelid.

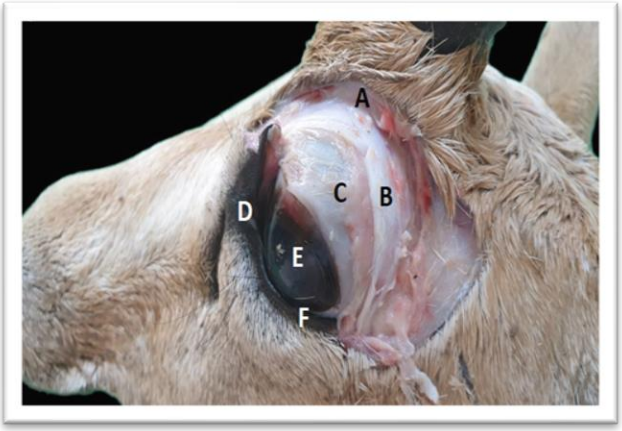


Figure.2: Lacrimal gland inside the orbital cavity of gazelle show: A- Body of lacrimal gland, B- Zygomatic process of temporal bone, C- Upper eyelid.

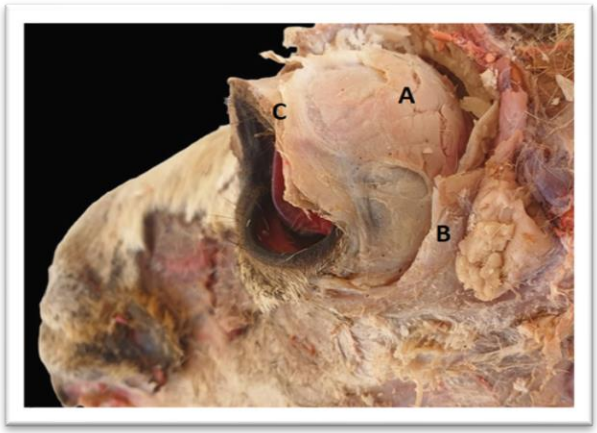


Figure.3: Lacrimal gland in situe of gazelle show: A- Zygomatic process of frontal bone, B- Body of lacrimal gland, C- Medial canthus, D- Upper eyelid.

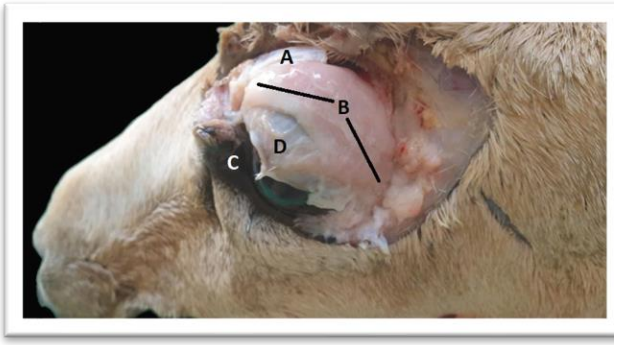


Figure.4: Dorsolatral view of lacrimal gland in gazelle show : A- Body of lacrimal gland, B- Appendage of lacrimal gland, C- Upper eye lid D- Lateral canthus

Figure.5: Dorsal view of the left lacrimal gland in gazelle show: A- Body of lacrimal gland, B- Appendage of lacrimal gland, C. Lacrimal artery.

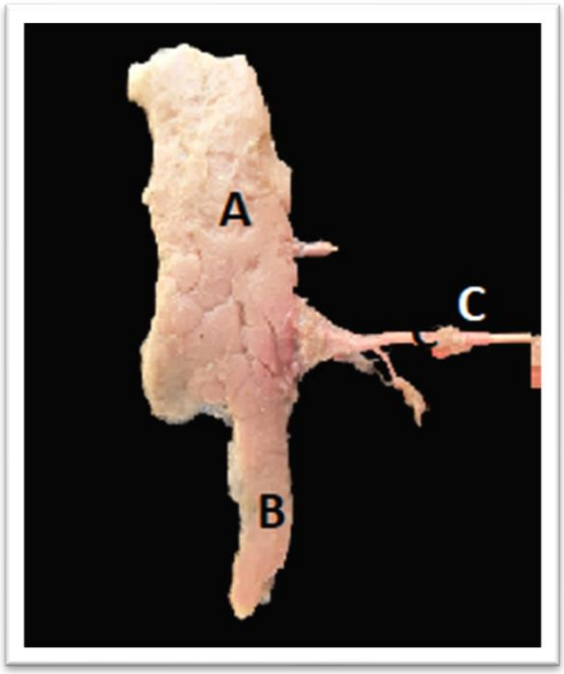


Table.1: Macroscopic parameters of the body lacrimal gland in gazelle (Mean ±SE, P>0.05).

