

Anatomical and Morphometric Study of Lacrimal Apparatus in Adult Male Indigenous Gazelle (*Gazelle subgutturosa*)

Ali Abdulkareem Jabbar

Department of Anatomy and Histology, College of Veterinary Medicine, University of Baghdad, Baghdad, Iraq, Ali.Abdulkareem1108a@cvm.uobaghdad.edu.iq

Mahdi Abdulkareem Atyia

Department of Anatomy and Histology, College of Veterinary Medicine, University of Baghdad, Baghdad, Iraq, Mahdi.a@cvm.uobaghdad.edu.iq

Abstract

This study was done to investigate the anatomical location, morphological and morphometric appearance of lacrimal apparatus in adult male of Indigenous Gazelle (*Gazelle subgutturosa*) which includes dorsal and ventral lacrimal puncta, paired canaliculi, lacrimal sac and the nasolacrimal duct. Eight healthy adult male of indigenous gazelle were used in the current study after collecting them from nature preserve, to investigate and describe the anatomical features, morphometric and location of the lacrimal apparatus in these species. The mean live weight was about (18 kg) in healthy animals. After slaughtering gazelle one after another, the apparatus was identified (shape, position, dimensions and general description of each left and right apparatus). Duct system Corrosion cast technique was done to detect, the course and the internal shape of the nasolacrimal duct after injection of tap water and air by using 8 pair of specimens, then photographs was taken and measurements was recorded in all animals by using digital Verna, measurement tape and ruler. Due to lack of researches on gazelle's lacrimal apparatus which play an important role with lacrimal gland in eye health in this animal and subsequently in general health. In conclusion, the lacrimal glands in the gazelle are similar to many species in some morphometric and morphological characters and differ with many animals in the same characters 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.

Keywords: *B Gazelle, Lacrimal gland, Lacrimal apparatus, Nasolacrimal duct.*

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, 2]. The goitered gazelles are middle-sized gazelles, which live in semi-deserts, deserts on the Asian Continent and Iraq. 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*) [3]. 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 [4-6]. 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, while lacrimal apparatus system provides a passage for tear drainage from the eye to the nasal cavity. The system for each eye in most species consists of dorsal and ventral lacrimal puncta, paired canaliculi, lacrimal sac and the nasolacrimal duct [7]. The nasolacrimal system of sheep has been studied previously by [8]. The lacrimal puncta in goats were slit-like opening, take grayish-black in color, they are located near the medial canthus of the eye. Dorsal and ventral cylinder canaliculi which were narrow and short extended from lacrimal puncta to the lacrimal sac [9]. The authors defined the lacrimal puncta in goats as slit-like opening, 0.72 mm in diameter [10]. In sheep, there were two lacrimal puncta located in the medial canthus of the eyes, their color differs conferring to the color of the skin. Lacrimal canals start from ventral and dorsal lacrimal puncta and after unification together lead to the medial canthus of the eye [11]. Other studies referred to the buffalo as having dorsal and ventral puncta positioned in the medial canthus of the eyeball slit-like, extending from it two ducts that junction together to form the lacrimal sac [12, 13].

It explained that the conducting part of Iranian river buffaloes involves the lacrimal puncta, which seemed as slit-like openings, the dorsal and ventral canaliculi were 7 to 9 mm long and united into a small dilatation, the lacrimal sac located in the lacrimal fossa of the lacrimal bone [14]. Different studies showed that the two lacrimal ducts start blindly in the camel [15-17]. While other was described the lacrimal puncta as were slit-like openings, 0.5-1 mm in diameter, 4 -10 mm from afar the medial canthus located at 1.0 mm [18]. The lacrimal ducts in the camel were 8 mm in length and unite into a small dilatation and lead to a lacrimal sac [19]. It explained that there were two lacrimal ducts each one about 10 mm in length [20]. It was open into the lacrimal sac after passing through the periorbital tissue. In cattle, there were two

small (dorsal and ventral) rounded puncta about 2 mm in diameter leading to cylinder narrow dorsal and ventral lacrimal canaliculi [9]. The lacrimal sac in most domestic animals is a small dilatation located in the orbit within the fossa of the lacrimal bone as a conversion of dorsal and ventral lacrimal canaliculi, except in the pig; there is no lacrimal sac [21, 22]. In goats, the dorsal and ventral lacrimal canaliculi were united together at their distal end to form small lacrimal sac. It was situated outside the periorbital in the lacrimal fossa of the lacrimal bone. The mean length of the lacrimal sac was 19.65 [9, 10].

