

# Morphological and histological study of superior lacrimal gland of third eyelid in camel (*Camelus dromedarius*)

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## Summary

In this study ten pairs of superior gland of third eyelid of 10 adult male camels free of apparent ocular disease were examined to compare the normal anatomical and histological properties of these glands. After dissecting, all of the glands were characterized and measured (length and width) on both the left and right side. In the camels, the superior gland of the third eyelid was oval shaped and irregular in outline. The gland was located within the orbit on the medial aspect of the eyeball in animals that possess a nictitating membrane. Posterior surface of the gland was convex and attached to the nictitating membrane. The anterior surface that is contacted with the bulb of the eye was concave. The mean length of the superior gland of the third eyelid was  $28.7 \pm 2.7$  mm and  $27.2 \pm 2.4$  mm in the left and right side, respectively in the anterior-posterior direction. The mean width was  $17.4 \pm 0.8$  mm and  $16.1 \pm 0.9$  mm on the left and right side, respectively in the superior-inferior dimension. There was significant difference between the width of the left and right superior gland of the third eyelid. The mean width of the left superior gland was greater than the right ( $P < 0.05$ ). The histology of the gland revealed secretory units of tubuloacinar and serous with scattered alveolar units. Secretory cells had the typical appearance of serous cells. Tubuloacinar units completely surrounded the hyaline cartilage of the third eyelid. The Masson Trichrome stained connective tissue septae surround the individual acinus and tubules in camel superior gland. Larger sheets of connective tissue with inter and intralobular ducts as well as veins and arteriols were found and separated the gland into lobules.

**Key words:** Morphology, Camel, Lacrimal gland, Histology, Third eyelid

## Introduction

Lacrimal glands of mammals synthesize and secrete an aqueous solution in which different chemical substances are present, i.e. protein and mucosubstances. The glands are responsible for the production of tear fluid that helps to maintain corneal health. The tear film consists of a superficial oily layer, a central aqueous layer and thin glycoprotein layer covering the cornea. The superficial oily layer is produced by the tarsal glands and provides lubrication, prevents overflow of tears from the lid margin and retards evaporation of the underlying aqueous layer. The aqueous layer is the major component of the tear film and is produced by the lacrimal gland and the

gland of the third eyelid. It moistens and nourishes the cornea. The innermost layer is produced by the goblet cells of the conjunctival epithelium and assists in adherence of the precorneal film to the corneal surface. In most species, the majority of tears are secreted from the dorsal lacrimal gland.

In general, the lacrimal glands are tubuloacinar structures that produce serous or mucoserous secretions. In literature, the morphology of dorsal lacrimal glands of cattle, dogs, cats, horses, pigs, rabbits, sheep and guinea pigs has been described (Gillette *et al.*, 1980; Martin *et al.*, 1988; Gargiulo *et al.*, 2000; Schlegel *et al.*, 2001). There is, however, no information about the morphology and histology of the superior

gland of the third eyelid in camel in literature. The main purpose of the present study is to describe and compare normal anatomical and histological findings of left and right superior glands of the third eyelid in camels.

## Materials and Methods

The lacrimal glands of 10 adult male one humped camels destined for slaughter were removed 1 h after death. Post-mortem examination of the eyes and adnexa revealed no apparent ocular disease. Length and width to the nearest millimeter were recorded for each gland and mean values were established for each group of glands. Student's t-test was conducted to compare the length and width of lacrimal glands. Histological analysis was performed on randomly selected samples collected from five camels. Fixation with 10% buffered formalin for 24-48 h was performed prior to processing. Each gland was sectioned in a sagittal plane and paraffin-embedded. Sections (5  $\mu$ m) were stained with hematoxylin and eosin and Masson Trichrome methods and examined by light microscopy for histological description.