parameters	side	value
Weight (gm)	Right side	1.331±0.191
	Left side	1.348±0.150
Length (mm)	Right side	34.599±1.67
	Left side	34.057±0.941
Width (mm)	Right side	19.025±1.05
	Left side	18.288±0.879
Thickness (mm)	Right side	3.49±0.313
	Left side	3.393±0.317
Volume (mm3)	Right side	2.6±0.192
	Left side	2.6±0.192

There are no significant differences between two sides $p < 0.05$

Table.2: Macroscopic parameters of the appendage part of lacrimal gland in gazelle (Mean ±SE, P>0.05)

Parameter	Side	value
Weight (gm)	Right side	0.16±0.017
	Left side	0.156±0.016
Length (mm)	Right side	12.74±2.147
	Left side	12.19±1.612
Width (mm)	Right side	5.098±0.985
	Left side	4.028±0.749
Thickness (mm)	Right side	1.914±0.147
	Left side	1.804±0.255
Volume (mm3)	Right side	0.013±0.168
	Left side	0.013±1.59

There are no significant differences between two sides $p < 0.05$

Figure.6: Main excretory ducts of lacrimal gland in gazelle show: A- Body of lacrimal gland, B- Appendage of lacrimal gland, C- Main excretory ducts of lacrimal gland, D- Upper eye lid.

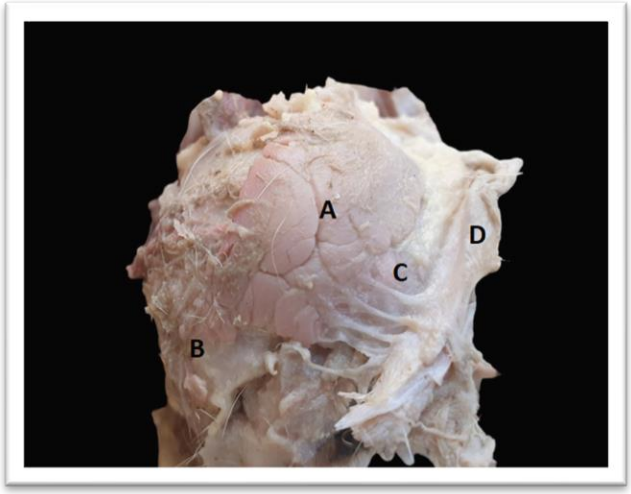


Figure.7: Upper eyelid of gazelle show: Opening of main lacrimal excretory ducts in upper fornix (white arrow)

Figure.8: Arterial supply of the lacrimal gland in gazelle

A- External carotid artery. B-Maxillary artery, C- Transverse facial artery, D-Superficial lateral palpebral artery, E-External ophthalmic artery, F- Frontal branc,. G-Upper eyelid, H-Lower eyelid, I-Eyeball.

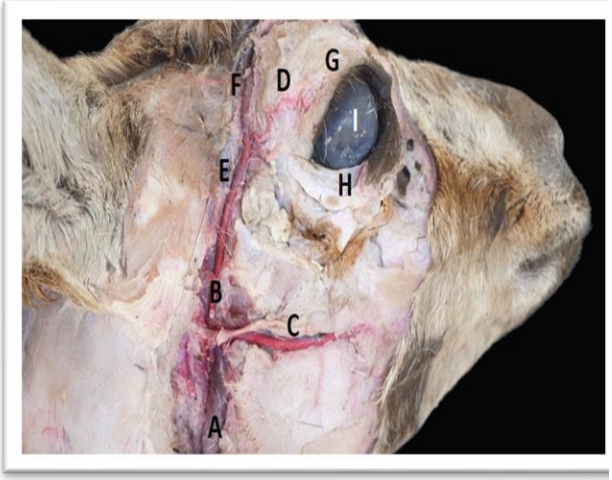


Fig. 9: Dorsal view of arterial supply of the lacrimal gland in gazelle: A- Lacrimal gland, B- Lacrimal artery, C- External ophthalmic artery, D- Superficial lateral palpebral artery, E- Maxillary artery, F- External carotid artery, G- Common carotid artery.