Many authors described the lacrimal sac in buffalo as elongated funnel shape dilation after the junction of two lacrimal canaliculi near the medial canthus of the eyeball occupying the lacrimal fossa [12, 13]. It was referred to as the beginning of the nasolacrimal duct, the extra tear production passes to the nasolacrimal duct through the dorsal and ventral puncta and the two lacrimal canaliculi. Other researchers recorded that the mean length and width of the lacrimal sac were 15 mm, and 9 mm respectively [13]. In cattle, the lacrimal sac is positioned at the junction of the distal ends of the dorsal and ventral lacrimal canaliculi as a small dilatation in the fossa of the lacrimal bone. Distally the lacrimal sac was continuous with the nasolacrimal duct. The mean length of the lacrimal sac was 23.6 mm [9]. Lacrimal sac in Lori sheep was placed in the medial angle of the orbit within the lacrimal bone [11]. The lacrimal sac in a one-humped camel was described as round or funnel-shaped located in the lacrimal fossa, and 15 mm in length [20]; while another reports recorded that the length of the lacrimal sac was 20 mm [17]. In domestic animals, the nasolacrimal duct starts from the lacrimal sac on the medial canthus to ends in the nasal vestibule extending along the medial side of the maxillary bone below the mucosa of the nasal cavity [23, 24]. In another study, it was described the nasolacrimal duct

in goat, it was started from the distal end of the lacrimal sac and ended in the nasal vestibule by the nasolacrimal orifice consisting of proximal, middle and distal parts [9]. The proximal part of the nasolacrimal duct was passing ventrally through a bony canal made by lacrimal and maxillary bone; it was covered by the middle and dorsal nasal concha. The middle part was placed under the mucous membrane of the nasal cavity, extended until the base of alar cartilage. While, the distal part passing between the mucous membrane of the nasal cavity the alar cartilage ends by the nasolacrimal opening. The nasolacrimal duct was ended by a slit-like shape orifice located on the ventral process of alar cartilage. It also recorded that the nasolacrimal duct in the goat divided into three parts, the proximal (osseous canal) was extended rostrally in lacrimal, zygomatic, and maxillary bones [10]. The middle part was crossing the ventral conchal crest and appeared through the osseous lacrimal canal. The distal part crossed the nasal cavity in a straight way and was enclosed only by nasal mucosa and a thin connective tissue membrane. While in Korean native goat the duct had a straight way with nasal bone and was open in the nasal vestibule [25]. In Awassi sheep and black goat, the nasolacrimal ducts end at the nasal opening that was very clear, especially in Awassi sheep. The right nasal opening of the black goat was significantly larger in diameter than the right nasal opening in Awassi sheep [26]. The researchers were defined the nasolacrimal duct in Lori sheep extends from the lacrimal sac to the nasal vestibule [11]. The nasolacrimal ducts open into the medial side of the lateral surface of the nasal cavity and are scarcely observable. In one report, the findings explained that the nasolacrimal duct in buffalo is the last part of the nasolacrimal apparatus that was started from the lacrimal sac dorsally and run on the lateral surface of the nasal cavity to about 50 mm above the external