## Results

In one humped camel, the third eyelid is situated at the medial angle of the eye and moves over the medial portion of the bulb of the eye quite freely. It consists of a semilunar fold of the conjunctiva which covers an underlying irregular rod shaped cartilage. The thick portion of the cartilage is nearest the free edge of the third eyelid, and the thin part of the cartilage projects ventromedially. The cartilage, particularly the deep part, is embedded in the superior gland and fat at the medial side of the eyeball. The superior gland of the third eyelid was an oval shape with a convex surface that contact the third eyelid and the concave surface which is attached to the bulbar eye (Figs. 1 and 2). The mean length of the superior gland of the third eyelid was  $28.7 \pm 2.7$  mm and  $27.2 \pm 2.4$  mm on the left and right side, respectively in the anterior-posterior direction. The mean width was  $17.4 \pm 0.8$  mm and  $16.1 \pm 0.9$  mm on the left

and right side, respectively, in the superior-inferior dimension (Table 1). There was a significant difference between the width of the left and right dorsal lacrimal glands. The mean width of the left superior gland was greater than the right and the difference was significant ( $P < 0.05$ ).

**Table 1: Statistical analysis of dimensions of superior lacrimal gland of third eyelid in one humped camel**

Parameter (mm)	Side	
	Left (Mean $\pm$ SD)	Right (Mean $\pm$ SD)
Length	$28.7 \pm 2.7$	$27.2 \pm 2.4$
Width	$17.4 \pm 0.8^*$	$16.1 \pm 0.9$

\*Significant with  $P < 0.05$

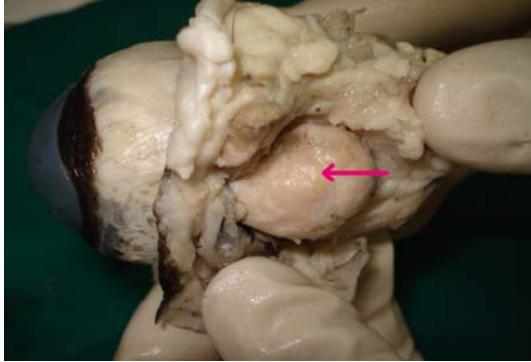
Histological examination of the superior gland of the third eyelid revealed compound tubuloacinar serous units that completely surrounded the hyaline cartilage shaft of the third eyelid. Also, dispersed alveolar units were seen. The acini were composed of a tall pyramidal or columnar cell with small lumen. The alveolar units were seen intermingled between the nests of acini and composed cuboidal epithelium. The gland was surrounded in the hyaline cartilage. The units were separated by dense sheets of connective tissue into lobules (Figs. 3 and 4). Within a lobule, single sheets of connective tissue separated tubuloacinar and alveolar units from each other. In the camels, tubuloacinar units completely surrounded the cartilage shaft of the third eyelid. In general, these tubuloacinar units were less compacted compared with the dorsal lacrimal gland (Mohammadpour, 2008).

The Masson Trichrome stained connective tissue septae surround individual acinus and tubules in camel superior gland. Larger sheets of connective tissue were found and separated the gland into lobules. In these large sheets of connective tissue, inter and intralobular ducts, as well as veins and arterioles were seen (Fig. 5). Goblet cells were present in the interlobular excretory ducts (Fig. 6).

## Discussion

The superior gland of the third eyelid in

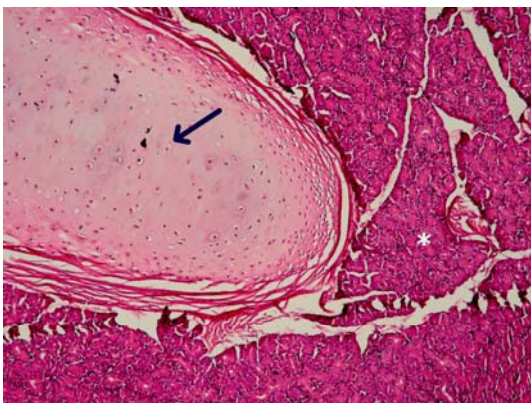
camels is oval shaped and composed of tubuloacinar serous units. In comparison with other animals, the histology and shape were different. In bovine, the superior gland of the third eyelid is arranged in a round lobular portion and a flattened portion that seems to cover the palpebral surface of the



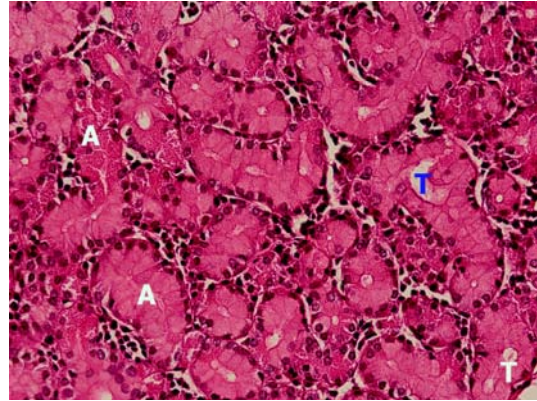
**Fig. 1:** Lateral view of camel eye. The exact location of superior gland of third eyelid in one humped camel (Arrow)