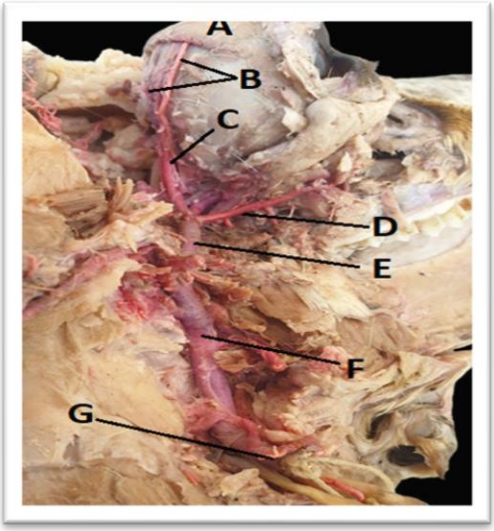
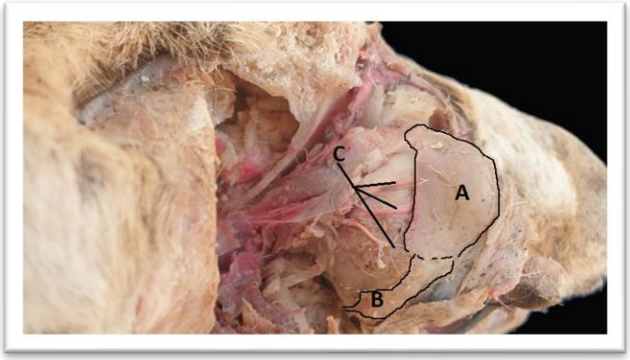


Figure. 10: Dorsal view of arterial supply of the lacrimal gland in Gazelle: A-body of lacrimal gland, B-appendage of lacrimal gland, C-Lacrimal artery.



Discussion

The lacrimal gland in the gazelle was located on the dorso-lateral aspect of the eyeball and it extended on the dorsal ocular rectus muscle and the lateral ocular rectus muscle. It was caudally extended lengthways the medial surface of the zygomatic process of the frontal bone and frontal process of the zygomatic bone. The lacrimal glands were connected strongly with the periosteum of an internal side of the orbit by periorbital connective tissue. They were enclosed by periorbital connective tissue and adipose tissue. The above results agreement with the findings of [13, 21, 22, 28, 29, 30, and 31] that found the lacrimal gland located in the dorsolateral area of orbital cavity behind the orbital rim, caudo-dorsal to the eyeball. These results agree with other results because this location provides highly protection to the eye and the lacrimal gland.

Lacrimal glands in the gazelle take pale pink color, covered by a preorbital connective tissue, it accordance with [33, 34] found the color of lacrimal gland in horse, dog and one-humped camel was pale red; [29] show the lacrimal gland was pink to red in color in the Philippine water buffalo; [35, 44] showed that lacrimal

gland in European bison, alpaca and dog correspondingly were light pink in color. Whereas disagreement with [15, 22, 36, 37, 38, 39] in Zavot fetuses, Bactrian camels, one-humped camel, donkey, goat, Lori sheep and cattle respectively, who said that lacrimal gland take light brown in color; [11] described the lacrimal gland with pale yellowish color in American bison and cattle;[40, 41] also agree with him. The difference in color of the lacrimal glands may be due to different species, age of animals and blood remaining in the blood vessels inside gland (ill bleeding) of the animals. In the current study show the lacrimal glands in gazelle were consist of two parts main part (body) and accessory part (appendage).These results agree with [15, 18, 21, 37] in camel; [11, 36] in cattle; [42] in feline; [30] in buffalo and [31] in dog showed the lacrimal glands were divided into two parts body (main) and appendage, but disagreed with [43, 44, 45] in European bison and alpaca the lacrimal gland was uninformed and undivided. In gazelle, the body of the lacrimal gland has lobulated irregular rectangular shape, It consist of dorsal and ventral surfaces, cranial and caudal border, medial and lateral end. The medial end was narrow while the lateral end was wide and attached with the appendage. The dorsal surface was convex opposite to the inner surface of the orbit thus it takes the shape of the inner surface of it. Whereas the ventral surface was concave opposite the convexity of the dorsal (upper) surface of the eyeball and take the fit shape of it. The cranial border was thin while the caudal border is thicker and more rounded. This findings disagree with [11, 36, 41] findings in cattle and buffalo the lacrimal gland was oval in shape, lobulated, divided into two parts; and [15] who found that the lacrimal gland in goat was oval flattened shape, each gland appeared having two parts or lobes (body and appendage); he found that the lacrimal gland in camel was elongated lobular, divided into three lobes and irregular flattened gland, while [37] said that lacrimal gland in camel was crescent shape.