nasal orifice at the connection between the skin and nasal mucous of the ventral concha [13]. The osseous lacrimal canal is formed from lacrimal and maxillary bones. One study described the nasolacrimal duct in buffalo extending from the lacrimal sac into the wall of the nasal vestibule [14]. It was enclosed only by nasal mucosa and a thin connective tissue. The nasolacrimal duct in camel is composed of cranial, caudal, and middle parts, located laterally on the periosteum of the maxillary bone and was enclosed medially by the nasal mucosa and ventral nasal concha and the nasolacrimal duct was described in one-humped camel as fenestrated 210-230 mm in length consisting of three portions and starting from the end of the lacrimal sac to the external orifice [16-19]. In llama, the nasolacrimal duct with a uniform diameter takes a sigmoid course and covered by the nasal mucosa [27]. The nasolacrimal duct comprised of three parts, the proximal part was passed through the lacrimal foramen to enter the lacrimal canal (osseous canal) at the level of the second premolar tooth [28, 29]. It was described the nasolacrimal duct in cattle, that was represented the last part of lacrimal apparatus beginning distal to the lacrimal sac to terminated in the nasolacrimal opening in the nasal vestibule [9]. The present study on the lacrimal apparatus of the gazelle might be useful for diagnosis of clinical cases affecting the lacrimal system area.

Material and Methods

Ethical approval

This study was licensed the Scientific Committee of the College of Veterinary Medicine (University of Baghdad, Baghdad, Iraq), and conducted under the approval No. 389/PG.

Study animals

Four 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. The four fresh heads were removed from the carcasses 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 with tap water and stored in clean plastic containers [5]. 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 [30 and 31].

Laboratory examination

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 and lacrimal duct system (apparatus). Finally, the interior and coarse morphology of the gazelle's nasolacrimal duct is exploited for detection. The nasolacrimal duct was cleaned and any mucous sediment that may have been present was removed in the first stage by injecting warm tap water into it. In order to remove any fluid that may have been present in the nasolacrimal duct after it has been washed with tap water, air should be forced inside the duct. Corrosion cast technique was done by using a 50 ml syringe and a plastic catheter that was inserted inside the lumens of the nasolacrimal orifice that is located on the medial side of the lateral wall of the vestibule of the nasal cavity, the nasolacrimal duct was injected with self-curing denture material from the external orifice of the duct to make a cast for the duct [32]. The interior shape of the nasolacrimal duct was discovered by using the casting technique, self-cure denture material set (liquid and powder 2 to 1), which was made from 20% monomethyl-methacrylate powder

and 80% polymethyl-methacrylate liquid and added the appropriate colours, is used to inject into the nasolacrimal duct. When the injection is finished, the nasolacrimal orifice should be ligatured with metallic wire to avoid any mixture loss from the orifice. Pieces of cotton should also be used to apply pressure to the dorsal and ventral lacrimal puncta to prevent any potential seeping. For the purpose of polymerization, the samples were incubated for 24 hours at room temperature. The solution, which is a macerated fluid created by dissolving 1000 g of sodium carbonate in 5000 ml of tap water and letting it sit for 72 hours to corrode, was placed in the drain opening. The sample was then cleaned and photographed after being rinsed under running water [32].

Result and Discussion

The current study was done on the lacrimal apparatus in the adult local breed of gazelle (*Gazella subgutturosa*) which consists of glandular part and conducting system conveys the secretion. The glandular part was consisting of right and left lacrimal glands located intraorbital. The conducting system started from the main excretory ducts, dorsal and ventral puncta, dorsal and ventral lacrimal canaliculi, common lacrimal duct, lacrimal sac, and finally the nasolacrimal duct located in the nasal cavity. This finding disagreed with other researchers who found that lacrimal apparatus consists from lacrimal gland, dorsal and ventral lacrimal puncta, lacrimal canaliculi, lacrimal sac, nasolacrimal duct and nasal punctum and lack of common lacrimal duct [9, 13, 21]. Also disagreement with [15, 17] described the lacrimal apparatus in one-humped camel was consists lacrimal gland and excretory duct, lacrimal sac, nasolacrimal duct and lack the two puncta. Others were recorded the present of puncta in camel slight like open 0.5-1 mm [18].