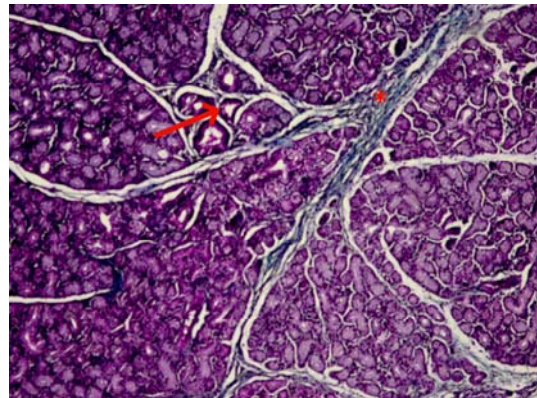
**Fig. 2:** Superior gland of third eyelid in one humped camel in convex surface



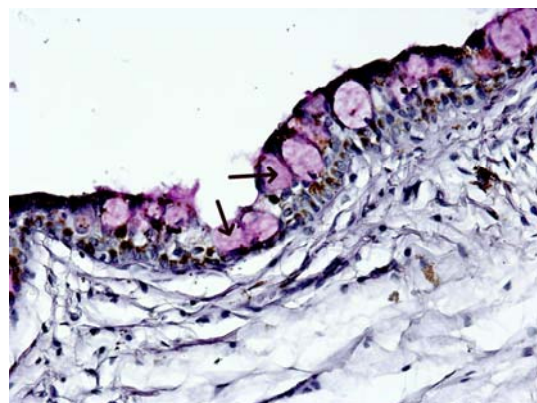
**Fig. 3:** The camel superior gland of third eyelid composed of tubuloacinar units (\*) that surrounded the hyaline cartilage (Arrow, H&E,  $\times 64$ )



**Fig. 4:** The camel superior gland of third eyelid has tubuloacinar serous units that are loosely arranged throughout the gland. The acinar cells (A) have granulated cytoplasm and these cells are pyramidal in shape. The tubules have empty lumen (T), (H&E,  $\times 160$ )



**Fig. 5:** Masson Trichrome staining of the camel superior gland of third eyelid. Sheets of connective tissue (\*) separated the glands into lobules as shown here, interlobular ducts (Arrow) with clear lumen located in these sheets ( $\times 64$ )



**Fig. 6:** The interlobular duct. As shown here, the epithelium of duct is stratified with goblet cell (Arrow, Periodic acid Schiff,  $\times 640$ )

cartilage shaft (Getty, 1975). The rounded portion of the gland is mostly serous, while the flattened portion of the gland appears to be mixed. The deep glandular tissue on the bulbar side of the cartilage is variable in size and consists of an anterior portion which is attached to the gland of the third eyelid and appears to be serous. The posterior part of the gland tissue on the bulbar side of the cartilage appears on histological examination to be mucous in nature (Getty, 1975).

In sheep, the superior gland of the third eyelid is found on the palpebral surface of the cartilage of the third eyelid. This gland surrounds the stem of the hyaline cartilage that is found in the lid. It measures 22 mm in height, 14 mm in width and its maximum thickness is 4.5 mm. The deeper gland that is found on the bulbar side of the cartilage of the third eyelid in some mammals (Harderian gland) is absent in sheep (Getty, 1975).

In animals, the third eyelid is supported by a T-shaped piece of cartilage which consists of elastic cartilage in the horse, pig and the cat and of hyaline cartilage in the dog and ruminants. The base of the cartilage is surrounded by the superficial gland of the third eyelid. It is a mixed seromucous gland in the ox, sheep and dog, serous in the cat and horse and mucous in the pig. It contributes considerably to the production of the precorneal tearfilm (Konig and Liebich, 2004).

The cartilage of the nictitating membrane is a hyaline cartilage. The glandular tissue is a tubuloalveolar mixed gland. The gland is divided into lobules by septa that contain blood vessels, nerves, ducts and some adipose tissue. The mucous acini of the gland are located at the periphery of the lobule of the gland (Getty, 1975).