The lacrimal gland's appendage in gazelle was large triangular elongated shape, located ventrolaterally to the body of the gland and directed toward the lateral canthus. This study confirmed the arrangement with [15] who found that the lacrimal gland in goat was oval flattened shape, each gland appeared having two parts or lobes (body and appendage) and [22] in cattle and goat who found that the lacrimal gland in cattle was lobulated, elongated, flattened in shape and divided with elongated, irregular appendage, while the lacrimal gland in goat was flattened a rectangle shape with small rod elongated shape appendage. But these results disagreed with [46] who showed that the lacrimal gland in goat was undivided, irregular, flattened and triangular to oval in shape. [39]Described the lacrimal gland in Lori sheep was spherical to irregular oval in shape and has a lobular appearance. On the other hand, [47] described the lacrimal gland in pig was a triangle in shape and undivided. Also, [48] described the lacrimal gland in the dog was oval shape and single lobe. [43]Explain the lacrimal gland goat and sheep was flattened, undivided and oval in shape. [49] Show that lacrimal gland in the dog was flat, irregular in shape (ranged from triangular, round, or oval to the heart or dumbbell-shaped), lobulated and non-encapsulated. The results of biometric measurement of the lacrimal gland have differed from results of all authors below.

The present study, in gazelle, reported the mean weight, length, width, thickness and volume of body the right lacrimal gland was 1.331±0.191 gm, 34.599±1.67 mm, 19.025.±1.05 mm, 3.49±0.313 mm and 2.6±0.192 mm3

respectively, while the mean weight, length, width, thickness and volume of body the left lacrimal gland was 1.348±0.150 gm, 34.057±0.941 mm, 18.288±0.879 mm, 3.393±0.317 mm and 2.6±0.192 mm3 respectively. The right appendage of lacrimal gland as following the mean weight, length, width, thickness and volume were 0.16±0.017 gm, 12.74±2.147 mm, 5.098±0.985 mm, 1.914±0.147 mm and 0.013±0.168 mm3 respectively, and the mean weight, length, width, thickness and volume of appendage the left lacrimal gland was 0.156±0.016 gm, 12.19±1.612 mm, 4.028±0.749 mm, 1.804±0.255 mm and 0.013±0.159 mm3 respectively.

This result disagreed with [33] in bovine; [51] in goat; [52] in camel; [46] in goat; [53] in one-humped camel; [40] in buffalo; [15] in goat, camel and donkey; [20] in Roe deer; [39] in Lori sheep; [48] in dog; [44] in European bison; [45] in alpaca; [35] in dog; [31] in dog ; [34] in one-humped camel; and [22] in goat and cattle.

The results of this study identified present of 4-5 excretory ducts of the lacrimal gland in the gazelle had a small opening on the dorsal fornix which were difficult recognize because they were very minute opening. They were originated from the cranial borders of the body and appendage, this finding agreed with [34, 37] in camel, found that it is difficult to find the excretory ducts of lacrimal gland but were detected by black color imparted to them by melanin. But it disagreed with [34, 39] who found that in one-humped camel there were three small black ducts, two ducts for the main lacrimal gland and one for the accessory lobe and they were open into the superior conjunctiva, and also disagreed with [22] in goat, found that the excretory ducts of the lacrimal gland originate from the connection between body and appendage. These results disagreement with [15, 51]who reported the number of excretory ducts of the lacrimal gland in goat and donkey was 2 ducts. [34, 37] found in one-humped camel the main lacrimal gland had two excretory ducts, but the accessory lobe contains one duct. Also, [54] found the lacrimal gland's excretory duct of the porcine was seven main excretory ducts responsible for transporting tear to the eye surface. [22]Reported the number of excretory ducts in goats was 1-2 ducts. But disagreement with [21, 33] show the number of excretory ducts was 6-8 in ox, 5-6 in pig and 12-16 in the horse. [36]Found the excretory ducts of the lacrimal gland in Zavot fetuses were of 5-7 in number can seem in the fornix of the eye. [22]In cattle, reported the number of excretory ducts was 6-7 ducts. Also, [37] found that the lacrimal gland in camel had 3-4 excretory ducts. But [15, 55] reported the lacrimal gland in camels has possessed 3 excretory ducts originating from the ventral aspect of the gland. The difference in the number of ducts is due to different species of animals.

Conclusion

The lacrimal glands in the gazelle are similar to many species in some morphometerical and morphological characters and differ with many animals in the samecharacters and this difference may be due to the differences in genus, species and age of the animals. There are no significant differences between left and right gland in the same animal. Anatomically there is no different in the location of lacrimal gland of gazelle from all other animals because this location provides full protection for this gland.

Conflict of interest

Non.

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