There were two puncta (dorsal and ventral) can be observed near the margin of the medial canthus of the eye. The puncta were slit-like

opening, take grayish black in color. This result was compatible with other studies [9-13, 21] show most mammals had two lacrimal puncta of upper and lower eyelids in the medial canthus of eyes and the color of puncta differs. The difference in the color of the puncta depends on the color skin of animals. On the other hand, these results disagreed with other researchers who explained that the lacrimal puncta in camel were absent and the lacrimal ducts start blindly [15-18].

In gazelle the diameter and distance of punctum from medial canthus of right and left dorsal puncta were 1.161 ± 0.071 mm, 1.18 ± 0.124 mm, 3.981 ± 0.187 mm, 4.096 ± 0.161 mm respectively, while the right and left ventral puncta were 1.17 ± 0.072 mm, 1.215 ± 0.103 mm, 4.073 ± 0.389 mm and 4.218 ± 0.371 mm respectively. This result nearly accordance in some measurements and differ in other with [33] reported that in goat the diameter and distance of punctum from medial canthus of right and left dorsal puncta were 1.21 ± 0.13 mm, 1.08 ± 0.06 mm, 4.94 ± 0.22 mm and 4.81 ± 0.27 mm respectively, while the right and left ventral puncta were 1.54 ± 0.15 mm, 1.50 ± 0.14 mm, 3.63 ± 0.16 mm and 3.75 ± 0.16 mm respectively. it explained that in goat the diameter and distance of punctum from medial canthus of right and left dorsal puncta were 1.121 ± 0.071 mm, 1.16 ± 0.114 mm, 3.961 ± 0.177 mm, 4.086 ± 0.151 mm respectively [9]; while, the right and left ventral puncta were 1.16 ± 0.062 mm, 1.205 ± 0.093 mm, 4.053 ± 0.379 mm and 4.218 ± 0.361 mm respectively. Also, a report explained that in sheep the diameter and distance of punctum from medial canthus of right and left dorsal puncta were 1.01 ± 0.01 mm, 1.14 ± 0.12 mm, 4.95 ± 0.31 mm and 4.75 ± 0.25 mm respectively, while the right and left ventral puncta were 1.85 ± 0.12 mm, 1.85 ± 0.12 mm, 3.25 ± 0.41 mm and 3.06 ± 0.38 mm respectively [33].

This result disagreed with a study reported that in goat and donkey the ventral and dorsal lacrimal puncta was 0.5 mm in diameter and 5 mm away from the medial canthus of the eye [19]; whereas other described the lacrimal puncta in goat was 0.72 mm in diameter and 2.36 mm from the medial canthus of the eye [10]. One study explained that in cattle the diameter and distance of punctum from medial canthus of right and left dorsal puncta were 2.317 ± 0.089 mm, 2.163 ± 0.090 mm, 5.828 ± 0.626 mm and 5.688 ± 0.804 mm respectively [9]; while other explained that in horse the mean diameter and distance from medial canthus was 2mm and 8mm respectively [21]. It showed that the lacrimal puncta were 0.5-1 mm in diameter, 4 -10 mm away from the medial canthus [17]. The difference in the measurement in goat in this study and other authors was due to different species and age of animals.

The lacrimal ducts were two ducts (dorsal and ventral) that started from the lacrimal puncta in the medial canthus. It appeared irregular cylinder at the proximal part while the middle part appeared irregular conical dilation before joining together to form a short narrowing common lacrimal duct distally.

The current results disagreed with all authors explained the lacrimal canaliculi in other animals as [12] in buffalo, and [11] in Lori sheep, reported that there were two Lacrimal canals begin from ventral and dorsal lacrimal puncta and after merging together lead to the medial angle of the eye. [11] in sheep explained two lacrimal ducts start by a small upper and lower opening, but in camel, the lacrimal ducts start blindly [15, 16]. [9] in cattle and goat, reported that the lacrimal ducts were started from the lacrimal puncta in the medial canthus of the eye and reached into the lacrimal sac. In cattle the dorsal and ventral puncta lead into two cylinders, narrow and short canaliculi (dorsal and ventral); while in goats, the two puncta lead into two conical

dilatation and end by short narrowing canaliculi (dorsal and ventral).