In one humped camel, the cartilage of the third eyelid was hyaline type. In literature, in dog, cow and small ruminants the cartilage consists of hyaline quality and only in the neighbouring connective tissue are some elastic fibers detectable. Moreover, there are significant differences with regard to the quality of the cartilage, especially concerning the presence and distribution of elastic fibers (Schlegel *et al.*, 2001).

In many species of mammals of varying body size, the form, dimensions and structure of the cartilage of the third eyelid were studied. The cartilage was thin lamina concave in its corneal side, usually elongated in the oral-aboral direction. In most species studied the outline of the cartilage may be inscribed in a triangle with an oral base, a dorsal margin, a ventral margin and an aboral apex. A study of stained sections revealed the presence of elastic fibers in the aboral part of the cartilage in more than half of the species; these fibers are particularly numerous, but non uniformly distributed, in the Equidae, lion and Suidae (Barasa, 2003).

There are some reports on the effect of ageing on the lacrimal system in humans (Draper *et al.*, 1999) and rat (Bromberg and Welch, 1985; Draper *et al.*, 1998). To examine the effects of ageing on the lacrimal system in camel, a longitudinal study is required which is beyond the scope of the present study.

It is well known that the main function of the mammalian lacrimal fluid is to clean and moisten the anterior part of the eyeball and the nasal mucosa. The latter function is not possible in the camel because of the absence of the puncta lacrimalia (Abdalla *et al.*, 1970). Therefore, the main function of the lacrimal fluid in the camel is confined to the washing and moistening of the anterior part of the eyeball. This is an important function to an animal like the camel which inhabits dry, hot and sandy land with numerous sand storms.

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## References

- Abdalla, O; Fahmy, MFA and Arnautovic, I (1970). Anatomical study of the lacrimal apparatus of the one-humped camel. *Acta Anat.*, 75: 638-650.
- Barasa, A (2003). Morphology and structure of

- the nictitating membrane cartilage in mammals. *Morphologie*, 87: 5-12.
- Bromberg, BB and Welch, MH (1985). Lacrimal protein secretion: comparison of young and old rats. *Exp. Eye Res.*, 40: 313-320.
- Draper, CE; Adeghate, EA; Lawrence, PA; Pallot, DJ; Garner, A and Singh, J (1998). Age-relates changes in morphology and secretory responses of male rat lacrimal gland. *J. Aut. Nerv. Syst.*, 69: 173-183.
- Draper, CE; Adeghate, EA; Singh, J and Pallot, DJ (1999). Evidence to suggest morphological and physiological alterations of lacrimal acini with ageing. *Exp. Eye Res.*, 68: 265-276.
- Gargiulo, AM; Dall'Aglio, C; Coliolo, P; Ceccarelli, P and Pedini, V (2000). Complex carbohydrate histochemistry and ultracytochemistry of the sheep lacrimal gland. *Anat. Histol. Embryol.*, 29: 19-23.
- Getty, R (1975). *Sisson and Grossman's the anatomy of the domestic animals*. 5th Edn., Vol. 1, Philadelphia, W. B. Saunders Co., PP: 1024-1063.
- Gillette, TE; Allansmith, MR; Greiner, JV and Janusz, M (1980). Histologic and immunohistologic comparison of main and accessory lacrimal tissue. *Am. J. Ophthalmol.*, 89: 724-730.
- Konig, HE and Liebich, HG (2004). *Veterinary anatomy of domestic animals: textbook and color atlas*. 1st Edn., Stuttgart, Germany, Schattauer Co., PP: 547-567.
- Martin, CL; Munnell, J and Kaswan, R (1988). Normal ultrastructure and histochemical characteristics of canine lacrimal glands. *Am. J. Vet. Res.*, 49: 1566-1572.
- Mohammadpour, AA (2008). Anatomical characteristics of dorsal lacrimal gland in one humped camel (*Camelus dromedarius*). *J. Biol. Sci.*, 8: 1104-1106.
- Schlegel, T; Brehm, H and Amselgruber, WM (2001). The cartilage of the third eyelid: a comparative macroscopical and histological study in domestic animals. *Ann. Anat.*, 183: 165-169.