The mean length of the right dorsal and ventral lacrimal canaliculi was 9.555 ± 0.491 mm and 12.045 ± 0.448 mm respectively, whilst the left dorsal and ventral lacrimal canaliculi were 9.361 ± 0.526 mm and 12.48 ± 0.935 mm respectively. The mean length of right and left of common lacrimal duct was 9.677 ± 1.446 mm and 10.645 ± 1.809 mm respectively (Table 1).

Our results in gazelle were not in disagreement with the animals that reported by [28] in cat, [20] in the camel, [14] in Iranian river buffaloes, and [19] in the camel, [10, 33] in goat, [9] in cattle and goat, this due to different species. The two lacrimal canaliculi were joined together forming a short distal channel, which lead to the small dilatation lacrimal sac. It was located in the shallow lacrimal fossa of the lacrimal bone. This finding was similar with [33, 10] in goat, [12, 13] in buffalo, [11] in sheep, [9] in cattle and goat. But dispute with [33] explain that in sheep the lacrimal sac was a small bulge funnel shape located the osseous fossa. The mean lengths of right and left lacrimal sac were 15.677 ± 1.436 mm and 16.645 ± 1.909 mm respectively (Table 1). This result was in disagreement with [33] who showed that in goat and sheep the mean length of right and left lacrimal sac were 4.21mm, 4.29, 5mm and 4.93 respectively. Also was in disagreement with [9] who showed that the mean length of right and left lacrimal sac in cattle were 23.6 ± 2.985 mm and 16.58 ± 3.314 mm, while in goat the mean length of right and left lacrimal sac were 23.677 ± 1.436 mm and 19.645 ± 1.909 mm respectively. The nasolacrimal duct in gazelle represented the last part of lacrimal apparatus starting from the distal end of the lacrimal sac and ended in the nasolacrimal opening in the nasal vestibule. The nasolacrimal duct runs on the lateral wall of the nasal cavity (Fig.5). Similar observation

[16] in camel; [12, 14] in buffalo; [34] in horse and [11] in sheep, [9] in cattle and goat the nasolacrimal duct origin from the lacrimal sac and extend to finish at the nostrils cavity. The nasolacrimal duct formed from three parts proximal, middle and distal. The proximal part of the nasolacrimal duct in gazelle was started from the caudal end of the lacrimal sac passing ventrally through a bony canal formed from by lacrimal and maxillary bone (Fig. 5). The canal was covered by the middle nasal concha and part of the dorsal nasal concha. The middle part of the nasolacrimal duct in gazelle located under the mucous membrane of the nasal cavity lies on the nasal bone. It passes until the base of the alar cartilage (Fig.6). The distal part was the shorter part pass between the alar cartilage and mucous membrane of the nasal cavity to end by the nasolacrimal opening (external opening) (Fig.6). This finding similar to that of [9, 10, 25, 29, 34] in cattle, goat and horse show the nasolacrimal duct extended from the lacrimal sac into the vestibule in the wall of the nasal cavity and divided into three parts, while disagreement with [35] who showed the lacrimal drainage system in dog divided in four regions they consider the canaliculi and lacrimal sac as the first part of the nasolacrimal duct. But [13] showed the nasolacrimal duct divided into two parts inside and outside osseous canals. [21] showed in dog the nasolacrimal duct has two parts.

The mean total length of the right and left nasolacrimal duct in gazelle was 87.51 ± 3.260 mm and 89.173 ± 2.98 mm respectively (Table 2). This finding was in disagreement with [11] in sheep described the mean length of duct was 125.7mm, [13] in buffalo described the total length left and right nasolacrimal duct was about 232 mm and 235 mm, [17] in one-humped camel the mean length of nasolacrimal duct was 210-230 mm, [20] in camel reported the nasolacrimal duct has 200 mm long, while [34] in horse show the mean length of the nasolacrimal duct was

had 310 mm in length, [9] in cattle and goat described the mean total length of the right and left nasolacrimal duct in cattle was 185.3 ± 7.60 mm and 190.01 ± 5.73 mm, while in goat was 89.71 ± 3.260 mm and 91.953 ± 2.98 mm respectively. Also, the difference in the measurement was due to species.

In gazelle, the mean length of the right and left the proximal part, middle part and distal part were 24.168 ± 3.178 mm; 28.401 ± 2.18 ; 39.543 ± 1.915 mm; 37.546 ± 1.813 mm; 22.932 ± 1.69 mm and 21.973 ± 2.481 mm respectively (Table 2). These results were in disagreement with findings by [25] in Korean native goat described the mean length proximal, middle and distal parts of the nasolacrimal duct in Korean native goat were 36.84-40 mm, 23.53- 24.31 mm and 14.55-14.73 mm respectively. [33] who reported that in goat and sheep the nasolacrimal duct divided into two parts. The mean length of the right and left in goat and sheep of the proximal part (inside the osseous canal) and distal part (outside the osseous canal) were 25mm, 25mm, 49mm, 50mm, 37mm, 37mm, 62mm and 61mm respectively. [34] in horse show the mean length of first, second and third regions of the nasolacrimal duct of were 125mm, 100mm and 90mm respectively. [16] in camel showed the mean length of cranial, middle and caudal parts of nasolacrimal duct 40 mm, 140mm and 40 mm respectively. This variation may be due to different species of animals. [9] in cattle and goat showed in cattle, the mean length of the right and left the proximal part, middle part and distal part were 55.08 ± 4.096 mm; 52.807 ± 3.26 mm; 95.01 ± 2.122 mm; 94.03 ± 3.342 mm; 41.28 ± 3.208 mm and 45.44 ± 2.11 mm respectively. Whereas in goat the mean length of the right and left the proximal part, middle part and distal part were 26.178 ± 3.178 mm; 30.411 ± 2.18 ; 40.553 ± 1.915 mm; 38.556 ± 1.813 mm; 22.942 ± 1.69 mm and 22.983 ± 2.481 mm respectively. The

nasolacrimal orifice in gazelle was slit like in shape located on the ventral process of alar cartilage (the ventral fold of ventral nasal concha) (Fig. 6). Its mean vertical diameter of right and left were 2.8123 ± 0.225 mm and 2.866 ± 0.097 mm respectively. The mean distance of nasolacrimal orifice from nostrils opening (external nasal opening) was right and left 13.162 ± 0.954 mm, 15.541 ± 2.339 mm respectively (Table 2). There were different between our results and the result of the other authors in different species usually related to the species, genus and age of animal [21] in dog, [16, 18, 20] in camel, [14] in buffalo, [33] in goat and sheep, [36] in mule, [11] in Lori sheep and [9] in cattle and goat.

Figure 1: Lateral view of the lacrimal puncta in gazelle show:

A- Dorsal punctum, B- Ventral punctum, C- Upper eyelid, D- Lower eyelid, E- Cornea of eyeball, F- Medial canthus, G- Lateral canthus.

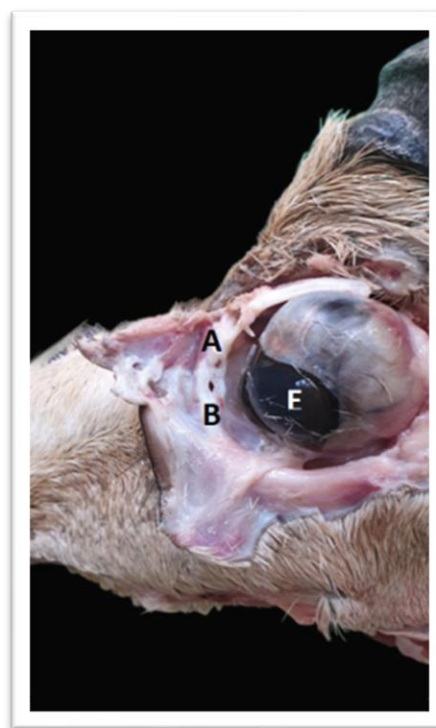


Figure 2: Dorsal view Course of right and left side of the lacrimal canaliculi, lacrimal sac and nasolacrimal duct in gazelle show:

A- Dorsal canaliculi, B- Ventral canaliculi, C- Lacrimal sac, D- Proximal of nasolacrimal duct, E- nasal concha

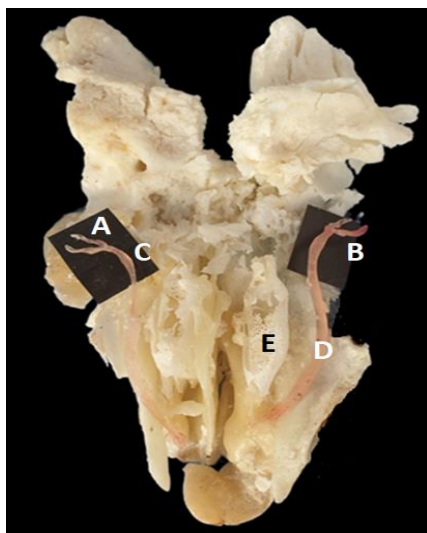


Figure 3: Medial view Course of right side of the lacrimal canaliculi, lacrimal sac and proximal part of nasolacrimal duct in gazelle show

A- Dorsal canaliculi, B- Ventral canaliculi, C- common lacrimal duct, D- Lacrimal sac, E- Proximal of nasolacrimal duct (osseous part), F. Dorsal concha

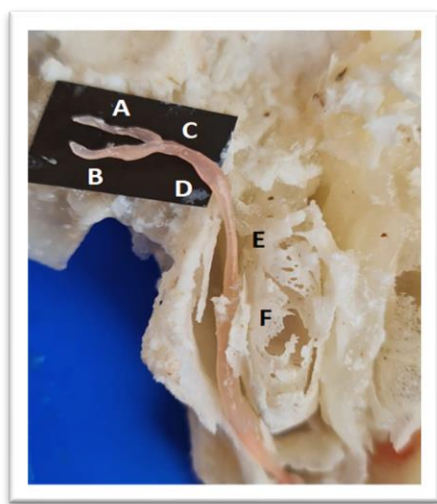


Fig.4: Medial view Course of right side of the lacrimal canaliculi, lacrimal sac and proximal part of nasolacrimal duct in gazelle show

A- Dorsal canaliculi. B- Ventral canaliculi. C- Lacrimal sac. D- Proximal of nasolacrimal duct, E. common lacrimal duct. F. middle part of nasolacrimal duct

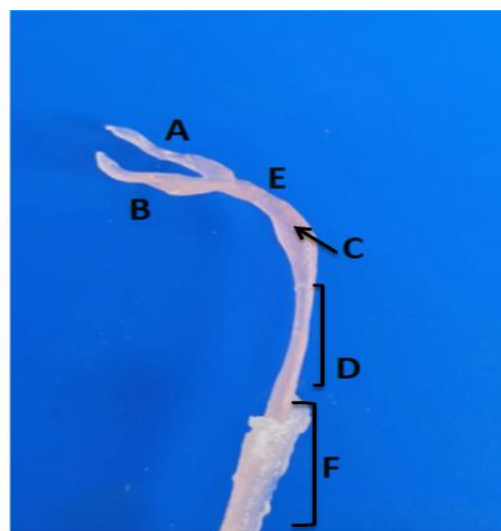


Fig. 5: Resin cast of nasolacrimal duct in gazelle shows

A- Lacrimal punctum, B- lacrimal canaliculi, C- common lacrimal duct, D- Proximal part of nasolacrimal duct, E- Middle part, F- distal part. G- mucus membran of the nasolacrimal duct

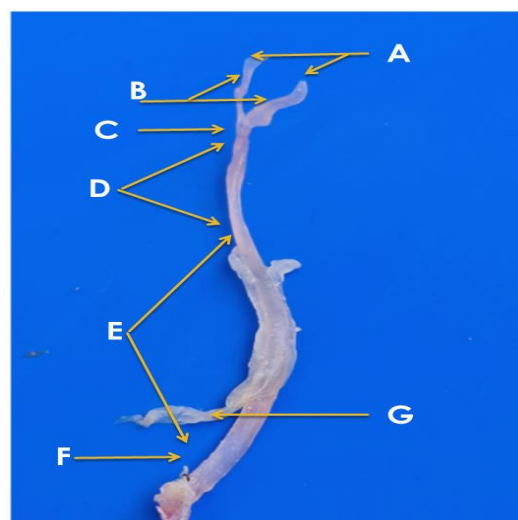


Fig. 6: medial view in the nasal cavity shows the nasolacrimal opening.

A- Nasolacrimal opening. B- Nasal septum, C- alar cartilage, D- distal part of nasolacrimal duct

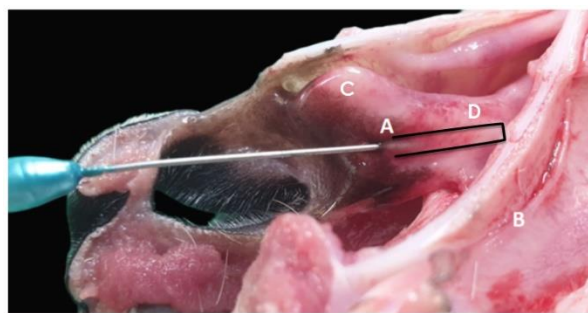


Table 1. Macroscopic parameters of lacrimal punctum, lacrimal canaliculi, common lacrimal duct, and lacrimal sac in gazelle (Mean $\pm$ SE, $P > 0.05$)

Parameter	Side	Value
Diameter of the dorsal punctum. mm	Right side	1.161 $\pm$ 0.071
	Left side	1.18 $\pm$ 0.1240
Diameter of ventral punctum. mm	Right side	1.17 $\pm$ 0.0720
	Left side	1.215 $\pm$ 0.103
Distance of dorsal punctum to the medial canthus. (mm)	Right side	3.981 $\pm$ 0.187
	Left side	4.096 $\pm$ 0.161
Distance of ventral punctum to the medial canthus. mm	Right side	4.073 $\pm$ 0.389
	Left side	4.128 $\pm$ 0.371
Length of dorsal lacrimal canaliculi. mm	Right side	9.555 $\pm$ 0.491
	Left side	9.361 $\pm$ 0.526
Length of ventral lacrimal canaliculi. mm	Right side	12.045 $\pm$ 0.448
	Left side	12.48 $\pm$ 0.935
Length of the common lacrimal duct mm	Right side	9.677 $\pm$ 1.446
	Left side	10.645 $\pm$ 1.809
Length of the lacrimal sac. mm	Right side	15.677 $\pm$ 1.436
	Left side	16.645 $\pm$ 1.909

Table 2: Macroscopic parameters of the nasolacrimal duct in gazelle (Mean $\pm$ SE, $P > 0.05$).

Parameter	Side	Value
Length of the nasolacrimal duct. mm	Right side	87.51 $\pm$ 3.260
	Left side	89.173 $\pm$ 2.98
Length of the proximal part (ossios)of the nasolacrimal duct. Mm	Right side	24.168 $\pm$ 3.178
	Left side	28.401 $\pm$ 2.18
Length of the middle part of the nasolacrimal duct. mm	Right side	39.543 $\pm$ 1.915
	Left side	37.546 $\pm$ 1.813
Length of the distal part of the nasolacrimal duct. mm	Right side	22.932 $\pm$ 1.69
	Left side	21.973 $\pm$ 2.481
Diameter of external nasolacrimal opening. mm	Right side	2.8123 $\pm$ 0.225
	Left side	2.866 $\pm$ 0.097
Distance of external nasolacrimal opening from nostrils. mm	Right side	13.162 $\pm$ 0.954
	Left side	15.541 $\pm$ 2.339

Conclusion

The lacrimal glands in the gazelle are similar to many species in some morphometrical and morphological characters and differ with many animals in the same characters 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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